References
to
Written Representations

for the
Royal Society for the Protection of Birds

Submitted for Deadline 1
18 November 2025

Planning Act 2008

In the matter of:

Application by National Grid Electricity Transmission (NGET) for an order granting development consent for

The South East Anglia Link (Sea Link) Project

Planning Registration Ref: EN020026
RSPB Registration Identification Ref: F5280E651

South East Anglia Link (Sea Link) Project
Deadline 1: References to RSPB Written Submission

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EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Areas

Alde-Ore Estuary (Suffolk)

The Alde-Ore Estuary proposed Special Protection Area (pSPA) is situated on the east coast of Suffolk between Aldeburgh in the north and Bawdsey in the south. The site comprises the estuary complex of the rivers Alde, Butley and Ore, including Havergate Island and Orfordness. The variety of habitats important for breeding and wintering birds includes vegetated shingle, intertidal mudflats, semi-improved grazing marsh, saltmarsh and saline lagoons.

The site includes the entire Alde-Ore Estuary SSSI, notified in 1985 (revised in 1992 under the Wildlife and Countryside Act, 1981). The Alde-Ore Estuary SSSI includes the Orfordness-Havergate NNR, the English Nature owned part of which has already been designated as Orfordness-Havergate SPA.

The site qualifies under Article 4.1 of the EC Birds Directive by sustaining nationally important numbers of the following Annex 1 species, marsh harrier *Circus aeruginosus* (breeding), avocet *Recurvirostra avosetta* (wintering and breeding) ruff *Philomachus pugnax* (wintering), sandwich tern *Sterna sandvicensis* (breeding) and little tern *Sterna albifrons* (breeding). Further Annex 1 species winter on site, including, bittern *Botaurus stellaris*, Bewick's Swan *Cygnus columbianus*, hen harrier *Circus cyaneus*, golden plover *Pluvialis apricaria*, and short-eared owl *Asio flammeus*. Mediterranean gull *Larus melanocephalus*, common tern *Sterna hirundo* and Arctic tern *Sterna paradisaea* breed on Havergate Island.

The site qualifies under Article 4.2 of the Directive by regularly supporting internationally important numbers of two migratory species. The Orfordness colony of breeding lesser black-backed gull *Larus fuscus graellsii*, represented in 1995, 12% of the British population and 8% of the world population of the *graellsii* race. The five year wintering peak mean 1989/90 to 1993/94 for redshank *Tringa totanus*, was 1,662 birds, representing 1.5 % of the British population and 1.1% of the east Atlantic flyway population.

The site supports over 1% of the British wintering population of the following (calculated from five year winter peak means 1989/90 to 1993/94), shelduck *Tadorna tadorna*, wigeon *Anas penelope*, teal *Anas crecca*, black-tailed godwit *Limosa limosa*. In addition, the site supports over 1% of the British breeding population of, Gadwall *Anas strepera*, shoveler *Anas clypeata* and herring gull *Larus argentatus*.

The site also supports a notable assemblage of breeding and wintering wetland birds, in addition to the species mentioned above. Breeding species include, oystercatcher *Haematopus ostralegus*, ringed plover *Charadrius hiaticula*, lapwing *Vanellus vanellus* (also winter) black headed gull *Larus ridibundus* and barn owl *Tyto alba*. Wintering species include, cormorant *Phalacrocorax carbo*, European white-fronted goose *Anser abifrons albifrons*, brent goose *Branta bernicla*, pintail *Anas acuta*, grey plover *Pluvialis squatarola*, dunlin *Calidris alpina* and curlew *Numenius arquata*.

[redacted]

on behalf of the Secretary of State for the Environment

SPA Citation
January 1996

Alde-Ore Estuary SPA

Last updated: 5 October 2023

Supplementary advice

The Supplementary Advice on Conservation Objectives (SACOs) present attributes which are ecological characteristics or requirements of the classified species within a site. The listed attributes are considered to be those which best describe the site's ecological integrity and which if safeguarded will enable achievement of the Conservation Objectives.

Conservation Objectives relating to extent and distribution of habitat and population abundance are reflected in single attributes within the Supplementary Advice. Structure and function of habitats, and supporting processes for those habitats, are reflected in multiple attributes describing integrity of these ecological characteristics.

The Conservation Objective relating to the distribution of qualifying features (individual species or assemblages) may apply to most or all of the attributes listed in the SACOs and should be considered against them. Ensuring integrity of attributes relating to supporting habitats and processes should allow birds to distribute themselves optimally within (and, sometimes, outside) the SPA boundary. This is perhaps particularly relevant for food availability; extent and distribution of supporting habitat; quality of supporting habitat; predation; and disturbance caused by human activity.

Attributes have a target which is either quantified or qualified depending on the available evidence. The target identifies as far as possible the desired state to be achieved for the attribute. In many cases, the attribute targets show if the current objective is to either 'maintain' or 'restore' the attribute. The targets given for each attribute do not represent thresholds to assess the significance of any given impact in Habitats Regulation Assessments. You will need to assess this on a case-by-case basis using the most current information available.

Where there is no evidence to determine a marine feature's condition, a vulnerability assessment, which includes sensitivity and exposure information for features and activities in a site, has been used as a proxy for condition. Evidence used in preparing the SACO has been cited with hyperlinks included where possible. Where references have not been provided, Natural England has applied ecological knowledge and expert judgement.

Some, but not all, of these attributes can also be used for regular monitoring of the condition of the classified features. The attributes selected for monitoring the features, and the standards used to assess their condition, are listed in separate monitoring documents, which will be available from Natural England. As condition assessment information becomes available, the conservation advice package will be reviewed accordingly.

When to use

You should use this information, along with the conservation objectives and case-specific advice issued by Natural England when developing, proposing or assessing an activity, plan or project that may affect the site.

Any proposals or operations which may affect the site or its features should be designed so they do not adversely affect any of the attributes in the SACO or achievement of the conservation objectives.

Features:
Choose one or more features and/or their sub-features below by selecting the applicable boxes in the tree. This will show the relevant targets. Where a feature has sub-features this will be indicated with a greyed out triangle below, which can be expanded.

- [x] Avocet (Recurvirostra avosetta), Breeding
- [x] Avocet (Recurvirostra avosetta), Non-breeding
- [ ] Lesser black-backed gull (Larus fuscus), Breeding
- [ ] Little tern (Sternula albifrons), Breeding
- [x] Marsh harrier (Circus aeruginosus), Breeding
- [x] Redshank (Tringa totanus), Non-breeding
- [x] Ruff (Calidris pugnax), Non-breeding
- [ ] Sandwich tern (Thalasseus sandvicensis), Breeding

Reset | Select all | Show attributes and targets for selected features

Attributes:
You can filter to show only targets for certain attributes by selecting one or more attributes from the list below (use ctrl click to select multiple). Note that only attributes for the features you have chosen are shown.

Breeding population: abundance
Connectivity with supporting habitats
Disturbance caused by human activity
Non-breeding population: abundance
Predation - all habitats
Productivity

Feature target

'Maintain' targets do not preclude the need for management, now or in the future, to avoid a significant risk of damage or deterioration to the feature. The supporting and/or explanatory notes in the SACOs set out why the target was chosen and any relevant site based supporting information. This is based on the best available information, including that gathered during monitoring of the feature's current condition.

Feature target

'Maintain' targets do not preclude the need for management, now or in the future, to avoid a significant risk of damage or deterioration to the feature. The supporting and/or explanatory notes in the SACOs set out why the target was chosen and any relevant site based supporting information. This is based on the best available information, including that gathered during monitoring of the feature's current condition.

Feature/ Subfeature name	Attribute	Target	Season	Supporting notes
Marsh harrier (*Circus aeruginosus*), Breeding	Breeding population: abundance	Maintain the size of the breeding population at a level to be agreed* whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: *In the absence of an abundance value from the SPA citation, for information, the JNCC standard data form states there were 3 pairs of breeding marsh harrier (Joint Nature Conservation Committee (JNCC), 2006). Natural England will consider this value as one option to inform the numerical target in due course. Please contact your local NE adviser for further information. The SSSI site assessment, completed in 2013, recorded two breeding pairs on Orford Ness Lantern Marshes and one breeding pair on Hazlewood Marshes (Natural England (NE), 2013). (Joint Nature Conservation Committee (JNCC), 2011) There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Breeding population: abundance	Restore the size of the breeding population at a level to be agreed* whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of

				error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: *In the absence of an abundance value from the SPA citation, for information, the JNCC standard data form states there were 104 pairs of breeding avocet (Joint Nature Conservation Committee (JNCC), 2006) Natural England will consider this value as one option to inform the numerical target in due course. Please contact your local NE adviser for further information. The 5 year peak mean (2009-2013) was 46 breeding pairs (Natural England (NE), 2013) (nesting at Havergate Island and Orford Ness including new habitat created in the Airfield (Warrington et al., 2014)). There is evidence from survey or monitoring that shows the feature to be negatively impacted.
Marsh harrier (*Circus aeruginosus*), Breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting, roosting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting, roosting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between roosting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from feeding and roosting areas is critical to adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between roosting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from feeding and roosting areas is critical to adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between roosting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from feeding and roosting areas is critical to adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary

				where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Burton et al., 2002);(Kirby et al., 2004) Site-specifics: Disturbance to birds in the site can be caused by people accessing the site by boats or through walking overland. Trampling can affect vegetated shingle habitats and aircraft, such as paramotors, helicopters and planes can cause disturbance to birds when flown low over the site. An investigation into public access/disturbance at the site will help inform a plan to raise awareness of disturbance and help reduce it (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Ruff (*Calidris pugnax*), Non-breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) Site-specifics: Disturbance to birds in the site can be caused by people accessing the site by boats or through walking overland. Trampling can affect vegetated shingle habitats and aircraft, such as paramotors, helicopters and planes can cause disturbance to birds when flown low over the site. An investigation into public access/disturbance at the site will help inform a plan to raise awareness of disturbance and help reduce it (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Non-breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts.

				Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Holm and Laursen, 2009) Site-specifics: Disturbance to birds in the site can be caused by people accessing the site by boats or through walking overland. Trampling can affect vegetated shingle habitats and aircraft, such as paramotors, helicopters and planes can cause disturbance to birds when flown low over the site. An investigation into public access/disturbance at the site will help inform a plan to raise awareness of disturbance and help reduce it (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Holm and Laursen, 2009) Site-specifics: Disturbance to birds in the site can be caused by people accessing the site by boats or through walking overland. Trampling can affect vegetated shingle habitats and aircraft, such as paramotors, helicopters and planes can cause disturbance to birds when flown low over the site. An investigation into public access/disturbance at the site will help inform a plan to raise awareness of disturbance and help reduce it (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures.

				'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) Site-specifics: Disturbance to birds in the site can be caused by people accessing the site by boats or through walking overland. Trampling can affect vegetated shingle habitats and aircraft, such as paramotors, helicopters and planes can cause disturbance to birds when flown low over the site. An investigation into public access/disturbance at the site will help inform a plan to raise awareness of disturbance and help reduce it (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Redshank (*Tringa totanus*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is above 1,662 whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: The Alde-Ore Estuary SPA citation document states that there were 1,662 non-breeding redshank (1989/90 – 1993/94) (Natural England (NE), 2014). The JNCC standard data form states there were 1,919 non-breeding redshank (5 year mean peak 1991/92-1995/96) (Joint Nature Conservation Committee (JNCC), 2006). The latest 5 year peak mean (2015/16 - 2019/20) is 2,187 showing an increase in the non-breeding redshank population at the site since classification (Frost et al., 2021). There are currently no BTO Wetland Bird Survey (WeBS) Alerts triggered for non-breeding redshank on the Alde-Ore Estuary SPA. WeBS Alerts results for this site show a 24% positive long term change since the winter of 1991/92. (Woodward et al., 2019). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is above 13 whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where

				there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: There is no abundance value stated for non-breeding ruff in the SPA citation document. The citation does give an abundance figure for redshank for the years 1989/90-1993/94, and so this indicates the time period of data used in the citation (Natural England (NE), 2014). Using BTO Wetland Bird Survey (WeBS) data from this same time period gives a 5 year peak mean of 13 non-breeding ruff (1989/90- 1993/94) and has been used to set a quantified target. The JNCC standard data form states there were 3 non-breeding ruff (5 year mean peak 1991/92-1995/96) (Joint Nature Conservation Committee (JNCC), 2006). The latest 5 year peak mean (2015/16 - 2019/20) is 5 (Frost et al., 2021). However there are currently no WeBS Alerts triggered for non-breeding ruff on the Alde-Ore Estuary SPA. WeBS Alerts results for this site show a 276% positive long term change since the winter of 1991/92, resulting in a maintain target. In the medium term (10 years) there has been a -17% change, and a 43% change in the short term (5 years) demonstrating how ruff population has also fluctuated at this site over time. The population trend of ruff at the Alde Ore Estuary SPA seems to track that of the Anglian region as well as Great Britain (Woodward et al., 2019). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is above 824 whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: There is no abundance value stated for non-breeding avocet in the SPA citation document. The citation does give an abundance figure for redshank for the years 1989/90-1993/94, and so this indicates the time period of data used in the citation (Natural England (NE), 2014). Using BTO Wetland Bird Survey (WeBS) data from this same time period gives a 5 year peak mean of 824 non-breeding avocet (1989/90 – 1993/94) (Frost et al., 2021) and has been used to set a quantified target. The JNCC standard data form states there were 766 non-breeding avocet (5 year mean peak 1991/92-1995/96) (Joint Nature Conservation Committee (JNCC), 2006). The latest 5 year peak mean (2015/16 - 2019/20) is 1,378 showing an increase in non-breeding avocet population at the site since classification (Frost et al., 2021). There are currently no WeBS Alerts triggered for non-breeding avocet on the Alde-Ore Estuary SPA. WeBS Alerts results for this site show a 61% positive long term change since the winter of 1991/92. (Woodward et al., 2019). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

Marsh harrier (*Circus aeruginosus*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators.	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators.	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Avocet (*Recurvirostra avosetta*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Redshank (*Tringa totanus*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility.

				(Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Ruff (*Calidris pugnax*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Marsh harrier (*Circus aeruginosus*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Avocet (*Recurvirostra avosetta*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Avocet (*Recurvirostra avosetta*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site	Year round – to ensure the habitat remains suitable	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats.

		on the Air Pollution Information System	for when the feature is present	Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: Target set as maintain based on the current information on the Air Pollution Information System (APIS) as of 26/02/2016. Please refer to the website (www.apis.ac.uk) for further information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: Target set as maintain based on the current information on the Air Pollution Information System (APIS) as of 26/02/2016. Please refer to the website (www.apis.ac.uk) for further information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: Target set as maintain based on the current information on the Air Pollution Information System (APIS) as of 26/02/2016. Please refer to the website (www.apis.ac.uk) for further information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: Target set as maintain based on the current information on the Air Pollution Information System (APIS) as of 26/02/2016. Please refer to the website (www.apis.ac.uk) for further information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: Target set as maintain based on the current information on the Air Pollution Information System (APIS) as of 26/02/2016. Please refer to the website (www.apis.ac.uk) for futher information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: A considerable part of the site is sympathetically managed by the Suffolk Wildlife Trust, National Trust, RSPB and Natural England (Joint Nature Conservation Committee (JNCC), 2011). Threats to supporting habitats posed by sea level rise and coastal squeeze are being addressed through the Environment Agency Local Environment Action Plan and the estuary Management Plan (Joint Nature Conservation Committee (JNCC), 2011). The issues associated with fox predation/disturbance are being assessed and will inform a predator control management plan (as part of the National Nature Reserve Management Plan) (Natural England (NE), 2014). Wildfowling on the site is managed through the Alde Ore Wildfowling Association Management Plan and Natural England consents. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: A considerable part of the site is sympathetically managed by the Suffolk Wildlife Trust, National Trust, RSPB and Natural England (Joint Nature Conservation Committee (JNCC), 2011). Threats to supporting habitats posed by sea level rise and coastal squeeze are being addressed through the Environment Agency Local Environment Action Plan and the estuary Management Plan (Joint Nature Conservation Committee (JNCC), 2011). The issues associated with fox predation/disturbance are being assessed and will inform a predator control management plan (as part of the National Nature Reserve Management Plan) (Natural England (NE), 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: A considerable part of the site is sympathetically managed by the Suffolk Wildlife Trust, National Trust, RSPB and Natural England (Joint Nature Conservation Committee (JNCC), 2011). Threats to supporting habitats posed by sea level rise and coastal squeeze are being addressed through the Environment Agency Local Environment Action Plan and the estuary Management Plan (Joint Nature Conservation Committee (JNCC), 2011). The issues associated with fox predation/disturbance are being assessed and will inform a predator control management plan (as part of the National Nature Reserve Management Plan) (Natural England (NE), 2014). Wildfowling on the site is managed through the Alde Ore Wildfowling Association Management Plan and Natural England consents. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: A considerable part of the site is sympathetically managed by the Suffolk Wildlife Trust, National Trust, RSPB and Natural England (Joint Nature Conservation Committee (JNCC), 2011). Threats to supporting habitats posed by sea level rise and coastal squeeze are being addressed through the Environment Agency Local Environment Action Plan and the estuary Management Plan (Joint Nature Conservation Committee (JNCC), 2011). The issues associated with fox predation/disturbance are being assessed and will inform a predator control management plan (as part of the National Nature Reserve Management Plan) (Natural England (NE), 2014). Wildfowling on the site is managed through the Alde Ore Wildfowling Association Management Plan and Natural England consents. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: conservation measures	Restore the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics:

		measures are not being undermined or compromised.		A considerable part of the site is sympathetically managed by the Suffolk Wildlife Trust, National Trust, RSPB and Natural England (Joint Nature Conservation Committee (JNCC), 2011). Threats to supporting habitats posed by sea level rise and coastal squeeze are being addressed through the Environment Agency Local Environment Action Plan and the estuary Management Plan (Joint Nature Conservation Committee (JNCC), 2011). The issues associated with fox predation/disturbance are being assessed and will inform a predator control management plan (as part of the National Nature Reserve Management Plan) (Natural England (NE), 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) . Please see site specific supporting notes for extent details.	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: This target may apply to supporting habitat which lies outside the site boundary. Birds will not be roosting on habitat regularly flooded by the tide but they will be found in intertidal habitats above the Mean High Water Mark (which may not have been mapped). Where information exists, the area of the supporting habitats is currently understood to be; • Intertidal mixed sediments (21.9 ha) • Intertidal mud (537.8 ha) • Intertidal sand and muddy sand (1.5 ha) Additional supporting habitats used by redshank in this site include; • Coastal lagoons (5.7 ha) • Freshwater and coastal grazing marsh (150.7 ha) • Intertidal biogenic reef: mussel beds (unknown extent) • Intertidal coarse sediment (unknown) • Intertidal rock (unknown) • Saltmarsh (298.7 ha), which is not feature-specific but an aggregation of the following features: • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • *Salicornia* and other annuals colonising mud and sand • *Spartina* swards (*Spartinion maritimae*) (Fermor and Docker, 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding). Please see site specific supporting notes for extent details.	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: This target may apply to supporting habitat which lies outside the site boundary. Birds will not be roosting on habitat regularly flooded by the tide but they will be found in intertidal habitats above the Mean High Water Mark (which may not have been mapped). The area of the supporting habitats is currently understood to be; • Intertidal mixed sediments (21.9 ha) • Intertidal mud (537.8 ha) • Intertidal sand and muddy sand (1.5 ha) Additional supporting habitats used by ruff in this site include; • Coastal lagoons (5.7 ha) • Freshwater and coastal grazing marsh (150.7 ha) • Intertidal coarse sediment (unknown) • Intertidal rock (unknown) • Saltmarsh (298.7 ha), which is not feature-specific but an aggregation of the following features:

				• Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • *Salicornia* and other annuals colonising mud and sand • *Spartina* swards (*Spartinion maritimae*) (Fermor and Docker, 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding). Please see site specific supporting notes for extent details.	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The area of the supporting habitats is currently understood to be; • Intertidal mixed sediments (21.9 ha) • Intertidal mud (537.8 ha) • Intertidal sand and muddy sand (1.5 ha) This target may apply to supporting habitat which lies outside the site boundary. Birds will not be roosting on habitat regularly flooded by the tide but they will be found in intertidal habitats above the Mean High Water Mark (which may not have been mapped). Additional supporting habitats used by avocet in this site include; • Coastal lagoons (5.7 ha) • Freshwater and coastal grazing marsh (150.7 ha) • Intertidal coarse sediment (unknown) • Intertidal rock (unknown) • Water column (unknown) • Saltmarsh (298.7 ha), which is not feature-specific but an aggregation of the following features: • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • *Salicornia* and other annuals colonising mud and sand • *Spartina* swards (*Spartinion maritimae*) (Fermor and Docker, 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). Please see site specific supporting notes for extent details.	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The area of the supporting habitats is currently understood to be; • Intertidal mixed sediments (21.9 ha) • Intertidal mud (537.8 ha) • Intertidal sand and muddy sand (1.5 ha) This target may apply to supporting habitat which lies outside the site boundary. Birds will not be nesting on habitat regularly flooded by the tide but they will be found in intertidal habitats above the Mean High Water Mark (which may not have been mapped). Additional supporting habitats used by breeding avocet in this site include; • Coastal lagoons (5.7 ha) • Freshwater and coastal grazing marsh (150.7 ha) • Intertidal coarse sediment (unknown extent) • Water column (unknown extent) (Natural England (NE), 2015) • Saltmarsh (298.7 ha), which is not feature-specific but an aggregation of the following features:

				• Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • *Salicornia* and other annuals colonising mud and sand • *Spartina* swards (*Spartinion maritimae*) (Fermor and Docker, 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). Please see site specific supporting notes for extent details.	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The area of the supporting habitats is currently understood to be 5.2 ha Coastal reedbeds (Gilbert et al., 1996). This target may apply to supporting habitat which lies outside the site boundary. Birds will not be nesting on habitat regularly flooded by the tide but they will be found in intertidal habitats above the Mean High Water Mark (which may not have been mapped). Additional supporting habitats used by marsh harrier in this site include; • Coastal lagoons (5.7 ha) • Freshwater and coastal grazing marsh (150.7 ha) • Intertidal coarse sediment (unknown) • Intertidal mixed sediments (21.9 ha) • Intertidal rock (unknown) • Intertidal sand and muddy sand (1.5 ha) • Saltmarsh (298.7 ha), which is not feature-specific but an aggregation of the following features: • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • *Salicornia* and other annuals colonising mud and sand • *Spartina* swards (*Spartinion maritimae*) (Fermor and Docker, 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Caddis flies, crustaceans, molluscs, worms dipteran flies, beetles, earthworms) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: the intertidal and grassland (marsh). (Cramp and Simmons, 1983), (del Hoyo et al., 1996), (del Hoyo et al., 1992) Site-specifics: Key prey items, including dipteran flies and beetles have been found in the Shingle Street lagoons, located within the site (The Institute of Estuarine and Coastal Studies (IECS), 2015), confirming that the habitat appears to support the prey species ruff feed upon. Key prey items, including crustaceans, molluscs and worms have been identified along the Alde Ore and Butley Estuaries (Curtis, 2014), confirming that the habitat appears to support the prey species ruff feed upon. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. earthworm, leatherjacket, grassland/marsh invertebrates, Hydrobia, Macoma, Corophium, Nereis) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: the intertidal, lagoons and grassland (marsh). (Cramp and Simmons, 1983), (del Hoyo et al., 1996), (Goss-Custard et al., 1977) Site-specifics: Key prey items, including *Hydrobia*, *Macoma* and *Corophium* have been identified along the Alde Ore and Butley Estuaries (Curtis, 2014), confirming that the habitat appears to support the prey species redshank feed upon. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Gammarus, Corophium, flies, beetles, Nereis, Hydrobia, Cardium, gobies) at preferred sizes (eg. Fish or worms between 4-15 mm long).	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: the intertidal and lagoons. (Cramp and Simmons, 1983), (Hill et al., 1989), (Reay, 1991), (Moreira, 1995), (del Hoyo et al., 1996) Site-specifics: Key prey items, including *Gammarus*, flies, beetles and worms have been found in the Shingle Street lagoons within the site (The Institute of Estuarine and Coastal Studies (IECS), 2015), confirming that the habitat appears to support the prey species avocet feed upon. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Gammarus, Corophium, flies, beetles, Nereis, Hydrobia, Cardium, gobies) at preferred sizes (eg. fish or worms between 4-15 mm long).	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: the intertidal and lagoons. (Cramp and Simmons, 1983), (Hill et al., 1989), (Reay, 1991), (Moreira, 1995), (del Hoyo et al., 1996) Site-specifics: Key prey items, including *Gammarus*, flies, beetles and worms have been found in the Shingle Street lagoons, located within the site (The Institute of Estuarine and Coastal Studies (IECS), 2015), confirming that the habitat appears to support the prey species avocet feed upon. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. mammals, birds) at preferred sizes (eg. voles, mice, rabbit; birds of pipit to duck size).	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: freshwater marsh and reedbed. (Cramp and Simmons, 1980), (Sills, 1984), (Underhill-Day, 1985) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: hydrology/flow within grassland (marsh)	Maintain water availability within feeding areas to maintain moderately high water tables that provide shallow surface water.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and / or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997), (Sutherland and Hill, 1995), (Ausden et al., 2003), (Smart et al., 2006) Site-specifics: A Water Level Management Plan has been in place at Orford Ness between 2010 and 2014 and is managed by the National Trust (Howe. A. et al., 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: hydrology/flow within grassland (marsh)	Maintain water availability within nesting areas to provide moderately high water tables that provide shallow surface water and/or damp field conditions between 1st March - 1st June inclusive.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and / or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997), (Newbold, 1997) Site-specifics: A Water Level Management Plan has been in place at Orford Ness between 2010 and 2014 and is managed by the National Trust (Howe. A. et al., 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: hydrology/flow within intertidal	Maintain the availability of fresh water on mudflats within feeding and resting areas.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and / or the likelihood of impacts on this attribute. (Ravenscroft and Beardall, 2003) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: hydrology/flow within intertidal	Maintain the availability of fresh water on mudflats within feeding and resting areas.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Ravenscroft and Beardall, 2003) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: hydrology/flow within standing water	Maintain the stability of standing water levels (<2 cm fluctuation) in order to prevent flooding of nests.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Cadbury et al., 1989) Site-specifics: A Water Level Management Plan has been in place at Orford Ness between 2010 and 2014 and is managed by the National Trust (Howe. A. et al., 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: hydrology/flow within standing water	Maintain the stability of standing water levels (<2 cm fluctuation) in order to prevent flooding of nests.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and / or the likelihood of impacts on this attribute. (Cadbury et al., 1989) Site-specifics: A Water Level Management Plan has been in place at Orford Ness between 2010 and 2014 and is managed by the National Trust (Howe. A. et al., 2014). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: landform	Maintain a high density of channel networks within intertidal feeding areas and shallow slope gradients to the length/perimeter of ditches, drains, pools and scrapes.	Year round – to ensure the habitat remains suitable for when the feature is present	The physical topography and landform of a site will strongly influence the quality and extent of supporting habitats used by this feature for feeding and / or roosting as appropriate. This will also influence the interactions with underlying supporting processes on which the supporting habitat may rely. Any changes or modifications to site topography may adversely affect the ability of the supporting habitats to support and sustain this feature. (Lourenço et al., 2005) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: landform	Maintain shallow slope gradients to the length/perimeter of ditches, drains, pools and scrapes.	Year round – to ensure the habitat remains suitable	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. The physical topography and landform of a site will strongly influence the quality and extent of supporting habitats used by this feature for feeding and / or roosting as appropriate. This will also influence the interactions with underlying supporting processes on which the supporting habitat may rely. Any changes or modifications to site topography may adversely affect the ability of the supporting habitats to support and sustain this feature.

			for when the feature is present	(Royal Society for the Protection of Birds (RSPB), 1997), (Sutherland and Hill, 1995), (Smart et al., 2006), (Natural England (NE), 2013) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: landform	Maintain the availability of shallow sloping nesting sites, grading to above water level, restricting the probability that they will flood.	Year round – to ensure the habitat remains suitable for when the feature is present	The physical topography and landform of a site will strongly influence the quality and extent of supporting habitats used by this feature for nesting / rearing, feeding and / or roosting as appropriate. This will also influence the interactions with underlying supporting processes on which the supporting habitat may rely. Any changes or modifications to site topography may adversely affect the ability of the supporting habitats to support and sustain this feature. (Hill, 1988), (Goutner, 1986), (del Hoyo et al., 1996) Site-specifics: The Havergate Management Plan (2010 - 2015) sets out to create additional lagoon habitat at Boyton Marshes and to maintain nesting islands with little or no vegetation, for nesting avocet (Royal Society for the Proctection of Birds (RSPB), 2010). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: landform	Maintain the availability of shallow sloping sites and avoid changes in the probability that they will flood at critical times of year.	Year round – to ensure the habitat remains suitable for when the feature is present	The physical topography and landform of a site will strongly influence the quality and extent of supporting habitats used by this feature for feeding and / or roosting as appropriate. This will also influence the interactions with underlying supporting processes on which the supporting habitat may rely. Any changes or modifications to site topography may adversely affect the ability of the supporting habitats to support and sustain this feature. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: landscape	Maintain continuous reed cover over large areas avoiding fragmentation of extensive reedbeds.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its nesting, roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within nesting, feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. (English Nature, 1994) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: landscape	Maintain open and unobstructed terrain around nesting, roosting and feeding sites.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: landscape	Maintain open and unobstructed terrain around nesting, roosting and feeding sites.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra*	Supporting habitat: landscape	Maintain the area of open and unobstructed terrain around roosting and feeding sites.	Year round – to ensure the habitat remains suitable	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat.

avosetta), Non-breeding			for when the feature is present	Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: landscape	Maintain the area of open and unobstructed terrain around roosting and feeding sites.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its nesting, roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within nesting, feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: salinity	Maintain water salinity at <2.5%	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to be particularly susceptible to changes in the salinity (concentration of salt) of its shallow brackish / fresh water habitat. Salinity is a major factor determining the distribution and composition of communities of aquatic invertebrates such as insects, crustaceans and worms on which this feature feeds. High levels of salinity can adversely affect invertebrate food for adults and chicks. The principal factors governing the temporal and spatial nature of the salinity regime of coastal sites are the diurnal incursion of the tide and fresh water flow from the river(s). Any activity changing either of these factors can result in a change to the salinity regime. (Cadbury and Richards, 1978), (Hill et al., 1989), (del Hoyo et al., 1996) Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: salinity	Maintain water salinity at <2.5%.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This feature is known to be particularly susceptible to changes in the salinity (concentration of salt) of its shallow brackish / fresh water habitat. Salinity is a major factor determining the distribution and composition of communities of aquatic invertebrates such as insects, crustaceans and worms on which this feature feeds. High levels of salinity can adversely affect invertebrate food for adults and chicks. The principal factors governing the temporal and spatial nature of the salinity regime of coastal sites are the diurnal incursion of the tide and fresh water flow from the river(s). Any activity changing either of these factors can result in a change to the salinity regime. (Cadbury and Richards, 1978), (Hill et al., 1989), (del Hoyo et al., 1996) Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: vegetation characteristics for feeding	Maintain the extent and distribution of predominantly short (<10 cm) grassland swards or arable fields in areas used for feeding.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain a management regime that ensures the constant availability of areas of dense reed stands as nesting cover.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting / rearing / concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Cramp and Simmons, 1980)

				Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: vegetation characteristics for nesting	Maintain an optimal mix of vegetation comprising both short and tussocky conditions.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Stroud et al., 1987), (Cadbury, 1992), (Cadbury, 1993), (Royal Society for the Protection of Birds (RSPB), 1997), (Vickery et al., 1996), (Newbold, 1997), (Milsom et al., 2000), (Vickery et al., 2001), (Smart et al., 2006) Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: vegetation characteristics for nesting	Maintain optimal mix of vegetation of short (<5 cm) to medium/long (>10 cm) vegetation throughout the nesting area.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (van Rhijn, 1991) Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the proportion of vegetated to bare ground within nesting areas with generally <40% vegetated.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Goutner, 1986) Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the proportion of vegetated to bare ground within nesting areas with generally <40% vegetated.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting / rearing / concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Goutner, 1986)

				Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: vegetation characteristics for roosting	Maintain a vegetation structure of key roost sites dominated by bare ground or a short sparsely-vegetated sward.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: vegetation characteristics for roosting	Maintain a vegetation structure of key roost sites dominated by bare ground or a short sparsely-vegetated sward.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. Site-specifics: Grazing management is implemented by the National Trust on Orford Ness with the aim to attract breeding and overwintering waders (National Trust and Royal Society for the Protection of Birds (RSPB), 2015). There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: water depth	Maintain the availability and area of standing water of 3-5 cm deep over at least 50% of the total standing water area.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Cadbury et al., 1989) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: water depth	Maintain the availability and area of standing water of 3-5 cm deep over at least 50% of the total standing water area.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Cadbury et al., 1989) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: water depth	Maintain the availability of standing water of 1-5 cm deep, over at least 50% of the total standing water area.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. This feature needs shallow water pools for its breeding habitat and may also prefer to feed in grasslands in the winter which are partly flooded. Site-specifics:

				The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: water depth	Maintain the availability of water at optimal depths, typically 1-3 cm deep, over at least 50% of the total water area (non-tidal).	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Stroud et al., 1990), (van Rhijn, 1991) Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water depth	Maintain the availability of water over the entire reedbed area, with a high proportion of the area with a water depth of 0.1 m to 0.3 m.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Newbold, 1997) Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. Alde & Ore WFD water body overlaps with 68% of this SPA. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. Alde & Ore WFD water body overlaps with 68% of this SPA. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present.

Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. Alde & Ore WFD water body overlaps with 68% of this SPA. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. Alde & Ore WFD water body overlaps with 68% of this SPA. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. Alde & Ore WFD water body overlaps with 68% of this SPA. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered.

		using the Environmental Agency 2019 water body classifications data.		Site-specifics: Between years 2009-2014 (except 2011 which was not assessed) dissolved oxygen within the site has been assessed as having High ecological status. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: Between years 2009-2014 (except 2011 which was not assessed) dissolved oxygen within the site has been assessed as having High ecological status. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: Between years 2009-2014 (except 2011 which was not assessed) dissolved oxygen within the site has been assessed as having High ecological status. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
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Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: Between years 2009-2014 (except 2011 which was not assessed) dissolved oxygen within the site has been assessed as having High ecological status. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat

		Agency 2019 water body classifications data.		affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
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Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics:

		the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.		The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Redshank (*Tringa totanus*), Non-breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
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Ruff (*Calidris pugnax*), Non-breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
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Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.

See further guidance on how to undertake an HRA for a plan or project on a European site.

These tables bring together the findings of the best available scientific evidence which may be updated or supplemented in further publications from Natural England and other sources. You may decide to use other additional sources of information.

These tables do not give advice about SSSI features or other legally protected species which may also be present within the European site.
Build 1.0.0.20230

COUNTY: SUFFOLK SITE NAME: LEISTON-ALDEBURGH

DISTRICT: SUFFOLK COASTAL

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authorities: SUFFOLK COASTAL DISTRICT COUNCIL, Suffolk County Council

National Grid Reference: TM 461595 Area: 534.34 (ha.) 1,319.82 (ac.)

Ordnance Survey Sheet 1:50,000: 156 1:10,000: TM 45 NE, TM 46 SE

Date Notified (Under 1949 Act): 1955 Date of Last Revision: –

Date Notified (Under 1981 Act): 1986 Date of Last Revision: 1999

Other Information:
Part RSPB and Suffolk Wildlife Trust reserves.
The site was named 'North Warren and Thorpeness Mere', before the 1999 boundary revision.

Description and Reasons for Notification:
Leiston-Aldeburgh contains a rich mosaic of habitats including acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle. This mix of habitats in close juxtaposition and the associated transition communities between habitats is unusual in the Suffolk Coast and Heaths. The variety of habitats support a diverse and abundant community of breeding and overwintering birds, a high number of dragonfly species and many scarce plants.

The heathland of North Warren, Aldringham Common, The Walks and Thorpeness Common is a fragment of the once extensive Sandlings heaths of coastal Suffolk and is of varying composition. There are patches of sand sedge *Carex arenaria* and heather *Calluna vulgaris* dispersed within acid grassland. Bracken *Pteridium aquilinum* and scrub, notably gorse *Ulex europaeus* and *U. gallii* also form part of the heathland. The short sward acidic grassland is dominated by sheep's-fescue *Festuca ovina* and common bent *Agrostis capillaris* with some bare patches, bryophytes and lichens. There is a varied associated flora including lady's bedstraw *Galium verum*, sheep's sorrel *Rumex acetosella* and the nationally scare mossy stonecrop *Crassula tillea* and clustered clover *Trifolium glomeratum*.

On the vegetated shingle there is a gradual transition between the strandline community and the shingle heath resulting from increasing stability and distance from tidal influence. On the open shingle, sea-kale *Crambe maritima* and yellow horned-poppy *Glaucium flavum* are frequent with the irregularly occurring sea spurge *Euphorbia paralias.* The stable shingle areas support many species including early hair-grass *Aira praecox*, the nationally scarce sand catchfly *Silene conica*, dune fescue

Vulpia fasciculata, bur medick *Medicago minima*, suffocated clover *Trifolium suffocatum* and sea pea *Lathyrus japonicus*.

Thorpeness Mere is a shallow, eutrophic water body on a peat substrate. The adjacent areas of swamp and carr woodland are hydrologically dependant on the mere. To the south of the mere, grey willow *Salix cinerea* woodland surrounds a fragmentary mosaic of fen communities, mostly reed dominant *Phragmites australis* with nettle *Urtica dioica*, hemp-agrimony *Eupatorium cannabinum* and wild parsnip *Pastinaca sativa*. In the fen meadow areas there is a richer suite of species including a large colony of adder's tongue *Ophioglossum vulgatum*.

Church Farm Marshes south of the mere consists of grassland that is mostly a mix of creeping bent *Agrostis stolonifera*, Yorkshire-fog *Holcus lanatus* and perennial rye-grass *Lolium perenne* with frequent crested dog's-tail *Cynosurus cristatus*. It is dissected by ditches dominated by spiked water-milfoil *Myriophyllum spicatum* and fennel pondweed *Potamogeton pectinatus* with water-crowfoot *Ranunculus baudotii* in the shallow margins.

The Fens area is dominated by common reed *Phragmites australis* with occasional lesser bulrush *Typha angustifolia*, yellow iris *Iris pseudacorus*, great willowherb *Epilobium hirsutum*, purple-loosestrife *Lythrum salicaria* and nationally scarce marsh sow-thistle *Sonchus palustris*. Water mint *Mentha aquatica* is present in the understorey with cleavers *Galium aparine* and bittersweet *Solanum dulcamara* frequent in the drier areas. Surrounding, and in many places merging into the fen, is grey willow *Salix cinerea* woodland and alder *Alnus glutinosa* woodland with a field layer containing a mix of remnant swamp species.

Many species of bird regularly breed using the great mix of habitats available. These include nightjar, woodlark and skylark on the dry grassland and heath. The scrub and woodland supports tree pipit, turtle dove, bullfinch and nightingale. The marshes, the open water and their margins, in particular, support a diverse range of breeding birds, including water rail, marsh harrier, gadwall and grasshopper warbler. The site is also attractive to wintering waterfowl including Bewick's swan and bittern and regularly supports important populations of white-fronted goose, gadwall and teal.

The variety of water bodies and terrestrial habitats provides suitable breeding and hunting areas for many species of dragonfly and damselfly, including the nationally scarce hairy dragonfly *Brachytron pratense.*

Operations likely to damage the special interest

Site name: Leiston-Aldeburgh, Suffolk

OLD2000370

Ref. No.	Type of Operation
1	Cultivation, including ploughing, rotovating, harrowing, and re-seeding.
2	The introduction of grazing and alterations to the grazing regime including type of stock, intensity or seasonal pattern of grazing.
3	The introduction of stock feeding and alterations to stock feeding practice.
4	The introduction of mowing or cutting and alterations to the mowing or cutting regime (such as hay making to silage).
5	Application of manure, slurry, silage liquor, fertilisers and lime.
6	Application of pesticides, including herbicides (weedkillers) whether terrestrial or aquatic, and veterinary products.
7	Dumping, spreading or discharge of any materials.
8	Burning.
9	Release into the site of any wild, feral, captive-bred or domestic animal*, plant, seed or micro-organism (including genetically modified organisms).
10	Killing, injuring, taking or removal of any wild animal* (including dead animals or parts thereof), or their eggs and nests, excluding pest control and disturbing them in their places of shelter.
11	Destruction, displacement, removal or cutting of any plant or plant remains, including tree, shrub, herb, dead or decaying wood, moss, lichen, fungus.
12	The introduction of tree and/or woodland management and alterations to tree and/or woodland management including planting, felling, tree surgery, thinning, coppicing, removal of fallen timber.
13a	Drainage including the use of mole, tile, tunnel or other artificial drains.
13b	Modification of the structure of watercourses including their banks and beds, as by re-alignment, re-grading, damming or dredging.
13c	Management of aquatic and bank vegetation for drainage purposes.
14	Alterations to water levels and tables and water utilisation including irrigation, storage and abstraction from existing water bodies and through boreholes. Also the modification of current drainage operations.
15	Infilling or digging of ditches, dykes, drains, ponds, pools, marshes or pits.
16a	The introduction of freshwater production and/or management and alterations to freshwater fishery production and/or management.
19	Erection and repair of sea defence or coast protection works, including cliff or stabilisation measures.
20	Extraction of minerals, including peat, shingle, sand and gravel, topsoil, sub-soil.
21	Destruction, construction, removal or rerouting, or regrading of roads, tracks, walls, fences, hardstands, banks, ditches or other earthworks, including soil and soft rock exposures or the laying, maintenance or removal of pipelines and cables, above or below ground.
22	Storage of materials.
23	Erection of permanent or temporary structures, or the undertaking of engineering works, including drilling.

26	Use of vehicles or craft.
27	Recreational or other activities likely to damage vegetation or disturb birds.
28a	Introduction of game or waterfowl management and alterations to game and waterfowl management and hunting practice.
28b	Use of lead shot.

* 'animal' includes any mammal, reptile, amphibian, bird, fish or invertebrate (including honey bees).

Views About Management

A statement of English Nature's views about the management of Leiston - Aldeburgh Site of Special Scientific Interest (SSSI).

This statement represents English Nature's views about the management of the SSSI for nature conservation. This statement sets out, in principle, our views on how the site's special conservation interest can be conserved and enhanced. English Nature has a duty to notify the owners and occupiers of the SSSI of its views about the management of the land.

Not all of the management principles will be equally appropriate to all parts of the SSSI. Also, there may be other management activities, additional to our current views, which can be beneficial to the conservation and enhancement of the features of interest.

The management views set out below do not constitute consent for any operation. English Nature's written consent is still required before carrying out any operation likely to damage the features of special interest (see your SSSI notification papers for a list of these operations). English Nature welcomes consultation with owners, occupiers and users of the SSSI to ensure that the management of this site conserves and enhances the features of interest, and to ensure that all necessary prior consents are obtained.

Management Principles

Artificial standing waterbodies
Artificial standing waterbodies include manmade lakes, reservoirs, gravel pits, subsidence pools, and flooded peat diggings. They may support wildlife equal to that of natural lakes, and can be important habitats for a range of specialised aquatic plant and animal species. They often support important populations of wintering wildfowl and breeding bird assemblages, as well as a varied invertebrate fauna (in particular dragonflies and damselflies).

Conservation value is largely determined by structural diversity and water quality. Increases in the amount of nutrients within the waterbody can lead to a loss of aquatic plants in favour of excessive growths of algae. This may result in a fundamental shift in the way a waterbody functions, reducing plant and invertebrate abundance and diversity, both of which are important food sources for a range of wetland birds. Increases in the amount of sediment entering a lake may smother stony beds and plants, reduce water depth in shallow lakes and also increase the amount of nutrients present. Some lakes may also be susceptible to acidification though control of this will require action at a catchment scale.

Sympathetic management of water levels is necessary for the maintenance of optimal water depths throughout the year (according to the requirements of the plant and animal species present). For example, the presence of extensive shallow water and wet marginal substrates will provide the feeding conditions required by a variety of wintering, passage and breeding wildfowl, such as dabbling ducks and waders. In shallow waterbodies (with an average water depth of less than 3 metres) plants may be able to grow throughout the waterbody . Changes in water levels can also alter nutrient regimes.

Management should aim to maintain the habitats associated with shallowly sloping margins that are not too exposed to wave action, as they are important for many species associated with standing open waters. For example, the maintenance of structural diversity within and between stands of aquatic vegetation (including emergent, floating and submerged vegetation) can provide important habitat for the immature stages of different dragonfly and damselfly species that require a wide variety of vegetation types.

Artificial waterbodies are susceptible to the introduction of invasive species, such as non-native crayfish, bottom feeding coarse fish, and plant species such as Australian swamp stonecrop, therefore some management may be necessary to control these. Where native crayfish are present any measures which may limit the risks of transferring non-native crayfish or crayfish plague (such as information and awareness-raising initiatives amongst visitors to the waterbody) should be encouraged. The control or removal of the natural aquatic vegetation can lead to a decrease in aquatic plants in favour of algae, and should therefore be avoided.

Standing waters and their surroundings are often also a popular environment for recreational activities such as angling and boating which should be managed sympathetically to avoid conflict with the management of the waterbody for nature conservation.

Swamp

Swamp habitats develop on the fringes of open water, or in shallow depressions with permanent standing water. The plants may be rooted in the submerged soil or form a floating mat of inter-twined roots, rhizomes and stems. Swamps usually consist of a dominant single species of plant (e.g. reeds, tussock sedges, reedmace, reed sweet grass, reed canary grass and bull rushes) with a few other species thinly distributed among them. In common with most other types of wetland, swamps represent a transient stage in the change from open water to dry land.

Management should either seek to retain swamp communities in the same place or should acknowledge the dynamics of succession by ensuring there is always a new niche for the swamp communities to develop in. The succession from swamp into floodplain fen, for example, as the diversity of species present increases, may be slowed by raising the water table and by periodically removing any encroaching scrub. If the vegetation surface of the whole wetland appears to be building up or drying out for some other reason it may be necessary to lower the ground level by creating scrapes or ponds. A programme of rotational cutting to maintain the reedbed may be necessary to encourage the vigorous growth of reed whilst preventing excessive build up of litter. Cutting should take place during the winter (November – March) and all cut material should be removed.

Management should ensure that appropriate water quality is maintained according to the requirements of the wetland communities present. Where swamp is in continuity with a waterbody, the water quality in the waterbody will affect the swamp. While some communities, such as reed swamp are unlikely to be very sensitive to nutritional enrichment, others, such as tussock sedge and narrow leaved reedmace, will be out-competed by other species (e.g. reed or reed sweet grass) where any increase in the amount of nutrients present occurs.

Swamp habitats have often survived where the vegetation has traditionally been cut for a variety of purposes, including use as building materials or animal bedding. It may be beneficial to consider re-instating these traditional management practices where they are not in conflict with other nature conservation objectives, such as the specific requirements of certain birds or invertebrates.

Marshy grassland

Marshy grassland requires active management if it is to retain its conservation interest. Generally, each year's growth of vegetation must be removed. Otherwise the sward becomes dominated by tall, vigorous grasses and rushes which, together with an associated build up of dead plant matter, suppress less vigorous species and lower the botanical richness of the sward. Traditionally, this management is achieved by grazing. Cattle are often the preferred stock, being relatively tolerant of wet conditions and able to control tall grasses and rank vegetation. Cattle also tend to produce a rather uneven, structurally diverse sward. However, ponies, or even hill sheep, can be used if necessary. Grazing usually takes place at times between late spring and early autumn, but the precise timing and intensity will depend on local conditions and requirements, such as the need to avoid trampling ground-nesting birds. Heavy poaching should be avoided but light trampling can be beneficial in breaking down leaf litter and providing areas for seed germination. An element of managed scrub, both within and fringing a field can be of importance to birds and invertebrates, as can a surrounding hedge. Careful maintenance of existing ditches and drains is usually acceptable practice, but abandonment or deepening of ditches can be harmful.

Dry lowland heath

Heathland supports the greatest diversity of plants and animals (including a diverse invertebrate fauna and a number of characteristic bird species) where management maintains the open nature of the heath and by promoting a varied structure of uneven-aged stands of native heathers and other characteristic plants. It is generally beneficial if all stages of the heather life cycle are present. Without such management, heathland becomes progressively dominated by bracken, gorse and, on wet ground, purple moor grass tussocks. Eventually scrub and trees will invade. The precise management requirements will vary both between and within sites according to the needs of the different heathland interests present and site conditions.

Low intensity grazing is a suitable means of managing areas of dry heath. By feeding selectively in different areas and on different plants, free-roaming livestock help to maintain variation in the vegetation composition and structure. They can also suppress scrub encroachment and provide some light poaching to create small pockets of bare ground that are of benefit to a variety of specialised plants, invertebrates and reptiles. Sheep grazing is an acceptable method of management but cattle or hardy ponies may also be used, although care must be taken to avoid damage to the heather by trampling. An appropriate stocking rate should take into account local conditions and the timing and length of grazing, but an off-take of between 30-40% of the current growth increment is desirable.

Alternatively, cutting or mowing may be useful options for managing dry heath where a mosaic of patches of heather of different ages is desired. The cut material should be removed to avoid nutrient accumulation on site and to allow the cut plants to re-sprout successfully. However, mowing or cutting may not be suitable on wet heath or on mature stands of dry heath of importance for rare reptiles.

There is some benefit in retaining a few scattered individual trees and some small patches of scrub. For example, the maintenance of scattered mature Scots pine in undisturbed locations will provide suitable nest sites for hobbies. However, this should not encroach on the open nature of the habitat, and mechanical control or manual cutting followed by the careful application (spot application on areas of wet heath) of a suitable herbicide may be necessary to prevent this. Bracken invasions may need to be controlled in the same way.

Where gorse is present, scattered stands with a bushy structure rather than large continuous blocks are of greater benefit to the characteristic bird and invertebrate species associated with gorse scrub. For example, Dartford warbler require areas of open heath (with less than 25 trees per hectare) with over 50% cover of mature heather (preferably over 30 cm tall) and patches of dense, compact, mature gorse bushes (0.5-3 m tall) to be maintained. Winter cutting of 'leggy' stands of gorse and the removal of cut material will maintain gorse at different stages of re-growth and avoid nutrient accumulation in the soil.

Lowland acid grassland
Free-draining, acidic soil is the key requirement of the grassland communities at this site, but their maintenance also depends on active management. If neglected, the sward becomes dominated by tall, vigorous grasses or bracken which, together with an associated build up of dead plant matter, suppress less vigorous species and reduce the botanical richness of the site. Eventually the sward reverts to scrub and even woodland. Traditionally, management has consisted of stock grazing and this remains the most appropriate management tool. Grazing, through the removal of plant matter and nutrients, helps to maintain an open sward of small tussocky grasses. It also, through disturbance and trampling, creates areas of open ground suitable for colonization by the lichens, ephemeral plants and invertebrates that are often characteristic of this type of grassland. However, rabbit grazing, though difficult to control, can also be a useful management tool in some situations. Occasional management of invasive scrub and bracken may be necessary.

Vegetated shingle
Shingle is defined as sediment with particle sizes from 2-200mm. Shingle beaches form where sediment is first deposited on the shore by wave action. These deposits can then build up into more stable spits, bars or forelands. The types of vegetation that occur on shingle depend on the stability and structure of the shingle itself, but all must be able to cope with the unique physical and hydrological conditions typical of this habitat. This results in some communities being unique to shingle; including unusual

moss- and lichen-rich communities that are of great conservation value. Shingle structures also provide important habitats for invertebrates and breeding birds.

A key management requirement is to avoid or minimise surface disturbance, especially in the more open communities. Many of the vegetation types and species associated with shingle are fragile and vulnerable to damage from trampling. This breaks up the fine humus that develops in the upper layers of the shingle that is vital for the plants to survive. Where recreational pressures are significant enough to result in the loss of vegetation cover, or prevent its recovery, it may be necessary to take steps to manage access. Disturbance of areas important for breeding birds should be minimised during the breeding season.

Where there is more closed vegetation cover, light grazing, by rabbits for example, may be all that is needed to prevent scrub encroachment on areas of grassland and heath. However, if there is a tradition of sheep grazing; it may be beneficial to continue this practice at a low intensity. In some cases grazing is not necessary, because of the low rates of plant growth on shingle structures, and can even be damaging, due to the fragility of shingle habitats. The introduction of grazing where it has not been traditionally practiced would not be beneficial.

Scrub
Scrub habitats are low-growing communities where the main woody components are bushes or small trees, such as hawthorn, rowan and juniper. Scrub supports a wide variety of species and ecological communities. In particular, the transitional zone between scrub and other habitats can be important for wildlife, especially invertebrates.

Often, scrub is a transitional stage that will develop into woodland if unmanaged. Maintaining structural diversity and a mosaic of age classes within areas of scrub is important for maintaining the diversity of species the scrub is able to support. For example, hawthorn scrub supports the greatest variety of bird and insect species in the early and middle stages of growth.

Scrub can be managed using rotational cutting, which should aim to maintain a mosaic of patches at different stages of growth. Scrub can also be cut in small patches to create an intimate mixture of scrub and grass and/or heath.

Grazing is another method for managing scrub and on some sites may be a more suitable management tool than cutting. By its nature, grazing can help to create a patchy mosaic of scrub and other upland habitats. As with cutting, it can also help to maintain a range of age classes. However, stock levels do need to be carefully controlled. If grazing pressure is too high the structure of the scrub vegetation may become impoverished. Also, the scrub may not be able to regenerate naturally, leading to a loss of cover over time. Where the objective is to increase the area of scrub an initial period of fencing to control grazing may be required.

Lowland wet woodland
Wet woodland includes a range of different woodland types but usually is dominated by ash, alder and willow species. It often supports important invertebrate species and assemblages.

Areas usually benefit from minimum intervention and are often best left undisturbed to limit damage to their fragile soils. This allows the development of old stands where individual trees reach maturity and die naturally to create gaps in the canopy, leading to a diverse woodland structure. However, works to remove dangerous trees in areas of public access may be necessary.

Where particularly important light-demanding or glade species interests are present, including where the woodland is spreading on to valuable open wetland habitat, it may be necessary to periodically clear areas of vegetation.

Broadleaved semi-natural woodland
There are many different ways in which broadleaved woodland can be managed to conserve its value for wildlife. The following gives broad views on a range of regimes that may be appropriate on your site.

A diverse woodland structure, with open space, a dense understory, and a more mature overstory is important. A range of ages and species within and between stands is desirable. Some dead and decaying wood, such as fallen logs, can provide habitats for fungi and invertebrates. However, work may be needed to make safe dangerous trees in areas of high public access. Both temporary and permanent open spaces benefit groups of invertebrates such as butterflies. They may require cutting to keep them open, and should be of sufficient size to ensure that sunny conditions prevail for most of the day.

Felling, thinning or coppicing may be used to create or maintain variations in the structure of the wood, and non-native trees and shrubs can be removed at this time. To avoid disturbance to breeding birds the work is normally best done between the beginning of August and the end of February. Work should be avoided when the ground is soft, to prevent disturbing the soil and ground flora. Normally successive felling, thinning or coppicing operations should be spread through the wood to promote diversity, but where there is open space adjacent plots should be worked to encourage the spread of species that are only weakly mobile. Natural regeneration from seed or stump regrowth is preferred to planting because it helps maintain the local patterns of species and the inherent genetic character of the site.

Deer management and protection from rabbits or livestock are often necessary. Whilst light or intermittent grazing may increase woodland diversity, heavy browsing can damage the ground flora and prevent successful regeneration. Invasive species, such as *Rhododendron* or Himalayan balsam, should be controlled.

All habitats
The habitats within this site are highly sensitive to inorganic fertilisers and pesticides, applications of which should be avoided both within the site itself and in adjacent surrounding areas. Herbicides may be useful in targeting certain invasive species, but should be used with extreme care. Access to this site, and any recreational activities within, may also need to be controlled.

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

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1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD	MM	YY

Designation date

Site Reference Number

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
Cambridgeshire PE1 1JY
UK
Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948
Email: RIS@JNCC.gov.uk

2. Date this sheet was completed/updated:
Designated: 05 January 1976

3. Country:
UK (England)

4. Name of the Ramsar site:
Minsmere–Walberswick

5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area:

** Important note: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

i) **hard copy** (required for inclusion of site in the Ramsar List): *yes* ✓ -or- *no* □;
ii**) an electronic format** (e.g. a JPEG or ArcView image) Yes
iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** *yes* ✓ -or- *no* □;

b) Describe briefly the type of boundary delineation applied:
e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

52 18 55 N 01 38 02 E

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

Nearest town/city: Southwold

Composite site situated on the coast of Suffolk, between Southwold in the north and Sizewell in the south.

Administrative region: Suffolk

10. Elevation (average and/or max. & min.) (metres): 11. Area (hectares): 2018.92

Min.	-1
Max.	24
Mean	9

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

This composite, Suffolk coastal site contains a complex mosaic of habitats, notably, areas of marsh with dykes, extensive reedbeds, mudflats, lagoons, shingle and driftline, woodland and areas of lowland heath. The site supports the largest continuous stand of reed in England and Wales and demonstrates the nationally rare transition in grazing marsh ditch plants from brackish to fresh water. The combination of habitats create an exceptional area of scientific interest supporting nationally scarce plants, British Red Data Book invertebrates and nationally important numbers of breeding and wintering birds.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

1, 2

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar criterion 1

The site contains a mosaic of marine, freshwater, marshland and associated habitats, complete with transition areas in between. Contains the largest continuous stand of reedbeds in England and Wales and rare transition in grazing marsh ditch plants from brackish to fresh water.

Ramsar criterion 2

This site supports nine nationally scarce plants and at least 26 red data book invertebrates.

Supports a population of the mollusc *Vertigo angustior* (Habitats Directive Annex II; British Red Data Book Endangered), recently discovered on the Blyth estuary river walls.

An important assemblage of rare breeding birds associated with marshland and reedbeds including: *Botaurus stellaris, Anas strepera, Anas crecca, Anas clypeata, Circus aeruginosus, Recurvirostra avosetta, Panurus biarmicus*

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15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation)**:**

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Atlantic

b) biogeographic regionalisation scheme (include reference citation):

Council Directive 92/43/EEC

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16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	acidic, neutral, shingle, sand, peat, nutrient-poor, mud, alluvium
Geomorphology and landscape	lowland, coastal, valley, floodplain, shingle bar, intertidal sediments (including sandflat/mudflat), open coast (including bay), estuary, lagoon
Nutrient status	mesotrophic
pH	circumneutral
Salinity	brackish / mixosaline, fresh, saline / euhaline
Soil	no information
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Lowestoft, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/lowestoft.html) Max. daily temperature: 13.0° C Min. daily temperature: 7.0° C Days of air frost: 27.8 Rainfall: 576.3 mm Hrs. of sunshine: 1535.5

General description of the Physical Features:

Minsmere – Walberswick comprises two large marshes, the tidal Blyth estuary and associated habitats. This composite coastal site contains a complex mosaic of habitats, notably areas of marsh with dykes, extensive reedbeds, mudflats, lagoons, shingle, woodland and areas of lowland heath. It supports the largest continuous stand of common reed *Phragmites australis* in England and Wales, and demonstrates the nationally rare transition in grazing marsh ditch plants from brackish to fresh water.

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17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

Minsmere – Walberswick comprises two large marshes, the tidal Blyth estuary and associated habitats. This composite coastal site contains a complex mosaic of habitats, notably areas of marsh with dykes, extensive reedbeds, mudflats, lagoons, shingle, woodland and areas of lowland heath.

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18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

No special values known

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19. Wetland types:

Marine/coastal wetland

Code	Name	% Area
Other	Other	30
U	Peatlands (including peat bogs swamps, fens)	30
G	Tidal flats	12.9
E	Sand / shingle shores (including dune systems)	12.4
H	Salt marshes	7.2
M	Rivers / streams / creeks: permanent	4
F	Estuarine waters	2.5
J	Coastal brackish / saline lagoons	1

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20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

This composite Suffolk coastal site contains a complex mosaic of habitats notably, areas of marsh with dykes, extensive reedbeds, mud flats, lagoons, shingle, woodland and areas of lowland heath. The site supports the largest continuous stand of reed *Phragmites australis* in England and Wales and nationally rare transition in grazing marsh ditch plants from brackish to fresh water. The combination of habitats create an exceptional area of scientific interest supporting nationally scarce plants, RDB invertebrates and nationally important numbers of breeding and wintering birds.

Ecosystem services

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21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Nationally important species occurring on the site.

Higher Plants.

This is one of few sites nationally for red-tipped cudweed *Filago lutescens* (RDB2) which occurs on light, sandy soils.
The nationally rare species *Corynephorus canescens* (RDB3) occurs on coastal dune habitat.

The site supports a range of nationally scarce plant species characteristic of heathland, wetland and coastal habitats, and the transitions between them. *Althaea officinalis, Myriophyllum verticillatum, Ruppia cirrhosa, Sium latifolium, Sonchus palustris, Ceratophyllum submersum, Ranunculus baudotii*, and *Carex divisa* (all nationally scarce) are associated with reedbeds, grazing marsh or ditches. *Hordeum marinum* occurs on sea-walls, *Lathyrus japonicus* on coastal shingle, and *Crassula tillaea* on heathland.

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds
Species currently occurring at levels of national importance:
Species regularly supported during the breeding season:

Eurasian marsh harrier , *Circus aeruginosus*, Europe	16 pairs, representing an average of 10.5% of the GB population (5 year mean 1993-1997)
Mediterranean gull , *Larus melanocephalus*, Europe	2 apparently occupied nests, representing an average of 1.8% of the GB population (Seabird 2000 Census)
Black-headed gull , *Larus ridibundus*, N & C Europe	2558 apparently occupied nests, representing an average of 1.9% of the GB population (Seabird 2000 Census)
Little tern , *Sterna albifrons albifrons*, W Europe	20 apparently occupied nests, representing an average of 1% of the GB population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Great bittern , *Botaurus stellaris stellaris*, W Europe, NW Africa	3 individuals, representing an average of 3% of the GB population (5 year peak mean 1998/9-2002/3 - spring peak)
Eurasian teal , *Anas crecca*, NW Europe	3083 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9-2002/3)
Ruff , *Philomachus pugnax*, Europe/W Africa	10 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)
Black-tailed godwit , *Limosa limosa islandica*, Iceland/W Europe	846 individuals, representing an average of 5.4% of the GB population (5 year peak mean 1998/9-2002/3 - spring peak)
Spotted redshank , *Tringa erythropus*, Europe/W Africa	15 individuals, representing an average of 11% of the GB population (5 year peak mean 1998/9-2002/3)
Common greenshank , *Tringa nebularia*, Europe/W Africa	9 individuals, representing an average of 1.5% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Greater white-fronted goose , *Anser albifrons albifrons*, NW Europe	212 individuals, representing an average of 3.6% of the GB population (5 year peak mean for 1996/7-2000/01)

Gadwall , *Anas strepera strepera*, NW Europe	261 individuals, representing an average of 1.5% of the GB population (5 year peak mean 1998/9-2002/3)
Northern shoveler , *Anas clypeata*, NW & C Europe	238 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9-2002/3)
Hen harrier, *Circus cyaneus*, Europe	15 individuals, representing an average of 2% of the GB population (5 year peak mean 1985/6-1989/90)
Water rail , *Rallus aquaticus*, Europe	5 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3)
Pied avocet , *Recurvirostra avosetta*, Europe/Northwest Africa	329 individuals, representing an average of 9.6% of the GB population (5 year peak mean 1998/9-2002/3)
European golden plover , *Pluvialis apricaria apricaria*, P. a. altifrons Iceland & Faroes/E Atlantic	4503 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)
Common redshank , *Tringa totanus totanus*,	1386 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3)
Lesser black-backed gull , *Larus fuscus graellsii*,	905 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)

Species Information

Nationally important species occurring on the site.

Invertebrates.

Ethmia bipunctella, Aleochara inconspicua, Philonthus dimidiatipennis, Deltote bankiana, Cephalops perspicuus, Erioptera bivittata, E. meijerei, Gymnancycla canella, Pisidium pseudosphaerium, Archanara neurica, Heliothis viriplaca, Pelosia muscerda, Photedes brevilinea, Senta flammea, Herminea tarsicrinalis, Haematopota grandis, Tipula marginata, Podalonia affinis, Arctosa fulvolineata, Eucosma catroptana, E.maritima, Melissoblaptes zelleri, Pima boisduvaliella, Acrotophthalmus bicolor, Limonia danica, Telmaturus tumidulus, Vertigo angustior (a Habitats Directive Annex II species (S1014)).

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23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic
Aquatic vegetation (e.g. reeds, willows, seaweed)
Environmental education/ interpretation
Livestock grazing
Non-consumptive recreation
Scientific research
Tourism

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No

If Yes, describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	+
Local authority, municipality etc.	+	
National/Crown Estate	+	
Private	+	+
Other	+	

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	+
Tourism	+	+
Recreation	+	+
Current scientific research	+	
Cutting of vegetation (small-scale/subsistence)	+	
Permanent arable agriculture		+
Grazing (unspecified)	+	
Flood control	+	
Transport route	+	+
Non-urbanised settlements	+	+

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. *Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.*
2. *Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.*

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
Erosion	2	Coastal squeeze within the Blyth Estuary	+		+
Recreational/tourism disturbance (unspecified)	2	Trampling damage to vegetated shingle and driftline communities, and disturbance of little tern nesting habitat	+		+

For category 2 factors only.
What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?
Erosion - English Nature provides advice to the Environment Agency and coastal local authorities in relation to flood and coastal protection management. This will inform the development of the Suffolk Estuaries strategies and the second generation shoreline management plan.

Recreational/tourism disturbance (unspecified) - English Nature to work with owners/occupiers and regulatory authorities to develop a strategy to manage visitor pressure on Suffolk vegetated shingle. These measures are likely to include temporary fencing and provision of boardwalks as well as measures to increase visitor awareness about the sensitivity of the shingle habitat, for example by interpretation, wardening.

Is the site subject to adverse ecological change? YES

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	
National Nature Reserve (NNR)	+	
Special Protection Area (SPA)	+	
Land owned by a non-governmental organisation for nature conservation	+	
Management agreement	+	
Site management statement/plan implemented	+	

Area of Outstanding National Beauty (AONB)	+	+
Environmentally Sensitive Area (ESA)	+	+
Special Area of Conservation (SAC)	+	

b) Describe any other current management practices:
The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Fauna.
Numbers of migratory and wintering wildfowl and waders are monitored annually as part of the national Wetland Birds Survey (WeBS) organised by the British Trust for Ornithology, Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee.

Flora.
NVC and vegetation monitoring, bird and invertebrate surveys/monitoring carried out on EN's NNRs, NT, SWT, RSPB reserves.

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Facilities at National Trust and Royal Society for the Protection of Birds reserves.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Activities, Facilities provided and Seasonality.
A popular area for tourists as it is an AONB and contains Minsmere bird reserve and Dunwich heath, both with toilets/shop/cafe. There are more visitors in the summer, however it well used throughout the year by walkers and bird watchers.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Head, Natura 2000 and Ramsar Team, Department for Environment, Food and Rural Affairs, European Wildlife Division, Zone 1/07, Temple Quay House, 2 The Square, Temple Quay, Bristol, BS1 6EB

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Site Designations Manager, English Nature, Sites and Surveillance Team, Northminster House, Northminster Road, Peterborough, PE1 1UA, UK

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see **15** above), list full reference citation for the scheme.

Site-relevant references

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Please return to: **Ramsar Secretariat, Rue Mauverney 28, CH-1196 Gland, Switzerland**
Telephone**: +41 22 999 0170** • Fax: **+41 22 999 0169** • email: [redacted]

EC Directive 79/409 on the Conservation of Wild Birds:
Special Protection Area

MINSMERE-WALBERSWICK (SUFFOLK)

The Minsmere-Walberswick proposed SPA contains areas of grazing marsh, extensive reedbeds, the estuary of the River Blyth, and areas of lowland heath and woodland. The boundaries of the site follows those of the Minsmere-Walberswick Heath and Marshes.SSSI.

Minsmere-Walberswick qualifies under Article 4.1, by supporting, in summer, nationally important breeding populations of the following Annex 1 species: 5 booming male bitterns *Botauris stellaris* (presumed to represent 5 breeding pairs; 22% of the British breeding population) ; 15 breeding female marsh harriers *Circus aeruginosus* (20% of British) ; 47 pairs of avocet *Recurvirostra avosetta* (12% of British) ; 32 pairs of little tern *Sterna albifrons* (1% of British): and 24 pairs of nightjar *Caprimulgus europaeus* (1% of British).

The site qualifies also under Article 4.1 by regularly supporting, in winter, a nationally important wintering population of hen harrier *Circus cyaneus* (15 individuals, 2% of the British wintering population).

Minsmere-Walberswick qualifies under article 4.2 by supporting, in summer, in recent years, nationally important breeding populations of three regularly occurring migratory species: 24 pairs of gadwall *Anas strepera* (4% of British); 73 pairs of teal *A. crecca* (1% of British): and 23 pairs of shoveler *A. clvpeata* (2% of British) . Also notable is a nationally important breeding population of bearded tit *Panurus biarmicus* (50 pairs, 8% of British).

The site qualifies also under Article 4.2 by supporting nationally important wintering populations of three migratory waterfowl. (average peak counts for the five year period 1985/86 to 1989/90): 100 European white-fronted geese *Anser albifrons albifrons* (2% of the British wintering population); 90 gadwall *Anas strepera* (1% of British) , and 100 shoveler *Anas clypeata* (1% of British).

Minsmere-Walberswick is also of importance for an outstandingly diverse assemblage of breeding birds of marshland and reedbed habitats, including bittern, garganey *Anas querquedula*, marsh harrier, water rail *Rallus aquaticus*, Cetti's warbler *Cettia cetti* and Savi's warbler *Locustella lusciniodes*. Also notable is an assemblage of wintering waterfowl including, in addition to species listed above, Bewick's swan *Cygnus columbianus*, wigeon *Anas penelope*, teal *Anas crecca*, avocet; spotted redshank *Tringa erythropus*; and redshank *Tringa totanus*.

During severe winter weather Minsmere-Walberswick can assume even greater national and international importance as wildfowl and waders from many other areas arrive, attracted by relatively mild climate, compared with continental areas, and the abundant food resources available.

SPA Citation
HTR December 1991

[redacted]

European Site Conservation Objectives for Minsmere–Walberswick Special Protection Area Site Code: UK9009101

NATURAL ENGLAND

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- **The extent and distribution of the habitats of the qualifying features**
- **The structure and function of the habitats of the qualifying features**
- **The supporting processes on which the habitats of the qualifying features rely**
- **The population of each of the qualifying features, and,**
- **The distribution of the qualifying features within the site.**

This document should be read in conjunction with the accompanying *Supplementary Advice* document, which provides more detailed advice and information to enable the application and achievement of the Objectives set out above.

Qualifying Features:

A021 *Botaurus stellaris*; Great bittern (Breeding)
A051 *Anas strepera*; Gadwall (Non-breeding)
A051 *Anas strepera*; Gadwall (Breeding)
A052 *Anas crecca*; Eurasian teal (Breeding)
A056 *Anas clypeata*; Northern shoveler (Breeding)
A056 *Anas clypeata*; Northern shoveler (Non-breeding)
A081 *Circus aeruginosus*; Eurasian marsh harrier (Breeding)
A082 *Circus cyaneus*; Hen harrier (Non-breeding)
A132 *Recurvirostra avosetta*; Pied avocet (Breeding)
A195 *Sterna albifrons*; Little tern (Breeding)
A224 *Caprimulgus europaeus*; European nightjar (Breeding)
A394 *Anser albifrons albifrons*; Greater white-fronted goose (Non-breeding)

This is a European Marine Site

This SPA is a part of the Minsmere–Walberswick European Marine Site (EMS). These Conservation Objectives should be used in conjunction with the Conservation Advice document for the EMS. Natural England's formal Conservation Advice for European Marine Sites can be found via GOV.UK.

Explanatory Notes: European Site Conservation Objectives

These Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations'). They must be considered when a competent authority is required to make a 'Habitats Regulations Assessment' including an Appropriate Assessment, under the relevant parts of this legislation.

These Conservation Objectives, and the accompanying Supplementary Advice (where this is available), will also provide a framework to inform the management of the European Site and the prevention of deterioration of habitats and significant disturbance of its qualifying features

These Conservation Objectives are set for each bird feature for a Special Protection Area (SPA).

Where these objectives are being met, the site will be considered to exhibit a high degree of integrity and to be contributing to achieving the aims of the Wild Birds Directive.

Publication date: 21 February 2019 (version 3). This document updates and replaces an earlier version dated 30 June 2014 to reflect the consolidation of the Habitats Regulations in 2017.

Minsmere-Walberswick SPA

Last updated: 5 October 2023

Supplementary advice

The Supplementary Advice on Conservation Objectives (SACOs) present attributes which are ecological characteristics or requirements of the classified species within a site. The listed attributes are considered to be those which best describe the site's ecological integrity and which if safeguarded will enable achievement of the Conservation Objectives.

Conservation Objectives relating to extent and distribution of habitat and population abundance are reflected in single attributes within the Supplementary Advice. Structure and function of habitats, and supporting processes for those habitats, are reflected in multiple attributes describing integrity of these ecological characteristics.

The Conservation Objective relating to the distribution of qualifying features (individual species or assemblages) may apply to most or all of the attributes listed in the SACOs and should be considered against them. Ensuring integrity of attributes relating to supporting habitats and processes should allow birds to distribute themselves optimally within (and, sometimes, outside) the SPA boundary. This is perhaps particularly relevant for food availability; extent and distribution of supporting habitat; quality of supporting habitat; predation; and disturbance caused by human activity.

Attributes have a target which is either quantified or qualified depending on the available evidence. The target identifies as far as possible the desired state to be achieved for the attribute. In many cases, the attribute targets show if the current objective is to either 'maintain' or 'restore' the attribute. The targets given for each attribute do not represent thresholds to assess the significance of any given impact in Habitats Regulation Assessments. You will need to assess this on a case-by-case basis using the most current information available.

Where there is no evidence to determine a marine feature's condition, a vulnerability assessment, which includes sensitivity and exposure information for features and activities in a site, has been used as a proxy for condition. Evidence used in preparing the SACO has been cited with hyperlinks included where possible. Where references have not been provided, Natural England has applied ecological knowledge and expert judgement.

Some, but not all, of these attributes can also be used for regular monitoring of the condition of the classified features. The attributes selected for monitoring the features, and the standards used to assess their condition, are listed in separate monitoring documents, which will be available from Natural England. As condition assessment information becomes available, the conservation advice package will be reviewed accordingly.

When to use

You should use this information, along with the conservation objectives and case-specific advice issued by Natural England when developing, proposing or assessing an activity, plan or project that may affect the site.

Any proposals or operations which may affect the site or its features should be designed so they do not adversely affect any of the attributes in the SACO or achievement of the conservation objectives.

Features:
Choose one or more features and/or their sub-features below by selecting the applicable boxes in the tree. This will show the relevant targets. Where a feature has sub-features this will be indicated with a greyed out triangle below, which can be expanded.

- [x] Avocet (Recurvirostra avosetta), Breeding
- [ ] Bittern (Botaurus stellaris), Breeding
- [x] Gadwall (Mareca strepera), Breeding
- [x] Gadwall (Mareca strepera), Non-breeding
- [x] Greater white-fronted goose (Anser albifrons albifrons), Non-breeding
- [ ] Hen harrier (Circus cyaneus), Non-breeding
- [ ] Little tern (Sternula albifrons), Breeding
- [x] Marsh harrier (Circus aeruginosus), Breeding
- [ ] Nightjar (Caprimulgus europaeus), Breeding
- [x] Shoveler (Spatula clypeata), Breeding
- [x] Shoveler (Spatula clypeata), Non-breeding
- [x] Teal (Anas crecca), Breeding

Reset | Select all | Show attributes and targets for selected features

Attributes:
You can filter to show only targets for certain attributes by selecting one or more attributes from the list below (use ctrl click to select multiple). Note that only attributes for the features you have chosen are shown.

Breeding population: abundance
Connectivity with supporting habitats
Disturbance caused by human activity
Non-breeding population: abundance
Predation - all habitats
Productivity

Feature target

'Maintain' targets do not preclude the need for management, now or in the future, to avoid a significant risk of damage or deterioration to the feature. The supporting and/or explanatory notes in the SACOs set out why the target was chosen and any relevant site based supporting information. This is based on the best available information, including that gathered during monitoring of the feature's current condition.

Feature/ Subfeature name	**Attribute**	**Target**	**Season**	**Supporting notes**
Marsh harrier (*Circus aeruginosus*), Breeding	Breeding population: abundance	Maintain the size of the breeding population at a level which is above 15 breeding females, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: At classification, the SPA's breeding population was recorded at 15 breeding pairs (1991 count) (English Nature, 1991). Since classification the number of marsh harrier nesting within the SPA has decreased by 16% to 12.6 breeding pairs (5 year mean peak count, 2011/12 - 2015/16)(Hardy and Woods, 2017). The SPA target has been set using the Generic Threshold Method where a decline of <25% triggers a maintain target. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Breeding population: abundance	Maintain the size of the breeding population at a level which is above 24 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available.

				Site-specifics: At classification in 1991, the SPA's breeding population was 24 pairs (English Nature, 1991). Since classification, the numbers of breeding gadwall using Minsmere-Walberswick SPA has increased by 251.6% to 84 breeding pairs (5 year mean peak count 2011/12 - 2015/16)(Hardy and Woods, 2017). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Breeding population: abundance	Maintain the size of the breeding population at a level which is above 47 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: Minsmere-Walberswick SPA supports internationally important numbers of breeding avocet. At classification in 1991, the SPA's breeding population was 47 breeding pairs (English Nature, 1991). Since classification, the numbers of avocet using Minsmere-Walberswick SPA has increased by 132.3% to 109 breeding pairs (5 year mean peak count, 2011/12 - 2015/16) (Hardy and Woods, 2017). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Breeding population: abundance	Maintain the size of the breeding population to a level which is above 23 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: At their time of classification in 1991, 23 pairs of breeding shoveler were present in Minsmere-Walberswick SPA (English Nature, 1991). The breeding population in the SPA has increased steadily since 2000. The current population is 65 breeding pairs (5 year mean peak count 2011/12 - 2015/16)(Hardy and Woods, 2017) representing a 186% population increase. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

[Teal (*Anas crecca*), Breeding]	Breeding population: abundance	Restore the size of the breeding population to a level which is above 73 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Breeding (summer) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: Minsmere-Walberswick SPA supports internationally important numbers of breeding teal. At classification in 1991, the SPA's breeding population was 73 breeding pairs (English Nature, 1991). Since classification, the numbers of teal using Minsmere-Walberswick SPA has decreased by 98.9% to 1 breeding pair (5 year mean peak count 2011/12 - 2015/16)(Hardy and Woods, 2017). The aspiration is to restore the size of the population, however it is unclear what is driving declines so site-specific conservation measures may not fully succeed. Further investigative actions are required to understand the causes of the decline in population numbers. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Teal (*Anas crecca*), Breeding]	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. (Tamisier, 1985) Site-specifics: The interlinking mosaic of habitats within the SPA, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters provide a range of areas for nesting and feeding. Reed cutting at the site creates pools for birds to feed in. Undisturbed reedbed areas attract insects for food and provide nesting sites (Natural England 2013). These reedbeds cover a vast area of the SPA and constitute one of the largest reedbeds in Britain (Rowlands et al., 2015). On the RSPB reserve, these are cut on rotation to improve connectivity and maintain areas of open water adjacent to dense vegetation, suitable for courtship, feeding and nesting. Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Shoveler (*Spatula clypeata*), Breeding]	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant.

				Site-specifics: The interlinking mosaic of habitats within the SPA, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters provide a range of areas for nesting and feeding. Reed cutting at the site creates pools for birds to feed in. Undisturbed reedbed areas attract insects for food and provide nesting sites (Natural England 2013). Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from feeding and roosting areas is critical to adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The interlinking mosaic of habitats within the SPA, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters provide a range of areas for nesting and feeding. Reed cutting at the site creates pools for birds to feed in. Undisturbed reedbed areas attract insects for food and provide nesting sites (Natural England 2013). Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: Adult breeding avocet tend to feed in proximity to their nests and avocet chicks may be unable to leave key nesting areas due to the perimeter fencing and ditches that deter predatory mammals (Harvey, 2018 Pers Comm). Habitat connectivity at fine scale is therefore important to this species. (Lengyel, 2006) found that avocet hatching young in semi-natural sites may lead them to more natural habitats when required to access better food resources for chick rearing. Habitat quality is therefore also important in considering connectivity. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Many of the habitats used for nesting and feeding at Minsmere-Walberswick SPA occur as a diverse mosaic at small scale (Hay, 2018 Pers Comm) and areas such as the scrape at Minsmere are intensively managed to provide conditions suitable for nesting, roosting and feeding waders (Rowlands et al., 2015). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. Avocet is also a target species for the Suffolk Wader Strategy, a partnership of conservation organisations looking to enhance breeding numbers and productivity on the Suffolk Coast. The partnership aims to create new habitat at coast wide scale which will improve connectivity with supporting habitat beyond Minsmere-Walberswick SPA (Harvey, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from nesting, feeding and roosting areas is critical to their breeding success and to the adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. Site-specifics: The interlinking mosaic of habitats within the SPA, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters provide a range of areas for nesting and feeding. Reed cutting at the site creates pools for birds to feed in. Undisturbed reedbed areas attract insects for

				food and provide nesting sites (Natural England 2013). These reedbeds cover a vast area of the SPA and constitute one of the largest reedbeds in Britain (Rowlands et al., 2015). On the RSPB reserve, these are cut on rotation to improve connectivity and maintain areas of open water adjacent to dense vegetation, suitable for courtship, feeding and nesting. Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Connectivity with supporting habitats	Maintain safe passage of birds moving between nesting and feeding areas.	Year round	This target has been included because the ability of the feature to safely and successfully move to and from feeding and roosting areas is critical to adult fitness and survival. This target will apply within the site boundary and where birds regularly move to and from off-site habitat where this is relevant. (Vickery and Gill, 1999), (Kear, 2005) --- Site-specifics: The interlinking mosaic of habitats within the SPA, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters provide a range of areas for nesting and feeding. Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. RSPB and Natural England generally regard connectivity between supporting habitats within Minsmere Walberswick SPA as good (Harvey, 2018 Pers Comm)(Hay, 2018 Pers Comm). Significant areas of habitat adjacent to the SPA are also managed for conservation by the RSPB and Suffolk Wildlife Trust, offering safe passage to broader areas of supporting habitat. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Kirby et al., 2004) --- Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Marsh harrier (*Circus aeruginosus*), Breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Holm and Laursen, 2009) Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Shoveler (*Spatula clypeata*), Non-breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Kirby et al., 2004); (Bregnballe et al., 2009) Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Kirby et al., 2004) Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014).

				The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) --- Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Kirby et al., 2004) --- Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to

				SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Disturbance caused by human activity	Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Breeding (summer) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Kirby et al., 2004) Site-specifics: Public access on the RSPB Reserve is carefully controlled and habitat management largely undertaken at a time that will least affect the birds (Harvey, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies Public/ Access as a key current threat to the SPA features. The SPA attracts a large number of recreational visitors which can result in bird disturbance. The Site Improvement Plan identifies the action to investigate the impact of public disturbance to SPA features, and feed the results of this investigation into the implementation of NNR management plans to minimise disturbance. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is above 100, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available.

				Site-specifics: At their time of classification in 1991, 100 non-breeding individuals (1985/86-1989/90) were present in Minsmere-Walberswick SPA (English Nature, 1991). Since classification, the numbers of over-wintering shoveler using Minsmere-Walberswick SPA has increased by 117% to 217 birds (5 year mean peak count 2012/13-2016/17) (British Trust for Ornithology (BTO), 2018). Dingle Marshes & Walberswick NNR and Minsmere are particularly important areas for non-breeding shoveler. Individuals have been identified by WeBS Counts in highest numbers over 15 years (2000- 2015) at Minsmere (76 %), Dingle Marshes (12%), Blyth Estuary (11%), Tinker's Marshes (4%), Bulcamp Marshes (4%), Hen reedbed (3%) and Sandpit Covert (1%) (Hardy and Woods, 2017). The SPA target has been set using the Generic Threshold Method where a decline of <50% triggers a maintain target. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is above 90 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: Minsmere-Walberswick SPA supports internationally important numbers of over-wintering gadwall. At classification in 1991, the SPA's population was 90 (English Nature, 1991). Since classification, the numbers of over-wintering gadwall using Minsmere-Walberswick SPA has increased by 388% to 440 individuals (5 year mean peak count 2012/13-2016/17)(British Trust for Ornithology (BTO), 2018). The SPA target has been set using the Generic Threshold Method where a decline of <50% triggers a maintain target. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Non-breeding population: abundance	Restore the size of the non-breeding population at a level which is above 100, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available.

				Site-specifics: Minsmere-Walberswick SPA supports internationally important numbers of over-wintering greater white-fronted goose. At classification in 1991, the SPA's over-wintering population was 100 individuals (English Nature, 1991). Since classification, the numbers of white-fronted goose over-wintering at Minsmere-Walberswick SPA has decreased by 84% to 16 individuals (5 year mean peak count 2012/13-2016/17) (British Trust for Ornithology (BTO), 2018) There are a number of factors that may affect the population of white-fronted geese on the SPA. The numbers wintering in England in any single winter are largely dependent on weather conditions on the continent. A trend towards milder winters, coupled with increased food availability on farmland in continental wintering areas, is likely to have caused the decline in numbers in Britain since the mid-1980s (Collier et al., 2005) and is the reason for the species being of conservation concern in the UK (Suffolk Ornithologists' Group, 2016). Over-wintering WeBS data for this species at Minsmere-Walberswick SPA is possibly not an accurate representation of the numbers found on the site. The WeBS surveys are usually conducted during the day when the birds have left the SPA to graze on nearby farmland. The birds return late in the evening sometimes after dark to roost on the SPA and have therefore not been included in the counts. This is supported by evidence from the RSPB who have observed that white-fronted geese which feed mainly at North Warren during the day (peaking at over 300 in recent years), return after dark to roost at Minsmere on the Scrape and/or North Levels (Harvey, 2018 Pers Comm). However the national long term trend (1989/90 – 2014/15) is a 69% decline in population status (Wildfowl & Wetlands Trust, 2018). The aspiration is to restore the size of the population, however it is unclear what is driving declines so site-specific conservation measures may not fully succeed. Further investigative actions are required to understand the causes of the decline in population numbers. The SPA target has been set using the Generic Threshold Method where a decline of >50% triggers a restore target. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: As ground nesting birds, avocet are particularly vulnerable to predation (Ausden et al., 2009). Avocet nest in colonies and collectively defend eggs and chicks from predators, e.g. by mobbing predatory birds (Lengyel, 2006). Under high predation pressure colonial nesting seems to be an important factor in choice of nest site (Lengyel, 2006). Collective defence may be less successful in deterring mammalian predators like fox, so physical barriers, e.g. islands surrounded by water, electric fencing and ditches are important in restricting predation. Predation remains a significant issue at Minsmere and is influenced by interactions between predatory species, some of which are themselves designated features of the SPA (Harvey, 2018 Pers Comm). At the scrape, a 2km long perimeter electric fence excludes large mammals, making the area a safe haven for breeding bird species. These include an increasing population of black-headed gull which are the main predator of avocet chick. Prior to fence repairs in 2015 incursions by fox and badger held black-headed gull numbers down. By 2016, gull numbers had dramatically increased again and avocet productivity dropped to a low level (Harvey, 2018 Pers Comm). There are also serious concerns about predators associated with nearby outdoor pig farming and pheasant shoots, e.g. corvid, rat, gull and fox (Hay, 2018 Pers Comm). Their impact on local breeding avocet population and productivity is unclear, however predators may also compete for resources and disturb nesting birds or displace them onto sub-optimal habitat (Lengyel, 2006) affecting breeding success indirectly. Marsh harrier and other raptors such as buzzards, sparrowhawks, hobbies and kestrel are also present on the SPA. These may predate eggs and chicks opportunistically. Control of predator numbers by trapping and culling is considered essential to safeguard breeding bird productivity and recruitment (Hay, 2018 Pers Comm)(Rowlands et al., 2015) in addition to fencing out large mammalian predators at key nesting sites. Site managers also utilise habitat management to manage predation pressure, reducing the need for non-lethal and lethal control (Rowlands et al., 2015). For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus*	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management

***aeruginosus*), Breeding**				is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: Predators such as crow, rat, and gull associated with farming in adjacent areas present a threat to eggs and chicks to breeding birds on the SPA (Hay, 2018 Pers Comm) as do fox, badger and mink (Rowlands et al., 2015). Control of predator numbers by trapping and culling is considered essential to safeguard breeding bird productivity and recruitment (Hay, 2018 Pers Comm)(Rowlands et al., 2015). For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: Predators such as crow, rat, and gull associated with farming in adjacent areas present a threat to eggs and chicks to breeding birds on the SPA (Hay, 2018 Pers Comm) as do fox, badger and mink (Rowlands et al., 2015). Control of predator numbers by trapping and culling is considered essential to safeguard breeding bird productivity and recruitment (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Anti-predator fencing is also in use around the lagoons and islands created at Minsmere, however this provides no protection against avian predators and the vast majority of the SPA is unfenced. Deep water may deter predators in some areas. Black-headed gull predate eggs of other birds at Minsmere (Harvey, 2018 Pers Comm). Marsh harrier and other raptors such as buzzards, sparrowhawks, hobbies and kestrel are also present on the SPA. These may predate eggs and chicks opportunistically. American mink have also been recorded in the RSPB reserve and are trapped throughout the breeding season to prevent colonisation (Rowlands et al., 2015). For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: Predators such as crow, rat, and gull associated with farming in adjacent areas present a threat to eggs and chicks to breeding birds on the SPA (Hay, 2018 Pers Comm) as do fox, badger and mink (Rowlands et al., 2015). Predators may also compete for resources and disturb nesting birds or displace them onto sub-optimal habitat (Lengyel, 2006) affecting breeding success indirectly. Their impact on breeding teal populations at Minsmere-Walberswick SPA has not been quantified, however predation of breeding birds is a significant issue at Minsmere (Harvey, 2018 Pers Comm). Control of predator numbers by trapping and culling is considered essential to safeguard breeding bird productivity and recruitment (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Anti-predator fencing is also in use around the lagoons and islands created at Minsmere, however this provides no protection against avian predators and the vast majority of the SPA is unfenced. Deep water may deter predators in some areas, however teal are likely to nest near shallow water so they can feed effectively.

				Black-headed gull predate eggs of other birds at Minsmere (Harvey, 2018 Pers Comm). Marsh harrier and other raptors such as buzzards, sparrowhawks, hobbies and kestrel are also present on the SPA. These may predate teal eggs and chicks opportunistically. American mink have also been recorded in the RSPB reserve and are trapped throughout the breeding season to prevent colonisation (Rowlands et al., 2015). County-wide decreases in the number of breeding Teal (Suffolk Ornithologists' Group, 2016) and broader demographic changes (Fox and Cristensen, 2018) suggest that predation at this specific site may not be directly linked to the dramatic decline in breeding teal. However control of predators remains essential if teal are to continue nesting at this site. For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Predation - all habitats	Restrict predation and disturbance caused by native and non-native predators	Breeding (summer) season	This will ensure that breeding productivity (number of chicks per pair) and survival are sustained at rates that maintain or restore the abundance of the feature. Impacts to breeding productivity can result directly from predation of eggs, chicks, juveniles and adults, but also from significant disturbance. The presence of predators can influence bird behaviours, such as abandonment of nest sites or reduction of effective feeding. Where evidence suggests predator management is required, measures can include their exclusion through fencing, scaring and direct control. Any such measures must consider the legal protection of some predators, as well as the likely effects of such control on other qualifying features. Predation can influence distribution on a local scale (e.g. through abandonment) or at a wider population scale. (Smith et al., 2010), (Smith et al., 2011) Site-specifics: Predators such as crow, rat, and gull associated with farming in adjacent areas present a threat to eggs and chicks to breeding birds on the SPA (Hay, 2018 Pers Comm) as do fox, badger and mink (Rowlands et al., 2015). Control of predator numbers by trapping and culling is considered essential to safeguard breeding bird productivity and recruitment (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Anti-predator fencing is also in use around the lagoons and islands created at Minsmere, however this provides no protection against avian predators and the vast majority of the SPA is unfenced. Deep water may deter predators in some areas. Black-headed gull predate eggs of other birds at Minsmere (Harvey, 2018 Pers Comm). Marsh harrier and other raptors such as buzzards, sparrowhawks, hobbies and kestrel are also present on the SPA. These may predate eggs and chicks opportunistically. American mink have also been recorded in the RSPB reserve and are trapped throughout the breeding season to prevent colonisation (Rowlands et al., 2015). For more detailed information, please see the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Teal (*Anas crecca*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016).

				Site-specifics: To be completed.
Gadwall (*Mareca strepera*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Marsh harrier (*Circus aeruginosus*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Avocet (*Recurvirostra avosetta*), Breeding	Productivity	[Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.	Breeding (summer) season	This target has been included because successful breeding is an essential part of bird population biology and data on productivity is often considered to be an important part of effective conservation measures for threatened and rare bird species (Sutherland et al., 2004). Productivity can be defined as "the mean number of fledged chicks produced per breeding pair, clutch or nest per year" (OSPAR Commission, 2016). This can be assessed as an average value for a colony or for individual nests. Theoretically, in order to maintain the size of a population, the number of chicks fledged and recruited into the adult population, plus immigration, must be equal to or greater than the loss of adults from that population (OSPAR Commission, 2016). However, numbers of birds will fluctuate due to many external factors and demographic factors, as well as breeding success. For longer-lived birds, changes in the timing of breeding and reduced productivity can reflect changes in environmental conditions before they become apparent through other attributes. Therefore, changes in productivity may serve as an early warning of impending changes in population abundance (OSPAR Commission, 2016). Site-specifics: To be completed.
Shoveler (*Spatula clypeata*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed

Marsh harrier (*Circus aeruginosus*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Avocet (*Recurvirostra avosetta*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Gadwall (*Mareca strepera*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Gadwall (*Mareca strepera*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed

Teal (*Anas crecca*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Shoveler (*Spatula clypeata*), Breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from nutrient nitrogen (N), ammonia (NH3), nitrogen oxide (NOx) and acidity deposition on the broad habitat. No critical level has been assigned to shoveler regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014).

				It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from nutrient nitrogen (N), ammonia (NH3), nitrogen oxide (NOx) and acidity deposition on the broad habitat. No critical level has been assigned to shoveler regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from acidity deposition, nutrient nitrogen, NOx and NH3 on the broad habitat. No critical level has been assigned to gadwall regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018 and assessed at a site level. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. There is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.
Teal (*Anas crecca*), Breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from nutrient nitrogen (N), ammonia (NH3), nitrogen oxide (NOx) and acidity deposition on the broad habitat. No critical level has been assigned to teal regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from acidity deposition, nutrient nitrogen, NOx and NH3 on the broad habitat. No critical level has been assigned to gadwall regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018 and assessed at a site level. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There are currently no expected negative impact from nutrient nitrogen (N), ammonia (NH3), nitrogen oxide (NOx) and acidity deposition on the broad habitat. No critical level has been assigned to greater white-fronted goose regarding sulphur dioxide (SO2) deposition. The target has been set as 'Maintain' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: air quality	Restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014).

				It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There is an expected negative impact on this feature's broad scale habitat due to exceedance of critical loads for the following atmospheric pollutant deposition: nutrient nitrogen (N), ammonia (NH3) and nitrogen oxide (NOx). There are currently no expected negative impact from acidity deposition on the broad habitat. No critical level has been assigned to marsh harrier regarding sulphur dioxide (SO2) deposition. The target has been set as 'Restore' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet *(Recurvirostra avosetta)*, Breeding	Supporting habitat: air quality	Restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the feature' supporting habitat on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of nesting, feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There is an expected negative impact on this feature's broad scale habitat and/or food supply due to exceedance of critical loads for the following atmospheric pollutants: nutrient nitrogen (N) ammonia (NH3) and nitrogen oxides (NOx). There are currently no expected negative impact from acidity deposition on the broad habitat. No critical level has been assigned to avocet regarding sulphur dioxide (SO2) deposition. The target has been set as 'Restore' based on the current information on the Air Pollution Information System (APIS) as of 08.10.2018. Please refer to (Air Pollution Information System (APIS), 2018) for further information and detail. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet *(Recurvirostra avosetta)*, Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, The The Royal Society for the Protection of Birds (RSPB) and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: < Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Teal (*Anas crecca*), Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other	Year round – to ensure the habitat remains suitable	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found

		measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	for when the feature is present	within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and / or management agreements. Site-specifics: Much of the SPA is managed directly for nature conservation. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. Through management plans, a number of conservation measures are implemented for bird species, including; habitat management, water level management, vermin control, anti-predator fencing, visitor management and wardening. For site specific information about the management requirements for Minsmere-Walberswick SPA, please refer to the Minsmere-Walberswick SPA Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding). There are no quantified baseline figures for extent and distribution of supporting habitat at Minsmere-Walberswick SPA.	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The most recent extent data for shoveler supporting habitats within Minsmere-Walberswick SPA are: • Coastal lagoons: 25ha • Intertidal mud: 178ha • Intertidal coarse sediment: 1ha • Intertidal mixed sediments: 10ha • Atlantic salt meadows (Glauco-puccinellietalia maritimae): 256 ha • Salicornia and other annuals colonising mud and sand: 256 ha • Spartina swards (Spartinion maritimae): 256 ha • Coastal reedbeds: 253 ha • Freshwater and coastal grazing marsh: 103 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation. (Hay, 2018 Pers Comm). However the extent, location and nature of supporting habitats at Minsmere-Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). The site includes a mosaic of habitats, including mudflats, reedbeds, heathland and grazing marsh (Hay, 2018 Pers Comm). The Site Improvement Plan for Minsmere-Walberswick SPA identifies the development of *Spartina anglica* (Common cord-grass) as a current pressure for non-breeding shoveler (Site improvement Plan). *S. anglica* is found on the mud deposits in the lower intertidal and lower-middle saltmarsh zones. *S. anglica* can trap sediments, increasing the height of the saltmarsh, and resulting in the loss of mudflat and pioneer saltmarsh habitats (British Trust for Ornithology (BTO), 2015). The Site Improvement Plan identifies the need to investigate and monitor *S. anglica* encroachment onto estuarine muds and develop a management plan as appropriate (Natural England, 2014). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding). There are no quantified baseline figures for	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: Most recent extent data for gadwall supporting habitats with Minsmere-Walberswick SPA are as follows: • Coastal reedbed: 253 ha

		extent and distribution of supporting habitat at Minsmere-Walberswick SPA.		• Freshwater and coastal grazing marsh: 103 ha • Coastal lagoons: 25 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation. (Hay, 2018 Pers Comm). However the extent, location and nature of supporting habitats at Minsmere-Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). Minsmere-Walberswick SPA supports the largest continuous stand of Common Reed in England and Wales (Westwood Marshes). The floodplain fen and reed need to be managed by periodic cutting or in places grazing, and by the management of water levels. Management of 160ha of reedbed within Minsmere RSPB reserve aims to create a net increase in the extent of open water and connectivity within the site by 2020 (Rowlands et al., 2015). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding). There are no quantified baseline figures for extent and distribution of supporting habitat at Minsmere-Walberswick SPA.	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The most recent extent data for greater white-fronted goose supporting habitats within Minsmere-Walberswick SPA are: • Freshwater and coastal grazing marsh: 103 ha • Spartina swards (*Spartinion maritimae*): 256 ha • Salicornia and other annuals colonising mud and sand: 256 ha • Atlantic salt meadows (*Glauco-puccinellietalia maritimae*) : 256 ha • Intertidal mud: 178 ha • Intertidal mixed sediments: 10 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation. (Hay, 2018 Pers Comm). However the extent, location and nature of supporting habitats at Minsmere-Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). There are no quantified baseline f	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The most recent extent data for shoveler supporting habitats within Minsmere-Walberswick SPA are: • Coastal lagoons: 25ha • Intertidal mud: 178ha • Intertidal coarse sediment: 1ha • Intertidal mixed sediments: 10ha • Atlantic salt meadows (*Glauco-puccinellietalia maritimae*): 256 ha

				• Salicornia and other annuals colonising mud and sand: 256 ha • Spartina swards (*Spartinion maritimae*): 256 ha • Coastal reedbeds: 253 ha • Freshwater and coastal grazing marsh: 103 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation. (Hay, 2018 Pers Comm) However the extent, location and nature of supporting habitats at Minsmere Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). Minsmere- Walberswick SPA encompasses a range of habitats, including areas of grazing marsh, reedbeds, coastal lagoons, sparsely vegetated shingle and shallow coastal waters (English Nature, 2001). Shovelers breed in the summer in various wetland habitats, but preferentially nest in sparse cover near to shallow eutrophic still waters (Hardy and Woods, 2017)(Drewitt et al., 2008). Nests are shallow depressions in ground vegetation lined with grass, close to areas of open water (BirdsUc, 2014). Minsmere RSPB Reserve is a particularly important area of the SPA for breeding shovelers (Hardy and Woods, 2017). A 20 hectare area of shallow lagoons and islands has been created here for wading birds and wildfowl, within which shoveler breed. The Site Improvement Plan for Minsmere-Walberswick SPA identifies the development of *Spartina anglica* (Common cord-grass) as a current pressure for non-breeding shoveler (Site improvement Plan). *S. anglica* is found on the mud deposits in the lower intertidal and lower-middle saltmarsh zones. *S. anglica* can trap sediments, increasing the height of the saltmarsh, and resulting in the loss of mudflat and pioneer saltmarsh habitats (British Trust for Ornithology (BTO), 2015). The Site Improvement Plan identifies the need to investigate and monitor *S. anglica* encroachment onto estuarine muds and develop a management plan as appropriate (Natural England, 2014). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). There are no quantified baseline figures for extent and distribution of supporting habitat at Minsmere-Walberswick SPA.	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The most recent extent data for teal supporting habitats within Minsmere-Walberswick SPA are: • Coastal lagoons: 25 ha • Intertidal mud: 178 ha • Intertidal mixed sediments: 10ha • Coastal reedbed: 253 ha • Intertidal coarse sediment: 1ha • Spartina swards (*Spartinion maritimae*): 256 ha • Atlantic salt meadows (*Glauco-puccinellietalia maritimae*) : 256 ha • Salicornia and other annuals colonising mud and sand: 256 ha • Freshwater and coastal grazing marsh: 103 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. Areas such as Dingle Marshes offer breeding teal an extensive mix of coastal and freshwater habitats including reedbeds, heathland, saline lagoons, vegetated shingle and forest (The Wildlife Trust, 2018). The majority of breeding pairs recorded at Minsmere-Walberswick SPA between 1999 and 2016 favoured this area (Hardy and Woods, 2017). During this period several pairs were also noted in Hen Reedbeds at the north of the SPA, an area featuring reedbeds and grazing marsh (Hardy and Woods, 2017). Creation of a 20 ha area of shallow lagoons and islands at Minsmere has also attracted small numbers of breeding teal (Rowlands et al., 2015). Teal forage for food in a wide range of places, including reedbeds, small waterbodies, coastal lagoons, grazing marsh, saltmarsh and intertidal sand and mudflats. Preferred sites are in close proximity to water, where adult birds can forage and lead juvenile teal down to shallow water to dabble. Reedbeds at Minsmere-Walberswick SPA form part of an extensive wetland system incorporating dense cover and open water and are actively managed to maintain open water areas and provide shallow conditions (Rowlands et al., 2015).

				However coastal processes and climate change are gradually altering the extent and distribution of supporting habitats for teal on the SPA. For example, erosion and rising sea levels are resulting in more frequent inundation by sea water, raising salinity in formerly freshwater areas of the SPA (England, s.d. (Various)). In recent years the shingle banks separating land and sea at Dingle Marshes have breached annually, inundating low-lying reedbeds and grazing marshes with seawater (Rowlands et al., 2015)(The Wildlife Trust, 2018). Historically this has been a key site for breeding teal, a species which requires freshwater access during breeding season. Habitat at Dingle and Corporation Marshes (formerly freshwater grazing marsh) is now in transition to saltmarsh and grazing has been discontinued (Hay, 2018 Pers Comm). Rising salinity and roll back of shingle beaches (the eastern boundary of the SPA) are likely to increase saltmarsh extent at Dingle Marshes over the coming years at the expense of freshwater habitat, much of which may be lost (Miller, 2018 Pers Comm). Increased salinity will negatively impact freshwater invertebrates and plants (Hay, 2018 Pers Comm) which are key food sources for breeding teal. These habitat changes may favour brackish/saltwater invertebrates and teal also forage on saltmarsh and intertidal mudflats. This projected decline in freshwater habitat may limit selection of Minsmere-Walberswick SPA as a nesting location for teal. Loss of supporting habitat has been cited as a likely cause for the contracting range of teal in South and East England (British Trust for Ornithology, 2018). Teal may be relatively well placed to exploit emerging habitats at Minsmere-Walberswick SPA as supporting habitats change in response to coastal processes. Management to retain freshwater habitat and suitable vegetation cover nearby and preventing any anthropogenic loss of freshwater habitat will be essential if teal are to breed on the SPA in larger numbers in future. Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). There are no quantified baseline figures for extent and distribution of supporting habitat at Minsmere-Walberswick SPA.	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: The most recent extent data for marsh harrier supporting habitats with Minsmere-Walberswick SPA are: • Coastal reedbed: 253 ha • Freshwater and coastal grazing marsh: 103 ha • Coastal lagoons: 25 ha • Atlantic salt meadows (*Glauco-puccinellietalia maritimae*): 256 ha. These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation. (Hay, 2018 Pers Comm). However the extent, location and nature of supporting habitats at Minsmere-Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). Minsmere-Walberswick SPA supports the largest continuous stand of Common Reed in England and Wales (Westwood Marshes). The floodplain fen and reed need to be managed by periodic cutting or in places grazing, and by the management of water levels. Management of 160ha of reedbed within Minsmere RSPB reserve aims to create a net increase in the extent of open water and connectivity within the site by 2020 (Rowlands et al., 2015). Marsh harriers are far-ranging, and use a variety of semi-natural habitats for hunting. Favoured hunting habitats within the SPA are areas of freshwater and coastal grazing marsh and Atlantic salt meadows (including the features Salicornia and other annuals colonising mud and sand and Spartina swards (Hay, 2018 Pers Comm). Marsh harriers may rarely take prey from other intertidal habitats (e.g. coastal lagoons and intertidal sediments), however these would not be preferred hunting grounds within the site. Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: extent, distribution and availablity of	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all	Year round – to ensure the habitat remains suitable	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds.

	supporting habitat for the breeding season	necessary stages of its breeding cycle (courtship, nesting, feeding). There are no quantified baseline figures for extent and distribution of supporting habitat at Minsmere-Walberswick SPA.	for when the feature is present	Site-specifics: Most recent extent data for avocet supporting habitats within Minsmere-Walberswick SPA are: • Coastal lagoons: 25 ha • Intertidal mud: 178 ha • Intertidal mixed sediments: 10ha • Intertidal coarse sediment: 1ha • Atlantic salt meadows (*Glauco-puccinellietalia maritimae*): 256 ha • Spartina swards (*Spartinion maritimae*): 256 ha • Salicornia and other annuals colonising mud and sand: 256 ha • Freshwater and coastal grazing marsh: 103 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. Minsmere-Walberswick SPA is one of Britain's most important sites for breeding avocet. Since creation of new brackish lagoon and bare island habitat for waders at the Scrape within the RSPB reserve at Minsmere, the breeding population has increased (Hardy and Woods, 2017). Avocet utilise the scrape at Minsmere, brackish shore pools and scrape at Dingle Marshes and Tinker's Marshes for nesting (Harvey, 2018 Pers Comm). Occasional nests have also been noted in Hen Reedbed, at the north of the SPA (Hardy and Woods, 2017). Supporting habitat availability is probably now one of several constraints to further population growth at Minsmere (Harvey, 2018 Pers Comm). The SPA features around 25ha of coastal lagoons in total, providing a rich source of food for avocet and other waders. The scrape created at Minsmere provides around 20ha. of shallow brackish water, open mud and around 50 bare and sparsely vegetated islands suitable for breeding waders (Rowlands et al., 2015)(Burgess et al., 1992). Invasive vegetation is flooded and/or cut to prevent loss of nesting habitat. Water levels are controlled via a network of sluices at the start of breeding season; levels are then drawn down slowly to expose bare mud (England, s.d. (Various)). Water levels which gradually decline over the summer to expose additional feeding areas are thought to be one of the most important characteristics of avocet breeding habitat (Johnsgard, 1981)(Birdlife International, 2018). The SPA is situated in one of the lowest areas of rainfall in Britain, and evapotranspiration can exceed rainfall during avocet breeding season (Rowlands et al., 2015). Tinker's Marshes also experience occasional tidal inundation, which can affect habitat quality (Hay, 2018 Pers Comm). Dingle Marshes features a mosaic of brackish lagoons, grazing marsh, pioneer saltmarsh and reedbeds (Hay, 2018 Pers Comm). Hen Reedbeds, a new wetland created in 1999, includes areas of marsh, reedbeds, fens, dykes and pools (The Wildlife Trust, 2018). These provide additional habitat for nesting and feeding avocet. However, habitat at Dingle Marshes is already changing as a result of increased overtopping and infiltration by seawater, favouring the development of saltmarsh communities (Hay, 2018 Pers Comm). There has been no anthropogenic loss of supporting habitat in the SPA since designation (Hay, 2018 Pers Comm). However the extent, location and nature of supporting habitats at Minsmere Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). Both losses and gains are expected. For example, natural roll back of shingle at Dingle is encroaching on lagoon extent, however the predicted shift towards brackish conditions over large areas would favour creation of additional habitat suitable for avocet (with e.g. new saltmarsh and brackish lagoons displacing a proportion of freshwater marsh and reedbed) (Harvey, 2018 Pers Comm) (Miller, 2018 Pers Comm). Analysis of designated features at Dingle Marshes suggests that saline flooding may limit access to dry nest sites but offer better feeding opportunities for breeding avocet (Hay, 2018 Pers Comm). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). RSPB plan to create additional small scrapes with islands on the South Levels at Minsmere. The RSPB, Suffolk Wildlife Trust and Natural England are also working with stakeholders to scope plans for future management of Dingle Marshes. This could include creation of additional brackish lagoons (Harvey, 2018 Pers Comm). Habitat changes will most likely be of net benefit to avocet and maintain the extent, distribution and availability of suitable breeding habitat (Harvey, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: extent, distribution and availablity of supporting habitat for the breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding). There are no quantified baseline figures for	Year round – to ensure the habitat remains suitable for when the feature is present	To maintain or restore the extent of supporting habitats and their range in order to maintain the population. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending to the nature, age and accuracy of data collection. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds.

		supporting habitat at Minsmere-Walberswick SPA.		Site-specifics: most recent extent data for gadwall supporting habitats with Minsmere-Walberswick SPA are: • Coastal reedbed: 253 ha • Freshwater and coastal grazing marsh: 103 ha • Coastal lagoons: 25 ha These supporting habitats do not have fixed extents, they are subject to change over time through dynamic coastal processes. There has been no anthropogenic loss of supporting habitat in the SPA since designation (Hay, 2018 Pers Comm). However, the extent, location and nature of supporting habitats at Minsmere-Walberswick SPA continues to evolve as a result of active coastal processes (Miller, 2018 Pers Comm). At Minsmere, a 20 ha area of shallow lagoons and islands has been created for wading birds and wildfowl. This area is renowned for its breeding colony of gadwall and other species. Grazing marshes occur at Minsmere Level and Walberswick which are chiefly of value for these feeding and breeding birds (Rowlands et al., 2015). Minsmere-Walberswick SPA supports the largest continuous stand of Common Reed in England and Wales (Westwood Marshes). The floodplain fen and reed need to be managed by periodic cutting or in places grazing, and by the management of water levels. Management of 160ha of reedbed within Minsmere RSPB reserve aims to create a net increase in the extent of open water and connectivity within the site by 2020 (Rowlands et al., 2015). Management by Natural England, Suffolk Wildlife Trust and RSPB aims to accommodate and manage habitat changes associated with natural coastal processes and climate change whilst retaining and enhancing habitat for breeding and overwintering birds (Miller, 2018 Pers Comm)(Hay, 2018 Pers Comm). As a result of the dynamic nature of the estuary and the pattern of accretion / erosion, our objective is to avoid deterioration of the extent, distribution and function of the supporting habitats from their current levels. Evidence of natural changes to extent should not justify further loss to development. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. hatching midges, Glyceria fluitans, Agrostis stolonifera, Chara, Potomageton, Ceratophyllum spp., Ruppia) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: standing water. (Cramp and Simmons, 1977), (del Hoyo et al., 1992), (Kear, 2005), (Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: Gadwall are predominantly herbivorous, their diet consists mainly of seeds, leaves, grasses, roots and stems of aquatic plants (del Hoyo et al., 1992). Invertebrates can form nearly 50% of the gadwall diet in breeding season, but drops to around 5% in winter (All About the Birds, 2018). At Minsmere, a 20 ha area of shallow lagoons and islands has been created for wading birds and wildfowl. This area is renowned for its breeding colony of many species including gadwall. Grazing marshes occur at Minsmere Level and Walberswick, which are chiefly of value for feeding and breeding birds too (Rowlands et al., 2015). Reedbeds at Minsmere-Walberswick SPA form part of an extensive wetland system incorporating dense cover and open water and are actively managed to maintain open water areas and provide shallow conditions for submerged vegetation and aquatic invertebrates which are a food resource (Rowlands et al., 2015). Minsmere-Walberswick SPA features an intimate mosaic of different habitat types (Hay, 2018 Pers Comm), offering good connectivity for foraging at site scale. Natural England manage wetlands in the National Nature Reserve to optimise feeding opportunities for SPA bird features (Hay, 2018 Pers Comm). Inundation and percolation of low-lying freshwater marshes and reedbeds by seawater are gradually increasing as a result of dynamic coastal processes at Minsmere-Walberswick SPA. This is likely to negatively impact freshwater invertebrates and plants in some dykes, ditches and reedbeds and drive a gradual transition from freshwater grazing marsh towards saltmarsh communities in key breeding areas like Dingle Marshes (Hay, 2018 Pers Comm). A gradual loss of freshwater extent is inevitable in some areas of the SPA (Miller, 2018 Pers Comm). Rising salinity will favour plants and invertebrates tolerant of brackish or saline conditions (e.g. Salicornia and some Atriplex species) (Denning, 2018 Pers Comm). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. hatching midges, Glyceria fluitans, Agrostis stolonifera, Chara, Potomageton, Ceratophyllum spp., Ruppia) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: standing water. (Cramp and Simmons, 1977), (del Hoyo et al., 1992), (Kear, 2005), (Royal Society for the Protection of Birds (RSPB), 1997)

				Site-specifics: Gadwall are predominantly herbivorous, their diet consists mainly of seeds, leaves, grasses, roots and stems of aquatic plants (del Hoyo et al., 1992). Invertebrates can form nearly 50% of the gadwall diet in breeding season, but drops to around 5% in winter (All About the Birds, 2018). At Minsmere, a 20 ha area of shallow lagoons and islands has been created for wading birds and wildfowl. Reedbeds at Minsmere-Walberswick SPA form part of an extensive wetland system incorporating dense cover and open water and are actively managed to maintain open water areas and provide shallow conditions for submerged vegetation and aquatic invertebrates which are a food resource (Rowlands et al., 2015). Minsmere-Walberswick SPA features an intimate mosaic of different habitat types (Hay, 2018 Pers Comm), offering good connectivity for foraging at site scale. Wetlands are managed in the National Nature Reserve to optimise feeding opportunities for SPA bird features (Hay, 2018 Pers Comm). Inundation and percolation of low-lying freshwater marshes and reedbeds by seawater are gradually increasing as a result of dynamic coastal processes at Minsmere-Walberswick SPA. This is likely to negatively impact freshwater invertebrates and plants in some dykes, ditches and reedbeds and drive a gradual transition from freshwater grazing marsh towards saltmarsh communities in key breeding areas like Dingle Marshes (Hay, 2018 Pers Comm). A gradual loss of freshwater extent is inevitable in some areas of the SPA (Miller, 2018 Pers Comm). Rising salinity will favour plants and invertebrates tolerant of brackish or saline conditions (e.g. Salicornia and some Atriplex species) (Denning, 2018 Pers Comm). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose *(Anser albifrons albifrons)*, Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. cereal grains and potatoes, Puccinellia marima, Hordeum marinum, Lolium perenne, Festuca rubra, Alopecurus bulbosus, Trifolium repens, Lolium perenne, Poa trivialis, Holcus lanatus) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: cultivated/disturbed land, saltmarsh and grassland (improved). (del Hoyo et al., 1992), (Kear, 2005), (Owen, 1976), (Owen et al., 1986), (Ysebaert et al., 1988) Site-specifics: Traditionally foraging on coastal grasslands, saltmarshes and floodplains, where they graze on grass and clover, white-fronted geese have recently taken to feeding on autumn-sown wheat during the spring. Inland feeding areas are generally less than 10km from the roosting sites which are situated on established estuarine sandbanks (Suffolk Ornithologists' Group, 2016). Whilst the white-fronted geese use parts of the SPA as roosts sites, they will spend most of the day feeding on nearby farmland returning to roost after dark. This is supported by evidence from the RSPB who have observed that white-fronted geese which feed mainly at North Warren during the day (peaking at over 300 in recent years) return after dark to roost at Minsmere on the scrape and/or North Levels (Harvey, 2018 Pers Comm). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet *(Recurvirostra avosetta)*, Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Gammarus, Corophium, flies, beetles, Nereis, Hydrobia, Cardium, gobies) at preferred sizes (eg. fish or worms between 4-15 mm long).	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: the intertidal and lagoons. (Cramp and Simmons, 1983), (Hill et al., 1989), (Reay, 1991), (Moreira, 1995), (del Hoyo et al., 1996) Site-specifics: Food availability is a key determinant of avocet chick survival, which is often poor (Royal Society for the Protection of Birds (RSPB), 2018). Parents do not actively feed their young, instead guiding them to feeding territories and defending these from competitors. Fledging success is therefore correlated with the quality and quantity of water available to support prey (Axell, 1975). Avocet productivity is poor in most years; for example no young fledged at Minsmere in 2018. However this may reflect other factors, such as predation (Harvey, 2018 Pers Comm) in addition to food availability. Breeding avocet and their chicks forage in proximity to their nests. It is therefore important that good food sources are available in nesting areas and not solely at the scale of the wider SPA. Adults at Minsmere feed mainly on the lagoons of the Scrape but also forage at the Levels nearby; chicks cannot leave the area due to the presence of a perimeter ditch and electric fence (Harvey, 2018 Pers Comm). The RSPB aim to achieve a sufficient invertebrate biomass at Minsmere to ensure plentiful food for waders and wildfowl. Monitoring has been constrained by flooding, however 2016 sampling of North Girder and East North East areas suggests that invertebrate biomass has decreased since 2015 (Harvey, 2018 Pers Comm). Further monitoring of invertebrate food sources here and elsewhere in the SPA would be beneficial to establish whether these changes reflect any wider trend. Research suggests that the density of invertebrate food sources in artificial brackish lagoons such as those at Minsmere can be influenced by inter-specific predation and the extent and nature of any changes in e.g. salinity, water level and levels of organic matter (Robertson, 1993). Longitudinal studies also show that waterfowl populations on newly created artificial waterbodies typically peak within 3-5 years then decline, mirroring changes in dissolved nutrient levels and aquatic invertebrate densities (Burgess et al., 1992). Active management is therefore important to maintain productivity in artificial lagoon systems. The RSPB monitor and adjust salinity and water levels in the lagoons at Minsmere to maintain the availability of prey items and incorporate organic matter from islands into the lagoon bed when replacing overgrown islands (Rowlands et al., 2015). Other interventions, such as drying out and re-flooding lagoons on

				rotation (Burgess et al., 1992) or breaking up areas of hard substrate along the water's edge to facilitate feeding (Robertson, 1993) can also be used to increase food availability, however these may not be appropriate in natural lagoons or where designated aquatic plants or invertebrates would be affected. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. mammals, birds) at preferred sizes (eg. voles, mice, rabbit; birds of pipit to duck size).	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: freshwater marsh and reedbed. (Cramp and Simmons, 1980), (Sills, 1984), (Underhill-Day, 1985) Site-specifics: The RSPB and Natural England actively manage habitats within the Minsmere RSPB reserve and the Suffolk Coast National Natural Reserve to maintain diversity and encourage small mammals and birds, which are the favoured prey of the marsh harrier. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Salicornia, Atriplex, cereal grains, Polygonum, Eleocharis, Rumex, Ranunculus, Hydrobia, flies, caddisfly, beetles, bugs, hatching midges) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: standing water, cultivated/disturbed land, grassland (marsh/improved) and saltmarsh. (Tamisier, 1985), (Owen et al., 1986), (Nummi et al., 1995), (Kear, 2005), (Cramp and Simmons, 1977), (Royal Society for the Protection of Birds (RSPB), 1997), (del Hoyo et al., 1992) Site-specifics: Breeding season is a time of high energetic demand for teal, due to egg formation and incubation (Arzel et al., 2009). Food sources vary during the year but invertebrates usually form the main constituent of the teal's diet during spring and summer. Teal have access to a wide range of supporting habitats at the SPA for feeding, including shallow open water, grazing marsh and saltmarsh. Minsmere-Walberswick SPA features an intimate mosaic of different habitat types (Hay, 2018 Pers Comm), offering good connectivity for foraging at site scale. However female teal are unlikely to range far from the nest to forage during breeding season (Fisher, 2018 Pers Comm) and male Teal often depart the area to moult once incubation commences (Birdlife International, 2018). Food availability, particularly molluscs, worms, insects and crustaceans teal consume during breeding, is important for a successful breeding cycle. Natural England manage wetlands in the National Nature Reserve to optimise feeding opportunities for designated bird species (Hay, 2018 Pers Comm). The RSPB aim to achieve a sufficient invertebrate biomass at Minsmere to ensure plentiful food for waders and wildfowl. Monitoring has been constrained by flooding, however 2016 sampling of North Girder and East North East areas suggests that invertebrate biomass has decreased since 2015 (Harvey, 2018 Pers Comm). Further monitoring of invertebrate food sources here and elsewhere in the SPA would be beneficial to establish whether these changes reflect any wider trend. Inundation and percolation of low-lying freshwater marshes and reedbeds by seawater are gradually increasing as a result of dynamic coastal processes at Minsmere-Walberswick SPA. This is likely to negatively impact freshwater invertebrates and plants in some dykes, ditches and reedbeds and drive a gradual transition from freshwater grazing marsh towards saltmarsh communities in key breeding areas like Dingle Marshes (Hay, 2018 Pers Comm). A gradual loss of freshwater extent is inevitable in some areas of the SPA (Miller, 2018 Pers Comm) and may increase competition for food resources. Rising salinity will favour plants and invertebrates tolerant of brackish or saline conditions (e.g. Salicornia and some Atriplex species) (Denning, 2018 Pers Comm). However the net impact on food sources for teal is unknown. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Scirpus, Eleocharis, Carex, Potamogeton, Glyceria, surface plankton, hatching midges, Hydrobia, crustaceans, caddisflies, diptera, beetles) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: standing water. (Cramp and Simmons, 1977), (Owen et al., 1986), (del Hoyo et al., 1992), (Kear, 2005), (Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: The site is a complex mosaic of habitats which supports a variety of plant and animal species. Much of the SPA is managed directly for nature conservation as nature reserve. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England.

				The RSPB manage water levels on their Minsmere and Dingle Marshes Reserves for optimal feeding and breeding for the SPA features. Natural England manage Westwood Marshes to create a range of different habitats. When the reeds are cut, the cleared areas provide pools for birds to feed within. The undisturbed areas provide nesting sites and insects for food (Natural England 2013). Deep flooding of saline water may negatively impact reed litter invertebrates, and so is a potential impact of the overtopping on the shingle spit (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. Scirpus, Eleocharis, Carex, Potamogeton, Glyceria, surface plankton, hatching midges, Hydrobia, crustaceans, caddisflies, diptera, beetles) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: standing water. (Cramp and Simmons, 1977), (Owen et al., 1986), (del Hoyo et al., 1992), (Kear, 2005), (Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: Shovelers are surface feeders, and use their large, spatula-shaped, flat bills to filter out small molluscs, crustaceans, insects and plant matter (Royal Society for the Protection of Birds (RSPB), 2018). Wintering shoveler use freshwater and intertidal areas. Dingle Marshes & Walberswick NNR and Minsmere are particularly important areas for non-breeding shovelers within the SPA (Hardy and Woods, 2017). The site is a complex mosaic of habitats which supports a variety of plant and animal species. Much of the SPA is managed directly for nature conservation as nature reserve. Dingle Marshes Nature Reserve is managed through a unique partnership between the Suffolk Wildlife Trust, RSPB and Natural England. Hen Reedbeds Nature Reserve is managed by the Suffolk Wildlife Trust, Minsmere Nature Reserve is managed by the RSPB, and Walberswick National Nature Reserve is managed by Natural England. The RSPB manage water levels on their Minsmere and Dingle Marshes Reserves for optimal feeding and breeding for the SPA features. Natural England manage Westwood Marshes to create a range of different habitats. When the reeds are cut, the cleared areas provide pools for birds to feed within. The undisturbed areas provide nesting sites and insects for food (Natural England 2013). Deep flooding of saline water may negatively impact reed litter invertebrates, and so is a potential impact of the overtopping on the shingle spit (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: hydrology/flow within grassland (marsh)	Maintain water availability in feeding sites to provide shallow surface water and damp field condition	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997), (Newbold, 1997) Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit (Rowlands et al., 2015). Regular intervention is required to maintain the stability of standing water levels at Minsmere Walberswick SPA. Some areas are very wet and others very dry, whilst large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and lagoons (Hay, 2018 Pers Comm). RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth of from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The pools and scrapes are managed by the RSPB. Water levels are lowered in the summer and maintained at optimal depth for feeding and loafing for waders and wildfowl (Rowlands et al., 2015). This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: hydrology/flow within grassland (marsh)	Maintain water availability in feeding sites to provide shallow surface water and damp field condition	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for drinking, preening, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997), (Newbold, 1997) Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit (Rowlands et al., 2015). Regular intervention is required to maintain the stability of standing water levels at Minsmere Walberswick SPA. Some areas are very wet and others very dry, whilst large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and lagoons (Hay, 2018 Pers Comm). RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth of from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The pools and scrapes are managed by the RSPB. Water levels are lowered in the summer and maintained at optimal depth for feeding and loafing for waders and wildfowl (Rowlands et al., 2015). This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: hydrology/flow within standing water	Maintain the hydrology of a waterbody used as a feeding site such that water levels reduce (or are reduced) by 5-15% each month from the time of mean hatch date to the end of the breeding season.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit (Rowlands et al., 2015). Regular intervention is required to maintain the stability of standing water levels at Minsmere-Walberswick SPA. Some areas are very wet and others very dry, whilst large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and lagoons (Hay, 2018 Pers Comm). RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth of from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The pools and scrapes are managed by the RSPB. Water levels are lowered in the summer and maintained at optimal depth for feeding and loafing for waders and wildfowl (Rowlands et al., 2015). This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: hydrology/flow	Maintain the hydrology of a waterbody used as a feeding site such that water levels reduce (or are reduced) from the	Year round – to ensure the habitat remains suitable	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute.

	within standing water	time of mean hatch date to the end of the breeding season.	for when the feature is present	(Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: Areas of standing water include open water within extensive reedbeds, drains and ditches containing emergent and aquatic vegetation, seasonally flooded areas of wet grassland and coastal lagoons. These offer breeding teal a rich variety of food sources, including seeds and invertebrates such as Diptera larvae. As dabbling ducks teal, and especially their chicks, require shallow areas in proximity to their nests to feed effectively. Breeding female teal walk their chicks to the water's edge to feed independently and dabble or upend in shallow areas to reach invertebrates and aquatic plants; they also probe soft areas like mudflats and saltmarsh for prey (Carboneras, 1992). The SPA is situated in one of the lowest areas of rainfall in Britain, and evapotranspiration may exceed rainfall between April and August, when teal are incubating eggs and raising chicks (Rowlands et al., 2015). Some areas are very wet and others very dry and large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Hydrology/flow is therefore actively managed via drains and sluices to maintain suitable conditions for SPA bird features. Water levels in the RSPB Minsmere & Dingle Marshes reserve are intensively managed to optimise conditions for birds via a network of over 100 water control structures (Harvey, 2018 Pers Comm). Water levels in the reedbeds are maintained during early spring and then allowed to drop gradually during the summer months. In recent years breeding teal have mostly nested in Dingle Marshes. Nests have also been noted in the Hen Reedbeds area and the Blyth Estuary (Hardy and Woods, 2017), both at the northern end of the SPA and on the Scrape at Minsmere. Grazing marsh at the Dingle is fed by multiple springs, with the northenmost marshes fed by the Dunwich River. Dingle marshes drain north into the Dunwich River via an Environment Agency tidal flap sluice (Rowlands et al., 2015). Other areas actively managed to provide nesting habitat for waders (such as the lagoons and islands created at Minsmere) also offer areas of shallow water suitable for breeding and feeding Teal (Rowlands et al., 2015). This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: hydrology/flow within standing water	Maintain the hydrology of a waterbody used as a feeding site such that water levels reduce (or are reduced) from the time of mean hatch date to the end of the breeding season.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and/or the likelihood of impacts on this attribute. (Royal Society for the Protection of Birds (RSPB), 1997) Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit (Rowlands et al., 2015). Regular intervention is required to maintain the stability of standing water levels at Minsmere Walberswick SPA. Some areas are very wet and others very dry, whilst large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and lagoons (Hay, 2018 Pers Comm). RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth of from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The pools and scrapes are managed by the RSPB. Water levels are lowered in the summer and maintained at optimal depth for feeding and loafing for waders and wildfowl (Rowlands et al., 2015). This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: hydrology/flow within standing water	Maintain the stability of standing water levels (<2 cm fluctuation) in order to prevent flooding of nests.	Year round – to ensure the habitat remains suitable for when the feature is present	Changes in source, depth, duration, frequency, magnitude and timing of water supply or flow can have important implications for this feature. Such changes may affect the quality and suitability of habitats used by birds for nesting, drinking, preening, rearing, feeding or roosting. Unless these have already been undertaken, further site-specific investigations may be required to fully inform conservation measures for this feature and / or the likelihood of impacts on this attribute. (Cadbury et al., 1989) Site-specifics: Areas of standing water at Minsmere-Walberswick SPA include brackish lagoons, seasonally flooded areas of wet grassland, open water within drains and ditches and extensive reedbeds. Avocet nest on exposed, flat areas of land adjacent to water bodies which provide food sources such as benthic and nektonic invertebrates and small fish. However nests positioned close to water bodies are vulnerable to flooding (Rowlands et al., 2015). Regular intervention is required to maintain the stability of standing water levels at Minsmere-Walberswick SPA. Some areas are very wet and others very dry, whilst large areas are subject to seasonal flooding, both by freshwater and incursions of seawater (Hay, 2018 Pers Comm). Conversely the SPA is situated in one of the lowest areas of rainfall in Britain, and evapotranspiration may exceed rainfall between April and August, when avocet are incubating eggs and raising chicks (Rowlands et al., 2015). This can result in drying out of water bodies. Water levels are therefore adjusted via drains and sluices to maintain suitable conditions. Water levels in the RSPB Minsmere & Dingle Marshes reserve are intensively managed via a network of over 100 water control structures (Harvey, 2018 Pers Comm). Suffolk Wildlife Trust and Natural England also manipulate water levels elsewhere in the SPA, particularly on reedbeds and pools (Hay, 2018 Pers Comm). Standing water levels are also subject to natural phenomena such as seasonal overtopping of shingle barriers by sea water (at e.g. Dingle Marshes and Tinker's Marsh) and fluvial flooding following heavy rains (e.g. Minsmere) (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Both fluvial and seawater flooding may increase in frequency and severity as a result of increased storminess and more concentrated periods of heavy rainfall associated with climate change (Rowlands et al., 2015). Under such conditions existing water management structures may be inadequate to prevent flooding of nests. Conversely decreased inputs of water in warmer months may necessitate increased use of local watercourses to maintain water and salinity levels suitable for avocet and their prey (Rowlands et al., 2015). Such use may be constrained by water quality issues (Natural England, 2014). Such factors are being taken into account in management planning for the SPA. This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: landform	Maintain the availability of shallow sloping nesting sites, grading to above water level, restricting the probability that they will flood.	Year round – to ensure the habitat remains suitable for when the feature is present	The physical topography and landform of a site will strongly influence the quality and extent of supporting habitats used by this feature for nesting / rearing, feeding and / or roosting as appropriate. This will also influence the interactions with underlying supporting processes on which the supporting habitat may rely. Any changes or modifications to site topography may adversely affect the ability of the supporting habitats to support and sustain this feature. (Hill, 1988), (Goutner, 1986), (del Hoyo et al., 1996) Site-specifics: Minsmere-Walberswick SPA is situated in a flat, low-lying area on a coastline experiencing rapid change as a result of natural processes such as erosion of shingle, sea level change and increasing rates of extreme climatic events such as pluvial and fluvial flooding (Hay, 2018 Pers Comm)(Rowlands et al., 2015). As such, ground nesting species like avocet, which favour sites near water, are at risk of flooding. Water levels and topography are actively managed across much of the SPA to maintain shallow nest sites and manage flood risk (Hay, 2018 Pers Comm). The scrape, a key nesting area for avocet, features artificially created landforms (namely brackish lagoons and islands) created specifically to support breeding waders, including avocet. Ongoing management of these habitats by the RSPB allows regular fine-tuning of topography to optimise conditions for breeding birds. For example, new islands are periodically created using lagoon mud to replace those which have become overgrown by vegetation (Rowlands et al., 2015). Smaller artificial scrapes have also been created on the surrounding Levels and at Dingle Marshes (Harvey, 2018 Pers Comm) where they supplement natural lagoons and pools. Where excavations or vegetation clearance take place in ditches and pools their edges are re-profiled to maintain shallow access to the water's edge (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus*	Supporting habitat: landscape	Maintain continuous reed cover over large areas avoiding fragmentation of extensive reedbeds.	Year round – to ensure the habitat remains suitable	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its nesting, roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within nesting, feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat.

***aeruginosus*), Breeding**			for when the feature is present	(English Nature, 1994) Site-specifics: Reedbeds cover a vast area of the SPA and constitute one of the largest examples of this habitat in Britain (Rowlands et al., 2015). Reedbeds in the RSPB's Minsmere and Dingle Marshes reserve are cut on rotation to improve connectivity and maintain areas of open water adjacent to dense vegetation. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for foraging and roosting birds. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: landscape	Maintain open and unobstructed terrain and overall field sizes within at least 0.5 km of roosting and feeding areas.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. (Vickery and Gill, 1999) Site-specifics: The overwintering white-fronted geese at Minsmere-Walberswick SPA tend to spend most of their days outside of the SPA grazing in nearby farmland and returning after dark to roost. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for foraging and roosting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: landscape	Maintain the area of open and unobstructed terrain around roosting and feeding sites.	Year round – to ensure the habitat remains suitable for when the feature is present	This attribute ensures that important habitats used by the feature are not impacted, regardless of whether the bird is present at that time. This feature is known to favour large areas of open terrain, largely free of obstructions, in and around its nesting, roosting and feeding areas. Often there is a need to maintain an unobstructed line of sight within nesting, feeding or roosting habitat to detect approaching predators, or to ensure visibility of displaying behaviour. An open landscape may also be required to facilitate movement of birds between the SPA and any off-site supporting habitat. Site-specifics: Minsmere-Walberswick SPA is situated in a flat, low-lying landscape on a coastline experiencing rapid change as a result of natural coastal processes (Hay, 2018 Pers Comm). The landscape comprises an intimate mixture of predominately open terrain, including reedbeds, fen, heath, grazing marsh, saltmarsh and brackish lagoons, with taller scrub and woodland in some areas. Avocet breed in open areas such as islands on the scrape at Minsmere and in Dingle Marshes. In these areas vegetation management is required to maintain the open vistas and sparse ground cover that breeding avocet require for nesting. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for foraging and roosting birds. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: salinity	Maintain water salinity at <2.5%	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to be particularly susceptible to changes in the salinity (concentration of salt) of its shallow brackish / fresh water habitat. Salinity is a major factor determining the distribution and composition of communities of aquatic invertebrates such as insects, crustaceans and worms on which this feature feeds. High levels of salinity can adversely affect invertebrate food for adults and chicks. The principal factors governing the temporal and spatial nature of the salinity regime of coastal sites are the diurnal incursion of the tide and fresh water flow from the river(s). Any activity changing either of these factors can result in a change to the salinity regime. (Cadbury and Richards, 1978), (Hill et al., 1989), (del Hoyo et al., 1996) Site-specifics: In addition to diurnal fluctuations in some coastal lagoons salinity levels at Minsmere-Walberswick SPA are also subject to sudden and sometimes sustained changes as a result of e.g. overtopping of shingle barriers by seawater and pluvial and fluvial flooding (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Flooding is more common during winter but can have a lasting impact on aquatic invertebrates and floods have also occurred during avocet breeding season (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Evaporation and low rainfall during warmer months also increase lagoon salinity, and hypersalinity as a result of drought can have a negative impact on invertebrate populations (Harvey, 2018 Pers Comm). Salinity levels in key areas of Minsmere Walberswick SPA, such as lagoons at the Scrape, are actively managed by increasing freshwater inputs and/or using sluices and drains to manage water levels, maintaining suitable conditions for breeding birds and their prey. The RSPB ensure that high salinity areas at Minsmere remain wet all year round to prevent hypersaline conditions, ensuring healthy populations of benthic invertebrates (Rowlands et al., 2015).

				Target salinities vary between areas to maintain a diverse range of prey items for breeding and passage waders and wildfowl (Burgess et al., 1992). Salinity levels are also manipulated in some areas to manage invasive vegetation such as horsetail (Rowlands et al., 2015). As salinity levels vary significantly, regular monitoring is essential to inform management. The RSPB aim to monitor salinity at set points within the coastal lagoons, reedbeds and adjacent ditches and watercourses and to increase the frequency of monitoring during overtopping of the sea defences (Rowlands et al., 2015). Stable salinity regimes may be difficult to maintain in some areas (Rowlands et al., 2015). In addition natural saline transitions are a Ramsar feature in their own right and active coastal processes are gradually altering the salinity of large areas. Much of the grazing marsh at Dingle Marshes is in transition towards saltmarsh due to increasing inundation by seawater (Hay, 2018 Pers Comm). Natural England, Suffolk Wildlife Trust and the RSPB therefore encompass these longer term salinity changes in managing the SPA as a whole (Hay, 2018 Pers Comm). Roll back of brackish lagoons may be facilitated where needed to retain habitat and food sources for waders (Hay, 2018 Pers Comm)(Rowlands et al., 2015) and re-alignment of some fresh water courses will allow retention of freshwater habitat for wildfowl (Miller, 2018 Pers Comm). This landscape-scale management of salinity and water features will benefit a range of breeding birds. This site is subject to both fresh water and saline water inundation. Due to dynamic coastal processes and managed change, this site is likely to become more saline over time, as exhibited by the ongoing natural transition of fresh water grazing marsh to saltmarsh. This will affect the hydrology on the site as well as the extent, distribution and quality of the supporting habitats, including some of the bird species that depend on that supporting habitat. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: vegetation characteristics for feeding	Maintain vegetation heights at between 10-20 cm in areas used for feeding.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful concealment/roosting/foraging/feeding and/or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Vickery and Gill, 1999) Site-specifics: Traditionally foraging on coastal grasslands, saltmarshes and floodplains, where they graze on grass and clover, white-fronted geese have recently taken to feeding on autumn-sown wheat during the spring. Inland feeding areas are generally less than 10km from the roosting sites which are situated on established estuarine sandbanks. (Suffolk Ornithologists' Group, 2016). Many of the habitats used for feeding at Minsmere-Walberswick SPA occur as a diverse mosaic at small scale, rather than as large blocks of a single plant community (Hay, 2018 Pers Comm). Reedbeds are a notable exception- these cover a vast area of the SPA and constitute one of the largest reedbeds in Britain (Rowlands et al., 2015). RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for foraging birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain a management regime that ensures the constant availability of areas of dense reed stands as nesting cover.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting / rearing / concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Cramp and Simmons, 1980) Site-specifics: Marsh harriers nest on the ground in reedbeds, where good vegetation cover is available to conceal nests. Reedbeds within the site are cut on rotation to maintain a diverse structure (Rowlands et al., 2015). Marsh Harriers utilise both fresh and salt water habitats for hunting, but require proximity to freshwater reedbeds with good cover for breeding within the site. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for nesting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the overall heights of vegetation patches (20-60 cm) within nesting areas that are typically<50 m from the water's edge.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting/rearing/concealment/roosting/foraging/feeding and/or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Cramp and Simmons, 1977), (del Hoyo et al., 1992), (Snow and Perrins, 1998), (Kear, 2005)

				Site-specifics: At Minsmere, a 20 ha area of shallow lagoons and islands has been created for wading birds and wildfowl. This area is renowned for its breeding colony of gadwall and other species. Grazing marshes occur at Minsmere Level and Walberswick which are chiefly of value for these feeding and breeding birds (Rowlands et al., 2015). Minsmere-Walberswick SPA features one of Britain's most extensive areas of *Phragmites* reedbed (Rowlands et al., 2015). Accessible areas of marsh are grazed by livestock between breeding seasons to manage vegetation height. Grazing has recently ceased at Dingle Marshes as fresh water is not currently available for livestock (Hay, 2018 Pers Comm). This may increase vegetation height in the short term, however increasing salinity in this area as the result of active coastal processes is gradually driving displacement of grazing marsh by salt marsh communities (Hay, 2018 Pers Comm). This may affect gadwall nesting opportunities. Wet, species rich grazing marsh dissected by ditches in the south west of the SPA also provides potential nest sites and supporting habitat for breeding gadwall. Ditches choked with plants are cleared periodically to create greater variety in the structure of marginal and emergent vegetation and maintain areas of open water (Natural England, 2015)(Natural England, 2016). This provides conditions that may attract breeding gadwall in future. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for nesting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the overall heights of vegetation patches (20-60 cm) within nesting areas.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting/rearing/concealment/roosting/foraging/feeding and/or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Cramp and Simmons, 1977), (Kear, 2005) Site-specifics: In the south of Britain teal typically nest in well-hidden depressions along still or slowly moving water where good vegetation cover is available to conceal nests (British Trust for Ornithology, 2018). Such areas are scattered across Minsmere-Walberswick SPA. This offers a mosaic of wetland habitats interconnected by freshwater and brackish water bodies and actively managed to provide conditions suitable for breeding birds. Dingle Marshes, Hen Reedbeds and areas of the Blyth Estuary and the lagoons created at Minsmere have all hosted breeding teal in previous seasons (Rowlands et al., 2015). RSPB manage the reserve at Minsmere to provide a range of vegetation conditions suitable for breeding and overwintering birds. Islands in the scrape are primarily managed for waders and feature bare mud and sparse vegetation unsuitable for teal, however reedbeds are cut on rotation to maintain a more diverse structure (Rowlands et al., 2015). Grazing has recently ceased at Dingle Marshes as fresh water is not currently available for livestock (Natural England (NE), 2015). This may increase vegetation height in the short term, however increasing salinity in this area as the result of active coastal processes is gradually driving displacement of grazing marsh by salt marsh communities (Natural England (NE), 2015). Teal utilise saltmarsh for feeding but require proximity to freshwater for breeding. Wet, species rich grazing marsh dissected by ditches in the south west of the SPA also provides potential nest sites and supporting habitat for breeding teal. Ditches choked with plants are cleared periodically to create greater variety in the structure of marginal and emergent vegetation and maintain areas of open water (Natural England, 2015)(Natural England, 2016). This provides conditions that may attract breeding teal in future. As dynamic coastal processes such as the erosion and overtopping of shingle barriers increase inundation and infiltration by seawater freshwater areas at the SPA are likely to contract significantly, giving way to more brackish conditions (Miller, 2018 Pers Comm). Furthermore vegetation growth across the SPA is likely to be enhanced between breeding seasons as a result of increasing temperatures associated with climate change (Rowlands et al., 2015). Both processes may impact the extent and quality of breeding habitat available for teal. As such active management of vegetation to provide dense areas of cover around remaining freshwater areas will be vital if teal are to continue nesting at Minsmere-Walberswick SPA. RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for nesting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the overall heights of vegetation patches (20-60 cm) within nesting areas.	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting/rearing/concealment/roosting/foraging/feeding and/or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Thomas, 1980)

				Site-specifics: Shovelers preferentially nest in sparse cover near to shallow eutrophic still waters (Drewitt et al., 2008)(Hardy and Woods, 2017). Water levels in the reedbed are maintained from late winter to early spring. Reedbed levels are lowered when reed-cutting management takes place (Rowlands et al., 2015). Minsmere RSPB Reserve is a particularly important area of the SPA for breeding shovelers (Hardy and Woods, 2017), a 20 ha area of shallow lagoons and islands has been created for wading birds and wildfowl (Rowlands et al., 2015). Dingle Marshes are one of the largest freshwater reedbeds in the UK. A long shingle spit separates the reedbeds from the sea. These reedbeds are increasingly vulnerable to inundation of seawater during winter storms (Royal Society for the Protection of Birds (RSPB), 2018). RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for nesting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: vegetation characteristics for nesting	Maintain the proportion of vegetated to bare ground within nesting areas with generally <40%	Year round – to ensure the habitat remains suitable for when the feature is present	The height, cover, variation and composition of vegetation are often important characteristics of habitats supporting this feature which enables successful nesting / rearing / concealment / roosting / foraging / feeding and / or displaying. Many bird species will have specific requirements that conservation measures will aim to maintain, for others such requirements will be less clear. Activities that may directly or indirectly affect the vegetation of supporting habitats and modify these characteristics may adversely affect the feature. (Goutner, 1986) Site-specifics: Avocet favour bare conditions or sparse, low vegetation for nesting (Birdlife International, 2018) since this affords a clear view of any predators. Islands at the scrape in Minsmere were created specifically to offer conditions suitable for breeding waders like avocet (Burgess et al., 1992) and remain the most important location for nesting avocet at Minsmere-Walberswick SPA. Vegetation on the RSPB reserve is managed to create optimum conditions for nesting bird species, including avocet. Increasing salinity in some seaward areas of the SPA (for example at Dingle Marshes) is altering the vegetation communities present, favouring development of sparse saltmarsh vegetation rather than grazing marsh. This may provide vegetation conditions that appeal to nesting avocet, however nests on saltmarsh may be lost to high spring tides. (Van De Pol et al., 2010) analysed tidal and nesting data from Europe's largest coastal wetland and found that climate change is driving more extreme tidal events, decreasing the quality of low areas such as saltmarsh as nesting habitat for waders including avocet. There may be few environmental cues to indicate this increased flood risk between flooding events; as such low lying areas of saltmarsh can function as an 'ecological trap' for waders seeking nesting habitat. Vegetation management in sites less prone to flooding (for example in higher areas of saltmarsh) may therefore be valuable to mitigate the effects of climate change on breeding waders (Van De Pol et al., 2010). RSPB, Natural England and Suffolk Wildlife Trust, all manage the site to provide optimum vegetation heights and structure for nesting birds. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: water area	Maintain the number and size of waterbodies of optimal size (>20 ha).	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. (Owen et al., 1986) Site-specifics: Freshwater at Dingle grazing marshes is from springs (Rowlands et al., 2015), saline water seeps through the shingle bank creating the saline lagoons. The main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water levels, particularly on reedbeds and pools (Hay, 2018 Pers Comm). Water levels in the reedbeds are maintained at optimal depths from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place The grazing marsh is flooded in the winter for wildfowl. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: water area	Maintain the number of waterbodies of optimal size.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully nest, rear their young, feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. Site-specifics: Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and pools (Hay, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth from late

				winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The grazing marsh is flooded in the winter for wildfowl. Water levels are drawn down in the spring and summer (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: water area	Maintain the number of waterbodies of optimal size.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. Site-specifics: Saline water seeps through the shingle bank creating the saline lagoons. Main input to the reedbeds are via groundwater springs and rainfall. All of the Reserves manage water level, particularly on reedbeds and pools (Hay, 2018 Pers Comm). Water levels in the reedbed are maintained at an optimal depth from late winter to early spring. Reedbed levels are lowered with reed-cutting management is taking place (Rowlands et al., 2015). The grazing marsh is flooded in the winter for wildfowl. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: water area	Maintain the number of waterbodies of optimal size.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully nest, rear their young, feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. Site-specifics: Minsmere-Walberswick SPA features a range of waterbodies, including open water in reedbed areas, drains and ditches, seasonally flooded wet grassland and coastal lagoons. Breeding teal favour still or slow flowing bodies of freshwater in close proximity to marginal or other vegetation that offers good cover for nest sites. Minsmere Walberswick SPA features one of the largest *Phragmites* reedbed systems in Britain, an area of over 160ha interspersed with at least 22 ha. of standing water surrounded by dense vegetation. The reedbeds form part of an extensive wetland system and are cut on rotation to maintain multiple areas of open water at a scale suitable for wildfowl and to maintain connectivity throughout this vast area (Rowlands et al., 2015). The RSPB have also created 20 ha. of shallow lagoons and islands at Minsmere (Rowlands et al., 2015), providing additional suitable water area. Winter flooding dramatically increases the area of fresh standing water at Minsmere Walberswick SPA in most years, inundating low lying areas which gradually draw down to leave shallow pools on wet grassland (Rowlands et al., 2015). Such pools may benefit breeding teal, however spring flood events (reported in e.g. 2012 and subsequent years) can be detrimental to breeding birds, inundating nests and impacting reed litter invertebrates, a food source for teal (Rowlands et al., 2015). Flooding is cannot be fully controlled (as this is subject to weather conditions and broader flood management priorities e.g. EA main rivers) but is actively managed by way of sluices and drains to optimise habitat conditions (Rowlands et al., 2015). Dynamic coastal processes like erosion, saline percolation and overtopping of shingle barriers by seawater are gradually changing the extent, location and nature of water bodies (Hay, 2018 Pers Comm). These natural processes are an important feature of the site in their own right and may impact the number of waterbodies of optimal size in future (Agency, 2010). However long term management plans for the SPA prioritise retention of freshwater areas and will also support inland migration of coastal lagoons on coastal marshes at the seaward edge of the SPA (Hay, 2018 Pers Comm)(Miller, 2018 Pers Comm)(Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: water area	Maintain the number of waterbodies of optimal size.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. Site-specifics: Minsmere-Walberswick SPA features a range of waterbodies, including open water in reedbed areas, drains and ditches, seasonally flooded wet grassland and coastal lagoons. Minsmere-Walberswick SPA features one of the largest *Phragmites* reedbed systems in Britain, an area of over 160ha interspersed with at least 22 ha. of standing water surrounded by dense vegetation. The reedbeds form part of an extensive wetland system and are cut on rotation to maintain multiple areas of open water at a scale suitable for wildfowl and to maintain connectivity throughout this vast area (Rowlands et al., 2015). The RSPB have also created 20 ha. of shallow lagoons and islands at Minsmere (Rowlands et al., 2015), providing additional suitable water area. Winter flooding dramatically increases the area of fresh standing water at Minsmere Walberswick SPA in most years, inundating low lying areas which gradually draw down to leave shallow pools on wet grassland (Rowlands et al., 2015). Flooding cannot be fully controlled (as this is subject to weather conditions and broader flood management priorities, but it is actively managed by way of sluices and drains to optimise habitat conditions (Rowlands et al., 2015).

				Dynamic coastal processes like erosion, saline percolation and overtopping of shingle barriers by seawater are gradually changing the extent, location and nature of water bodies (Hay, 2018 Pers Comm). These natural processes are an important feature of the site in their own right and may impact the number of waterbodies of optimal size in future (Agency, 2010). However long term management plans for the SPA prioritise retention of freshwater areas and will also support inland migration of coastal lagoons on coastal marshes at the seaward edge of the SPA (Hay, 2018 Pers Comm)(Miller, 2018 Pers Comm)(Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: water area	Maintain the number of waterbodies of optimal size.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature depends on the presence and continuity of open water habitat; often requiring water bodies of a particular size to in order to successfully nest, rear their young, feed and/or roost. Changes in water area, and associated marginal habitat, can adversely affect the suitability of supporting open water habitat. Site-specifics: Minsmere Walberswick SPA features a range of waterbodies, including open water in reedbed areas, drains and ditches, seasonally flooded wet grassland and coastal lagoons. Breeding gadwall prefer still or slow flowing water with marginal or other vegetation that offers good cover for nest sites. Minsmere-Walberswick SPA features one of the largest *Phragmites* reedbed systems in Britain, an area of over 160ha interspersed with at least 22 ha. of standing water surrounded by dense vegetation. The reedbeds form part of an extensive wetland system and are cut on rotation to maintain multiple areas of open water at a scale suitable for wildfowl and to maintain connectivity throughout this vast area (Rowlands et al., 2015). The RSPB have also created 20 ha. of shallow lagoons and islands at Minsmere (Rowlands et al., 2015), providing additional suitable water area. Winter flooding dramatically increases the area of fresh standing water at Minsmere-Walberswick SPA in most years, inundating low lying areas which gradually draw down to leave shallow pools on wet grassland (Rowlands et al., 2015). Such pools may benefit breeding waterfowl including gadwall, however spring flood events (reported in e.g. 2012 and subsequent years) can be detrimental to breeding birds, inundating nests and impacting food sources. Flooding cannot be fully controlled (as this is subject to weather conditions and broader flood management priorities, but it is actively managed by way of sluices and drains to optimise habitat conditions (Rowlands et al., 2015). Dynamic coastal processes like erosion, saline percolation and overtopping of shingle barriers by seawater are gradually changing the extent, location and nature of water bodies (Hay, 2018 Pers Comm). These natural processes are an important feature of the site in their own right and may impact the number of waterbodies of optimal size in future (Agency, 2010). However long term management plans for the SPA prioritise retention of freshwater areas and will also support inland migration of coastal lagoons on coastal marshes at the seaward edge of the SPA (Hay, 2018 Pers Comm)(Miller, 2018 Pers Comm)(Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: water depth	Maintain the availability and area of standing water of 3-5 cm deep	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Cadbury et al., 1989) Site-specifics: Natural England, Suffolk Wildlife Trust and the RSPB monitor and actively manage water levels at the SPA to provide optimal depths for a range of birds, including waders (Hay, 2018 Pers Comm)(Rowlands et al., 2015). Shallow water margins are beneficial to feeding avocet. Water depth for this species should ideally not exceed 13cm and small chicks may struggle to feed in water over 5cm deep (Cadbury et al., 1989). Control of water levels is constrained by natural and practical factors, e.g. the main sluice at Minsmere is unable to drain pluvial flooding quickly enough to prevent episodes of detrimental flooding. Spring flooding results in the occasional loss of nests (Rowlands et al., 2015). The SPA is situated in one of the lowest areas of rainfall in Britain, and evapotranspiration can exceed rainfall during avocet breeding season (Rowlands et al., 2015). Water quality is therefore significant in managing water depth, as concerns regarding eutrophication or pollution can constrain use of local watercourses to maintain water and salinity levels suitable for avocet and their prey (Natural England, 2014)(Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: water depth	Maintain the availability of standing water at optimal depth, typically <0.3 m deep	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Cramp and Simmons, 1977), (Newbold, 1997)

				Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit of 179-203 mm. Freshwater at Dingle grazing marshes is from springs. (Rowlands et al., 2015). Water levels are managed within all Reserves within the SPA. RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). The grazing marsh is flooded in the winter for wildfowl. Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: water depth	Maintain the availability of standing water at optimal depth, typically <0.3 m deep	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Cramp and Simmons, 1977), (Newbold, 1997) Site-specifics: Suffolk has some of the lowest rainfall in Britain, and at Minsmere there is an annual water deficit of 179-203 mm. Freshwater at Dingle grazing marshes is from springs. (Rowlands et al., 2015). Water levels are managed within all Reserves within the SPA. RSPB Minsmere alone, has over 100 water control structures on site to intensively manage water levels according to the set management plan (Harvey, 2018 Pers Comm). The grazing marsh is flooded in the winter for wildfowl. Water levels are drawn down in the spring and summer (Rowlands et al., 2015). Further management can be found in the Site Improvement Plan (Natural England, 2014). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: water depth	Maintain the availability of standing water of optimal depth, typically <0.1 m deep	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Owen et al., 1986), (Gilburn and Kirby, 1992), (Newbold, 1997), (Kear, 2005) Site-specifics: Minsmere Walberswick SPA features a range of waterbodies, including open water in reedbed areas, drains and ditches, seasonally flooded wet grassland and coastal lagoons. Breeding teal favour still or slow flowing bodies of freshwater in close proximity to marginal or other vegetation that offers good cover for nest sites. Minsmere-Walberswick SPA features one of the largest *Phragmites* reedbed systems in Britain, an area of over 160ha interspersed with at least 22 ha. of standing water surrounded by dense vegetation. The reedbeds form part of an extensive wetland system and are cut on rotation to maintain multiple areas of open water at a scale suitable for wildfowl and to maintain connectivity throughout this vast area (Rowlands et al., 2015). The RSPB have also created 20 ha. of shallow lagoons and islands at Minsmere (Rowlands et al., 2015), providing additional suitable water area. Winter flooding dramatically increases the area of fresh standing water at Minsmere-Walberswick SPA in most years, inundating low lying areas which gradually draw down to leave shallow pools on wet grassland (Rowlands et al., 2015). Such pools may benefit breeding teal, however spring flood events (reported in e.g. 2012 and subsequent years) can be detrimental to breeding birds, inundating nests and impacting reed litter invertebrates, a food source for teal (Rowlands et al., 2015). Flooding is cannot be fully controlled (as this is subject to weather conditions and broader flood management priorities e.g. EA main rivers) but is actively managed by way of sluices and drains to optimise habitat conditions (Rowlands et al., 2015). Dynamic coastal processes like erosion, saline percolation and overtopping of shingle barriers by seawater are gradually changing the extent, location and nature of water bodies (Hay, 2018 Pers Comm). These natural processes are an important feature of the site in their own right and may impact the number of waterbodies of optimal size in future (Agency, 2010). However long term management plans for the SPA prioritise retention of freshwater areas and will also support inland migration of coastal lagoons on coastal marshes at the seaward edge of the SPA (Hay, 2018 Pers Comm)(Miller, 2018 Pers Comm)(Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: water depth	Maintain the availability of standing water of optimal depth, typically <0.1 m deep, over at least 22 hectares.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Thomas, 1980)

				Site-specifics: Natural England, Suffolk Wildlife Trust and the RSPB monitor and actively manage water levels at the SPA to provide optimal depths for a range of wildfowl including gadwall (Harvey, 2018 Pers Comm)(Rowlands et al., 2015). Shallow areas like these are beneficial to feeding wildfowl including gadwall. Water depth is also maintained in areas where salinity is high to prevent hypersalinity and ensure high numbers of longer-lived benthic invertebrates (Rowlands et al., 2015). Invertebrates can form nearly 50% of the gadwall diet in breeding season, but drops to around 5% in winter (All About the Birds, 2018). Ditches in Dingle Marshes are maintained at high water levels all year round to act as boundaries and benefit wildfowl and waders and Fen areas are actively waterlogged or flooded over winter (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: water depth	Maintain the availability of standing water of optimal depth, typically <0.1 m deep, over at least 22 hectares.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Thomas, 1980) Site-specifics: Natural England, Suffolk Wildlife Trust and the RSPB monitor and actively manage water levels at the SPA to provide optimal depths for a range of wildfowl including gadwall (Harvey, 2018 Pers Comm)(Rowlands et al., 2015). Water levels are drawn down slowly until July, exposing muddy edges suitable for access and feeding, and reedbed water levels are maintained in eastern areas of Dingle Marshes until the end of breeding season (Rowlands et al., 2015). Management of ditches at Minsmere and reedy islands in the North and South Levels includes re-profiling to ensure that breeding birds can access standing water and surrounding land (Rowlands et al., 2015). Shallow areas like these are beneficial to feeding wildfowl including gadwall. In July and August, low levels are maintained in freshwater areas for waders and wildfowl and to facilitate vegetation management. Water depth is also maintained in areas where salinity is high to prevent hypersalinity and ensure high numbers of longer-lived benthic invertebrates (Rowlands et al., 2015). Invertebrates can form nearly 50% of the gadwall diet in breeding season, but drops to around 5% in winter (All About the Birds, 2018). Ditches in Dingle Marshes are maintained at high water levels all year round to act as boundaries and benefit wildfowl and waders. Some surface water is retained after flooding until June when conditions allow (Rowlands et al., 2015). Fen areas at Dingle Marshes are actively waterlogged or flooded over winter but water levels are lower during breeding season to support fen vegetation communities (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water depth	Maintain the availability of water over the entire reedbed area, with a high proportion of the area with a water depth of 0.1 m to 0.3 m	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Deep water surrounding nesting sites may also be important to deterring predators. (Newbold, 1997) Site-specifics: Natural England, Suffolk Wildlife Trust and the RSPB monitor and actively manage water levels at the SPA to provide optimal depths for a range of birds including nesting marsh harriers (Hay, 2018 Pers Comm)(Rowlands et al., 2015). For example, in Minsmere and Dingle Marshes reserve, all compartments are managed to provide a mean depth of 10-15cm by March/April. Water levels are drawn down slowly until July, exposing muddy edges suitable for access and feeding, and reedbed water levels are maintained at around 20-30cm in eastern areas of Dingle Marshes (Rowlands et al., 2015). Management of ditches at Minsmere, and reedy islands in the North and South Levels, includes re-profiling to ensure that breeding birds can access standing water and surrounding land (Rowlands et al., 2015). The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Marsh harrier (*Circus aeruginosus*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated

		Agency 2019 water body classifications data.		levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Avocet (*Recurvirostra avosetta*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water

				body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Blyth (S) WFD water body overlaps with 12% of Minsmere-Walberswick SPA boundary. This water body failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Teal (*Anas crecca*), Breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

[Gadwall (*Mareca strepera*), Breeding]	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding]	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Avocet (*Recurvirostra avosetta*), Breeding]	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Marsh harrier (*Circus aeruginosus*), Breeding]	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Marsh harrier (*Circus aeruginosus*), Breeding]	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
[Avocet (*Recurvirostra avosetta*), Breeding]	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality.

		blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.		Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Gadwall (*Mareca strepera*), Breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
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Teal (*Anas crecca*), Breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Shoveler (*Spatula clypeata*), Non-breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
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Shoveler (*Spatula clypeata*), Breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats.

				Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
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Teal (*Anas crecca*), Breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
Gadwall (*Mareca strepera*), Non-breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
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[Greater white-fronted goose (*Anser albifrons albifrons*), Non-breeding]	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
[Avocet (*Recurvirostra avosetta*), Breeding]	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.
[Marsh harrier (*Circus aeruginosus*), Breeding]	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: The target has been set due to a lack of evidence that the feature is being impacted by any anthropogenic activities.

See further guidance on how to [undertake an HRA for a plan or project on a European site].

These tables bring together the findings of the best available scientific evidence which may be updated or supplemented in further publications from Natural England and other sources. You may decide to use other additional sources of information.

These tables do not give advice about SSSI features or other legally protected species which may also be present within the European site.
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Improvement Programme for England's Natura 2000 Sites (IPENS)

Planning for the Future

Site Improvement Plan

Minsmere to Walberswick Heaths and Marshes

Site Improvement Plans (SIPs) have been developed for each Natura 2000 site in England as part of the Improvement Programme for England's Natura 2000 sites (IPENS). Natura 2000 sites is the combined term for sites designated as Special Areas of Conservation (SAC) and Special Protected Areas (SPA). This work has been financially supported by LIFE, a financial instrument of the European Community.

The plan provides a high level overview of the issues (both current and predicted) affecting the condition of the Natura 2000 features on the site(s) and outlines the priority measures required to improve the condition of the features. It does not cover issues where remedial actions are already in place or ongoing management activities which are required for maintenance.

The SIP consists of three parts: a Summary table, which sets out the priority Issues and Measures; a detailed Actions table, which sets out who needs to do what, when and how much it is estimated to cost; and a set of tables containing contextual information and links.

Once this current programme ends, it is anticipated that Natural England and others, working with landowners and managers, will all play a role in delivering the priority measures to improve the condition of the features on these sites.

The SIPs are based on Natural England's current evidence and knowledge. The SIPs are not legal documents, they are live documents that will be updated to reflect changes in our evidence/knowledge and as actions get underway. The information in the SIPs will be used to update England's contribution to the UK's Prioritised Action Framework (PAF).

The SIPs are not formal consultation documents, but if you have any comments about the SIP or would like more information please email us at IPENSLIFEProject@naturalengland.org.uk, or contact Natural England's Responsible Officer for the site via our enquiry service 0300 060 3900, or enquiries@naturalengland.org.uk

This Site Improvement Plan covers the following Natura 2000 site(s)

UK0012809	**Minsmere to Walberswick Heaths & Marshes SAC**
UK9009101	**Minsmere-Walberswick SPA**

Site description

Minsmere – Walberswick Heaths & Marshes SAC and SPA is located on the Suffolk coast south of Southwold in eastern England. It comprises two large marshes, the tidal Blyth estuary and associated habitats. This composite coastal site contains a complex mosaic of habitats, notably areas of marsh with dykes, extensive reedbeds, mud-flats, lagoons, shingle, woodland and areas of lowland heath.

It supports the largest continuous stand of Common Reed *Phragmites australis* in England and Wales and demonstrates the nationally rare transition in grazing marsh ditch plants from brackish to fresh water. There are nationally important numbers of breeding and wintering birds. In particular, the reedbeds are of major importance for breeding Bittern *Botaurus stellaris* and Marsh Harrier *Circus aeruginosus*. A range of breeding waders (e.g. Avocets *Recurvirostra avosetta*) and heathland birds occur in other areas of the SPA. The shingle beaches support important numbers of breeding Little Tern *Sterna albifron*s, which feed substantially outside the SPA in adjacent marine waters. The site is also important for wintering Bitterns and raptors. The SAC features are heathland, vegetated annual and perrenial shingle habitats.

Plan Summary

This table shows the prioritised issues for the site(s), the features they affect, the proposed measures to address the issues and the delivery bodies whose involvement is required to deliver the measures. The list of delivery bodies will include those who have agreed to the actions as well as those where discussions over their role in delivering the actions is on-going.

Priority & Issue	Pressure or Threat	Feature(s) affected	Measure	Delivery Bodies
1 Coastal squeeze	Pressure	A051(B) Gadwall, A051(NB) Gadwall	Ensure there is scope for natural adapation or intertidal habitat creation, to offset the impacts of sea level rise	Environment Agency, National Trust, Natural England, RSPB, Suffolk Coastal District Council, Suffolk Wildlife Trust, Waveney District Council, Landowner(s), Blyth Estuary Group, EDF Energy
2 Public Access/Disturbance	Pressure	A021(B) Bittern, A021(NB) Bittern, A051(B) Gadwall, A051(NB) Gadwall, A056(B) Shoveler, A056(NB) Shoveler, A132(B) Avocet, A132(NB) Avocet, A195(B) Little Tern, A224(B) European nightjar, A246(B) Woodlark, A394(NB) Greater white-fronted goose, H1210 Annual vegetation of drift lines, H1220 Coastal shingle vegetation outside the reach of waves, H4030 European dry heaths	Reduce habitat and bird disturbance	Ministry of Defence (MoD), National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Coastal District Council, Suffolk Wildlife Trust, Waveney District Council, Local partnership

3 Changes in species distributions	Pressure	A081(B) Marsh Harrier, A195(B) Little Tern, A224(B) European nightjar, A246(B) Woodlark	Investigate population trends, identify threats and remedy accordingly	Forestry Commission, National Trust, Natural England, RSPB, Suffolk Wildlife Trust, British Trust for Ornithology (BTO), Sandlings Bird Group
4 Invasive species	Pressure	A051(NB) Gadwall, A056(NB) Shoveler, A132(B) Avocet, A132(NB) Avocet, A394(NB) Greater white-fronted goose	Monitor Spartina anglica, and manage as appropriate	Natural England
5 Inappropriate pest control	Threat	A224(B) European nightjar, A246(B) Woodlark	Ensure the adequate protection of nesting birds from predators	Natural England, RSPB, Suffolk Wildlife Trust, British Trust for Ornithology (BTO)
6 Air Pollution: impact of atmospheric nitrogen deposition	Pressure/ Threat	A051(B) Gadwall, A051(NB) Gadwall, A056(B) Shoveler, A056(NB) Shoveler, A132(B) Avocet, A132(NB) Avocet, A224(B) European nightjar, A246(B) Woodlark, A394(NB) Greater white-fronted goose, H4030 European dry heaths	Establish a Site Nitrogen Action Plan	Natural England
7 Water Pollution	Threat	A051(B) Gadwall, A051(NB) Gadwall, A056(B) Shoveler, A056(NB) Shoveler, A132(B) Avocet, A132(NB) Avocet, A394(NB) Greater white-fronted goose	Ensure appropriate thresholds are maintained	Environment Agency, Natural England
8 Deer	Threat	A021(B) Bittern, A021(NB) Bittern, A224(B) European nightjar, A246(B) Woodlark, H4030 European dry heaths	Ensure that coordinated deer management maintains sustainable numbers	Forestry Commission, National Trust, Natural England, RSPB, Suffolk Wildlife Trust, The Deer Initiative, Landowner(s)
9 Fisheries: Commercial marine and estuarine	Pressure	A195(B) Little Tern	Revised approach to fisheries management (Article 6 project) and the Little Tern project	Eastern Inshore Fisheries Conservation Authority (IFCA), Natural England, Centre for Environment, Fisheries and Aquaculture Science (Cefas)

Issues and Actions

This table outlines the prioritised issues that are currently impacting or threatening the condition of the features, and the outstanding actions required to address them. It also shows, where possible, the estimated cost of the action and the delivery bodies whose involvement will be required to implement the action. Lead delivery bodies will be responsible for coordinating the implementation of the action, but not necessarily funding it. Delivery partners will need to support the lead delivery body in implementing the action. In the process of developing the SIPs Natural England has approached the delivery bodies to seek agreement on the actions and their roles in delivering them, although in some cases these discussions have not yet been concluded. Other interested parties, including landowners and managers, will be involved as the detailed actions are agreed and delivered. Funding options are indicated as potential (but not necessarily agreed or secured) sources to fund the actions.

1 Coastal squeeze

As coastal change takes place there's a loss of SPA wintering and breeding habitat. Coastal Squeeze and greater frequency of coastal flooding is leading to loss of reedbed (at Walberswick and Corporation Marshes) and to loss of freshwater marsh (between Dunwich and Walberswick). There is evidence of erosion and accretion on leading edges at the Blyth (limited in most places) where coastal management is in line with the Shoreline Management Plan and deemed appropriate, but this may change in the future with sea level rise, increased flood risk and increased/reduced tidal prism. There is a risk of saline incursion into Westward Marshes if Waller's Wall is no longer maintained.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
1A	Ensure the Shoreline Management Plan considers coastal squeeze and incorporates appropriate mitigation and compensation for any change that affects the integrity of the site.	Not yet determined	2014-50	Shoreline Management Plan and Strategies	Not yet determined	Environment Agency	National Trust, Natural England, RSPB, Suffolk Wildlife Trust, Waveney District Council, Blyth Estuary Group, EDF Energy

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
1B	Investigate and monitor coastal squeeze/ coastal change to provide a robust evidence base against which appropriate management requirements can be determined. This should examine the short-, medium-, and long term, including how nature conservation interests are affected by coastal change, (e.g. freshwater to saline). Identify evidence gaps and undertake appropriate investigations.	£20,000	2015-25	Investigation / Research / Monitoring	Not yet determined	Environment Agency	Natural England, Landowner(s)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
1C	Develop a Minsmere to Walberswick Heaths and Marshes adaptation plan that captures all the known issues. Opportunities for habitat creation where known should be included. Once produced the plan should be appropriately assessed to ensure that proposed actions will maintain the integrity of the Minsmere to Walberswick Heaths and Marshes designated site network and the features for which it is designated.	£10,000	2015-20	Mechanism not identified / develop mechanism	Not yet determined	Environment Agency	National Trust, Natural England, RSPB, Suffolk Coastal District Council, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
1D	Address impacts of coastal squeeze on SPA/SAC features through the Environment Agency Regional Habitat Creation Programme, including enabling adaptation to take place and creation of freshwater marsh elsewhere to mitigate/compensate against loss of future loss of freshwater habitat (Dingle Marshes, and other locations.)	Not yet determined	2018-50	Habitat creation / restoration strategy: Other		Environment Agency	Natural England

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
1E	Extend Dunwich River diversion further to the south through Dingle Marshes to allow natural coastal process to take place and prevent river channel blockage through shingle roll back.	Not yet determined	2018-20	Flood Risk Maintenance Programme: Flood Risk Management - Capital/ Improvement Schemes	Flood and Coastal Erosion Risk Management (FCERM) 2015-21	Environment Agency	Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
1F	Improve Dingle Marshes sluice function at to allow better evacuation of seawater from Dingle Marshes following over topping events.	Not yet determined	2017	Flood Risk Maintenance Programme: Flood Risk Management - Capital/ Improvement Schemes	Flood and Coastal Erosion Risk Management (FCERM) 2015-21	Environment Agency	Suffolk Wildlife Trust

2 Public Access/Disturbance

A great number of recreational visitors are attracted by area contributing to bird disturbance (e.g. human and dog disturbance to Little terns, Nightjar and Woodlark). Increased corvid predation is perceived as birds are flushed. The downward trends for these species are a concern. Trampling of heathland habitat and vegetated shingle (and Dune) habitat is an issue. Private aircraft (helicopters and planes, paramotorists) and MOD aircraft (helicopters and planes) regularly fly low over the site leading to disturbance of SPA features. Whilst wildfowling/shooting activities on site are fully assessed the impact of disturbance from unregulated shooting activity adjacent to the SPA/SAC is not fully understood.

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2A	Undertake a comprehensive review of public access to heathland, incorporating existing research.	£20,000	2015	Investigation / Research / Monitoring	Local partnership, Developer Contributions Scheme (DCS)	Not yet determined	National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Coastal District Council, Suffolk County Council, Suffolk Wildlife Trust, EDF Energy

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2B	Investigate the impact of levels of public access/disturbance to heathland on SPA/SAC features, evaluate significance of problem in relation to other factors, and establish where resource should be allocated to address factors with greatest effect.	Not yet determined	2018	Investigation / Research / Monitoring	Local partnership	Not yet determined	National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk County Council, Suffolk Wildlife Trust, EDF Energy

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2C	Informed by investigation into impacts of disturbance, implement NNR management plans to ensure heathland habitat is managed to minimise disturbance to SPA/SAC features through access management/zonation.	Not yet determined	2014-24	National Nature Reserve (NNR) management plan	Natural England (NNR running costs)	Natural England	National Trust, RSPB, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2D	Implementation of NNR management plans to ensure appropriate level of summer wardening of heathland habitats, resourcing to be informed by investigation into impacts of disturbance.	Not yet determined	2014-24	National Nature Reserve (NNR) management plan	Natural England (NNR running costs)	Natural England	National Trust, RSPB, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2E	Establish wardening on heathland areas outwith NNR, informed by investigation into impacts of disturbance and patterns of use.	£30,000	2016-20	Advice: Wardening	Local Authority	Not yet determined	National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Coastal District Council, Suffolk County Council, Suffolk Wildlife Trust, EDF Energy

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2F	Undertake a comprehensive review of public access to beaches, incorporating existing research.	£15,000	2014-15	Investigation / Research / Monitoring	Not yet determined	Not yet determined	Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Coastal District Council, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2G	Investigate impact of public access/disturbance on beach SPA/SAC features, evaluate significance of problem in relation to other factors, and establish where resource should be allocated to address factors with greatest effect.	Not yet determined	2014-15	Investigation / Research / Monitoring	Not yet determined	Natural England	RSPB, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2H	Establish/Increase beach wardening to minimise impact of disturbance on Little terns (informed by investigation).	£15,000	2015-17	Advice: Wardening	LIFE	Local partnership	National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Wildlife Trust, Suffolk Little Tern Group

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2I	Establish beach wardening to minimise impact of disturbance on vegetated shingle.	Not yet determined	2015-20	Advice: Wardening	Not yet determined	Not yet determined	National Trust, Natural England, RSPB, Suffolk Coast & Heaths AONB, Suffolk Coastal District Council, Suffolk County Council, Suffolk Wildlife Trust

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2J	Ensure impacts are assessed and that measures are in place to mitigate against impact from increased disturbance from proposed Sizewell C Development; through displacement of users away from Sizewell area (and possibly onto SPA areas) and increased population during construction in the locality. Mitigation may include provision of recreational green space at robust locations (such as new country parks), etc.	Not yet determined	2015-25	Advice: Access Strategy	Not yet determined	Not yet determined	Natural England, Suffolk Coastal District Council, Suffolk County Council, EDF Energy

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2K	Investigate and monitor levels and impact of military and civilian aircraft on SPA features, evaluate significance of problem in relation to other factors, establish how to remedy impacts and where resource should be allocated to address factors with greatest effect. Incorporate existing research.	Not yet determined	2015-18	Investigation / Research / Monitoring	Not yet determined	Not yet determined	Ministry of Defence (MoD), RSPB, Suffolk Wildlife Trust, Joint Nature Conservation Committee (JNCC), Civil Aviation Authority (CAA)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2L	Reduce disturbance of SPA bird features from military aircraft through better recognition (and ideally avoidance) of sensitive locations.	Not yet determined	2015	Advice: Education & awareness raising	Ministry of Defence (MoD)	Ministry of Defence (MoD)	Natural England, Joint Nature Conservation Committee (JNCC)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2M	Reduce disturbance of designated bird features from civilian aircraft through better recognition (and ideally avoidance) of sensitive locations and understanding of third party responsibilities under the Wildlife & Countryside Act (as amended).	Not yet determined	2014	Advice: Education & awareness raising	Not yet determined	Natural England	Civil Aviation Authority (CAA)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2N	Formalise reporting of incidents of all aircraft flying low over designated sites, disturbing wintering and breeding birds to allow Natural England to undertake appropriate enforcement action in relation to any breach of SSSI legislation.	Not yet determined	2014	Partnership agreement: Other	Not yet determined	Natural England	National Trust, RSPB, Suffolk Wildlife Trust, Suffolk Little Tern Group

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2O	Establishment of a Paramotor Working Group to improve user awareness/behaviour.	Not yet determined	2015	Advice: Education & awareness raising	Not yet determined	Natural England	RSPB, Suffolk Coast & Heaths AONB, Suffolk Little Tern Group

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2P	Produce Aviation Code of conduct for Suffolk (and possibly Norfolk) Coast to improve user awareness/behaviour.	Not yet determined	2015-16	Advice: Education & awareness raising	Not yet determined	Natural England	Natural England, Suffolk Coast & Heaths AONB, Civil Aviation Authority (CAA), Suffolk Little Tern Group

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2Q	Investigate scope for having SPAs marked on Civil Aviation Authority air maps as avoidance areas to reduce disturbance.	Not yet determined	2015	Advice: Negotiation	Not yet determined	Natural England	Joint Nature Conservation Committee (JNCC), Civil Aviation Authority (CAA)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
2R	Investigate disturbance impacts of offsite shooting activities on SPA features, notably adjacent to the Blyth and Minsmere Levels.	Not yet determined	2014-19	Investigation / Research / Monitoring	Not yet determined	Natural England	RSPB, Suffolk Wildlife Trust, British Association for Shooting and Conservation (BASC)

3 Changes in species distributions

The downward trend in population numbers of Woodlark, Nightjar, Marsh Harrier and Little Tern presents concerns. Reasons for decline (predation, disturbance, habitat management, food sources, possibly persecution, etc.) need to be better understood and mitigated as appropriate. This issue links to Public Access/Disturbance issues.

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
3A	Investigation into the downward trend in population numbers of Nightjar, Woodlark and Marsh Harrier including habitat decline, predation, disturbance, etc.	Not yet determined	2015 onwards	Investigation / Research / Monitoring	Not yet determined	Natural England	Forestry Commission, National Trust, RSPB, Suffolk Wildlife Trust, British Trust for Ornithology (BTO), LIFE+ Little Tern Project, Suffolk Little Tern Group, Sandlings Bird Group

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
3B	Mitigate against Nightjar, Woodlark and Marsh Harrier population declines through active site management (habitat management, wardening, predation control, etc.).	Not yet determined	2015-20	National Nature Reserve (NNR) management plan	Not yet determined	Natural England	Forestry Commission, National Trust, RSPB, Suffolk Wildlife Trust, Sandlings Bird Group

4 Invasive species

Spartina anglica is encroaching on estuarine muds. With *Spartina* at the front, and reed encroaching at back, saltmarsh could be squeezed out.

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
4A	Investigation and monitoring of *Spartina anglica* encroachment onto estuarine muds.	Not yet determined	2018	Investigation / Research / Monitoring	Not yet determined	Natural England	n/a

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
4B	Develop *Spartina anglica* management plan as appropriate following investigation.	Not yet determined	2018-20	Invasive Control Plan: Invasive Species Control Programme	Not yet determined	Natural England	n/a

5 Inappropriate pest control

Corvids and gulls are attracted by feed of nearby outdoor pig farming, predating and disturbing SPA features

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
5A	Investigate the impacts of predation on SPA features (notably crows, gulls and rats attracted to pig feed, plus other mammals (badgers and foxes) at Minsmere & Dingle). More research is needed to understand actual impact of predation on nest survival and fledgling success.	Not yet determined	2014	Investigation / Research / Monitoring	Catchment Sensitive Farming (CSF)	Natural England	RSPB, Suffolk Wildlife Trust, British Trust for Ornithology (BTO)

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
5B	Negotiation with local pig farmers regarding feeding practice that reduces crow, gull and rat numbers, if they are found to be a problem.	Not yet determined	2014-19	Advice: Negotiation	Not yet determined	Natural England	n/a

6 Air Pollution: impact of atmospheric nitrogen deposition

Air pollution can impact on vegetation diversity. Modelled aerial deposits of nitrogen exceed the threshold limit above which the diversity of heathland vegetation begins to be altered and adversely impacted. Many land use practices contribute to this problem including land spreading, outdoor pigs, high nutrient inputs on fields, etc.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
6A	Control, reduce and ameliorate atmospheric nitrogen deposition.	Not yet determined	2015-20	Site Nitrogen Action Plan	Not yet determined	Natural England	Not yet determined

7 Water Pollution

Inappropriate surface and ground water quality may impact on SAC habitats and the supporting habitats of some SPA birds. The estuary water is nutrient rich with high pollutant levels. Eutrophication is having an influence on reed. Increased flood events could lead to habitat change/loss of diversity. nutrient run off from outdoor pig farming could exacerbate the issue locally. Ground water pollution on light lands from land use practices such as treatment plants, land spreading, outdoor pigs, high nutrient inputs on fields, etc, may be an issue locally. There is a lack of groundwater monitoring in place.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
7A	Establish a Ground Water site nutrient management plan including regularly monitor ammonium, nitrogen and phosphorus concentrations in ground water across site, particularly areas adjacent to outdoor pigs and farm land with high nutrient inputs. Investigate sources of high nutrient levels.	Not yet determined	2014-20	Investigation / Research / Monitoring	Not yet determined	Environment Agency	Natural England

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
7B	Establish a surface water site nutrient management plan including a robust regular monitoring regime for ammonium, nitrogen and phosphorus concentrations in water courses across site (including Estuary and ditches), particularly areas adjacent to outdoor pigs and farm land with high nutrient inputs. Investigate sources of high nutrient levels.	Not yet determined	2014-20	Diffuse Water Pollution Plan	Not yet determined	Environment Agency	Natural England (CSF)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
7C	Reduce nutrient inputs where monitoring identifies concentrations of nutrients (surface water and ground water) exceeding thresholds for Natura 2000 sites, by working with local landowners/managers, through DSF/DWP .	Not yet determined	2014-19	Advice: Education & awareness raising	Catchment Sensitive Farming (CSF)	Natural England	Environment Agency

8 Deer

High numbers of red deer are damaging reedbed (runways and wallows/loss of structure), woodland (reduced structural diversity) and heathland (erosion and reduced structural diversity) habitat. Minsmere RSPB Reserve has started a culling programme. Some areas/habitats benefit from deer browsing whilst others are damaged. There is no coordinated approach to deer control in the wider area. This issue links with Changes in species distribution and should be viewed in parallel with Public Access/Disturbance.

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
8A	Investigate the need for a coordinated deer management and monitoring programme for the area.	Not yet determined	2015-16	Investigation / Research / Monitoring	Not yet determined	Natural England	Forestry Commission, National Trust, RSPB, Suffolk Wildlife Trust, The Deer Initiative, Landowner(s)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
8B	If investigation identifies the need, establish a fully coordinated deer management programme for the area, through production of a Deer Management and Monitoring strategy/plan. Actions to be monitored.	£13,000	2015-25	Non-Natural England funded site management plan	Not yet determined	Natural England	Forestry Commission, National Trust, RSPB, Suffolk Wildlife Trust, The Deer Initiative, Landowner(s)

9 Fisheries: Commercial marine and estuarine

Many different fishing pressures close to shore that may include bycatch of juveniles numbers/ disturbance of fish nursery areas that could potentially have an impact on Little tern *Sterna albifrons*. Commercial fishing activities categorised as 'amber or green' under Defra's revised approach to commercial fisheries in EMSs require assessment and (where appropriate) management. This assessment will be undertaken by EIFCA. For activities categorised as 'green', these assessments should take account of any in-combination effects of amber activities, and/or appropriate plans or projects, in the site. Where these assessments indicate management is required, appropriate measures will be introduced by the Regulator by 2016. If management measures are established to protect the feature(s), on-going work will be required by the Regulator to ensure compliance and an appropriate level of reporting to ensure sites are well managed and to enable Natural England to provide advice on the condition of features and potential condition threats.

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
9A	Where the assessments indicate management is required, introduce appropriate measures.	Not yet determined	2016	Enforcement: Byelaws	Not yet determined	Eastern Inshore Fisheries Conservation Authority (IFCA)	Natural England, Centre for Environment, Fisheries and Aquaculture Science (Cefas)

Action	Action description	Cost estimate	Timescale	Mechanism	Funding option	Delivery lead body	Delivery partner(s)
9B	If management measures are established, ensure compliance with bye-law and provide an appropriate level of reporting to ensure sites are well managed and to enable Natural England to provide advice on the condition of features and potential condition threats. Ongoing action.	Not yet determined	2014-20	Enforcement: Byelaws	Not yet determined	Eastern Inshore Fisheries Conservation Authority (IFCA)	Centre for Environment, Fisheries and Aquaculture Science (Cefas)

Site details

The tables in this section contain site-relevant contextual information and links

Qualifying features

#UK Special responsibility

Minsmere to Walberswick Heaths & Marshes SAC	H4030 European dry heaths
	H1210 Annual vegetation of drift lines
	H1220 Perennial vegetation of stony banks
Minsmere-Walberswick SPA	A052(B) *Anas crecca*: Eurasian teal
	A021(B) *Botaurus stellaris*: Great bittern
	A081(B) *Circus aeruginosus*: Eurasian marsh harrier
	A082(NB) *Circus cyaneus*: Hen harrier
	A224(B) *Caprimulgus europaeus*: European nightjar
	A056(B) *Anas clypeata*: Northern shoveler
	A056(NB) *Anas clypeata*: Northern shoveler
	A051(B) *Anas strepera*: Gadwall
	A051(NB) *Anas strepera*: Gadwall
	A132(B) *Recurvirostra avosetta*: Pied avocet
	A195(B) *Sterna albifrons*: Little tern
	A394(NB) *Anser albifrons albifrons*: Greater white-fronted goose

Site location and links

Minsmere to Walberswick Heaths & Marshes SAC

Area (ha) **1265.52**	*Grid reference*	**TM468682**	Map link	
Local Authorities			Suffolk	
Site Conservation Objectives			European Site Conservation Objectives for Minsmere to Walberswick Heaths & Marshes SAC	

European Marine Site conservation advice	Minsmere-Walberswick Heaths and Marshes EMS
Regulation 33/35 Package	Regulation 33/35 package link
Marine Management Organisation site plan	n/a
Minsmere-Walberswick SPA	
Area (ha) **2018.92** *Grid reference* **TM476748**	Map link
Local Authorities	Suffolk
Site Conservation Objectives	European Site Conservation Objectives for Minsmere-Walberswick SPA
European Marine Site conservation advice	Minsmere-Walberswick Heaths and Marshes EMS
Regulation 33/35 Package	Regulation 33/35 package link
Marine Management Organisation site plan	n/a

Water Framework Directive (WFD)

The Water Framework Directive (WFD) provides the main framework for managing the water environment throughout Europe. Under the WFD a management plan must be developed for each river basin district. The River Basin Management Plans (RMBP) include a summary of the measures needed for water dependent Natura 2000 sites to meet their conservation objectives. For the second round of RBMPs, SIPs are being used to capture the priorities and new measures required for water dependent habitats on Natura 2000 sites. SIP actions for non-water dependent sites/habitats do not form part of the RBMPs and associated consultation.

Minsmere to Walberswick Heaths & Marsh

River basin	Anglian	Anglian RBMP
WFD Management catchment	East Suffolk	
WFD Waterbody ID (Cycle 2 draft)	GB105035046270, GB105035046271	

Minsmere-Walberswick SPA

River basin	Anglian	Anglian RBMP
WFD Management catchment	East Suffolk	
WFD Waterbody ID (Cycle 2 draft)	GB105035046270, GB105035046271, GB105035046300	

Overlapping or adjacent protected sites

Site(s) of Special Scientific Interest (SSSI)	
Minsmere to Walberswick Heaths & Marshes SAC	Minsmere-Walberswick Heaths & Marshes SSSI
Minsmere-Walberswick SPA	Minsmere-Walberswick Heaths & Marshes SSSI

National Nature Reserve (NNR)	
Minsmere to Walberswick Heaths & Marshes SAC	Suffolk Coast NNR
	Westleton Heath NNR
Minsmere-Walberswick SPA	Suffolk Coast NNR
	Westleton Heath NNR

Ramsar	
Minsmere to Walberswick Heaths & Marshes SAC	Minsmere/Walberswick
Minsmere-Walberswick SPA	Minsmere/Walberswick

Special Areas of Conservation (SAC) and Special Protection Areas (SPA)	
Minsmere to Walberswick Heaths & Marshes SAC	Minsmere-Walberswick SPA
Minsmere-Walberswick SPA	Minsmere to Walberswick Heaths & Marshes SAC

Other relevant documents and links		
	Touching the Tide	Web link
	Spartina anglica 2004 review	2004 Anglica spartina Review
	Suffolk Local Biodiversity Action Plan (Little tern)	Biodiversity Action Plan: Little Tern

Version	*Date*	*Comment*
1.0	08/10/2014	

EC Directive 79/409 on the Conservation of Wild Birds

Citation for Special Protection Area (SPA)

Name: Sandlings

Unitary Authority/County: Suffolk

Consultation proposal: All or parts of Blaxhall Heath Site of Special Scientific Interest (SSSI), Leiston - Aldeburgh SSSI, Sandlings Forest SSSI, Snape Warren SSSI, Sutton & Hollesley Heaths SSSI and Tunstall Common SSSI have been recommended as a Special Protection Area because of their European ornithological importance. In particular, for their breeding populations of Nightjars *Caprimulgus europaeus* and Woodlarks *Lullula arborea*.

Site description: The Sandlings SPA lies near the Suffolk Coast between the Deben Estuary and Leiston. In the 19th century, the area was dominated by heathland developed on glacial sandy soils. During the 20th century, large areas of heath were planted with blocks of commercial conifer forest and others were converted to arable agriculture. Lack of traditional management has resulted in the remnant areas of heath being subject to successional changes, with the consequent spread of bracken, shrubs and trees, although recent conservation management work is resulting in their restoration. The heaths support both acid grassland and heather-dominated plant communities, with dependant invertebrate and bird communities of conservation value. Woodlark *Lullula arborea* and Nightjar *Caprimulgus europaeus* have also adapted to breeding in the large conifer forest blocks, using areas that have recently been felled and recent plantation, as well as areas managed as open ground.

Size of SPA: The SPA covers an area of 3,391.80 ha.

Qualifying species:

The site qualifies under **article 4.1** of the Directive (79/409/EEC) as it is used regularly by 1% or more of the Great Britain populations of the following species listed in Annex I in any season:

Annex 1 species	Count and Season	Period	% of GB population
Nightjar *Caprimulgus europaeus*	109 males - breeding	Count as a 1992	3.2% GB
Woodlark *Lullula arborea*	154 pairs - breeding	Count as at 1997	10.3% GB

Bird figures from:

Morris, A., Burges, D., Fuller, R.J., Evans, A.D. & Smith, K.W. 1994. The status and distribution of nightjars *Caprimulgus europaeus* in Britain in 1992. A report to the British Trust for Ornithology. *Bird Study* **41**: 181-191.

Wotton, S.R. & Gillings, S. 2000. The status of breeding woodlarks in Britain in 1997. *Bird Study* **47**: 212-224.

Status of SPA

Sandlings was classified as a Special Protection Area on 10 August 2001.

European Site Conservation Objectives for Sandlings Special Protection Area Site Code: UK9020286

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the ‘Qualifying Features’ listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- **The extent and distribution of the habitats of the qualifying features**
- **The structure and function of the habitats of the qualifying features**
- **The supporting processes on which the habitats of the qualifying features rely**
- **The population of each of the qualifying features, and,**
- **The distribution of the qualifying features within the site.**

This document should be read in conjunction with the accompanying *Supplementary Advice* document, which provides more detailed advice and information to enable the application and achievement of the Objectives set out above.

Qualifying Features:

A224 *Caprimulgus europaeus*; European nightjar (Breeding)

A246 *Lullula arborea*; Woodlark (Breeding)

Explanatory Notes: European Site Conservation Objectives

These Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations'). They must be considered when a competent authority is required to make a 'Habitats Regulations Assessment' including an Appropriate Assessment, under the relevant parts of this legislation.

These Conservation Objectives, and the accompanying Supplementary Advice (where this is available), will also provide a framework to inform the management of the European Site and the prevention of deterioration of habitats and significant disturbance of its qualifying features

These Conservation Objectives are set for each bird feature for a Special Protection Area (SPA).

Where these objectives are being met, the site will be considered to exhibit a high degree of integrity and to be contributing to achieving the aims of the Wild Birds Directive.

Publication date: 21 February 2019 (version 3). This document updates and replaces an earlier version dated 30 June 2014 to reflect the consolidation of the Habitats Regulations in 2017.

Improvement Programme for England's Natura 2000 Sites (IPENS)

Planning for the Future

Site Improvement Plan

Sandlings

Site Improvement Plans (SIPs) have been developed for each Natura 2000 site in England as part of the Improvement Programme for England's Natura 2000 sites (IPENS). Natura 2000 sites is the combined term for sites designated as Special Areas of Conservation (SAC) and Special Protected Areas (SPA). This work has been financially supported by LIFE, a financial instrument of the European Community.

The plan provides a high level overview of the issues (both current and predicted) affecting the condition of the Natura 2000 features on the site(s) and outlines the priority measures required to improve the condition of the features. It does not cover issues where remedial actions are already in place or ongoing management activities which are required for maintenance.

The SIP consists of three parts: a Summary table, which sets out the priority Issues and Measures; a detailed Actions table, which sets out who needs to do what, when and how much it is estimated to cost; and a set of tables containing contextual information and links.

Once this current programme ends, it is anticipated that Natural England and others, working with landowners and managers, will all play a role in delivering the priority measures to improve the condition of the features on these sites.

The SIPs are based on Natural England's current evidence and knowledge. The SIPs are not legal documents, they are live documents that will be updated to reflect changes in our evidence/knowledge and as actions get underway. The information in the SIPs will be used to update England's contribution to the UK's Prioritised Action Framework (PAF).

The SIPs are not formal consultation documents, but if you have any comments about the SIP or would like more information please email us at IPENSLIFEProject@naturalengland.org.uk, or contact Natural England's Responsible Officer for the site via our enquiry service 0300 060 3900, or enquiries@naturalengland.org.uk

This Site Improvement Plan covers the following Natura 2000 site(s)

UK9020286 Sandlings SPA

Site description

The site is notified for its internationally important populations of woodlark and nightjar. The SPA is made up of lowland heathland, acid grassland and forestry plantations on sandy soils which once supported extensive heathland; the main conservation interest of which lies in the open areas such as young plantation and rotational clearfell which provide suitable breeding habitat.

Plan Summary

This table shows the prioritised issues for the site(s), the features they affect, the proposed measures to address the issues and the delivery bodies whose involvement is required to deliver the measures. The list of delivery bodies will include those who have agreed to the actions as well as those where discussions over their role in delivering the actions is on-going.

Priority & Issue	Pressure or Threat	Feature(s) affected	Measure	Delivery Bodies
1 Changes in species distributions	Threat	A224(B) European nightjar, A246(B) Woodlark	Address causes of Woodlark and Nightjar population decline once they have been identified	Forestry Commission, Natural England, RSPB, Suffolk Wildlife Trust
2 Inappropriate scrub control	Pressure	A224(B) European nightjar, A246(B) Woodlark	Establish a network of appropriately managed habitat throughout the SPA	Forestry Commission, Natural England, RSPB, Suffolk Coastal District Council, Suffolk Wildlife Trust
3 Deer	Threat	A224(B) European nightjar, A246(B) Woodlark	Reduce the impact of deer through implementation of a deer management plan	Forestry Commission, Natural England
4 Air Pollution: impact of atmospheric nitrogen deposition	Pressure	A224(B) European nightjar, A246(B) Woodlark	Control, reduce and ameliorate atmospheric nitrogen impacts	Natural England
5 Public Access/Disturbance	Pressure	A224(B) European nightjar, A246(B) Woodlark	Determine the impacts of recreational pressure, particularly by dogs off leads	Forestry Commission, Local Authority(ies), Natural England, RSPB, Suffolk Wildlife Trust, Landowner(s)

Issues and Actions

This table outlines the prioritised issues that are currently impacting or threatening the condition of the features, and the outstanding actions required to address them. It also shows, where possible, the estimated cost of the action and the delivery bodies whose involvement will be required to implement the action. Lead delivery bodies will be responsible for coordinating the implementation of the action, but not necessarily funding it. Delivery partners will need to support the lead delivery body in implementing the action. In the process of developing the SIPs Natural England has approached the delivery bodies to seek agreement on the actions and their roles in delivering them, although in some cases these discussions have not yet been concluded. Other interested parties, including landowners and managers, will be involved as the detailed actions are agreed and delivered. Funding options are indicated as potential (but not necessarily agreed or secured) sources to fund the actions.

1 Changes in species distributions

Woodlark and Nightjar populations on the Suffolk coast have declined by 65% and 66% respectively since notification in 2001.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
1A	Research to determine the causes of population decline.	£10,000	2015-17	Investigation / Research / Monitoring	Natural England	Natural England	Forestry Commission, RSPB, Suffolk Wildlife Trust

2 Inappropriate scrub control

Scrub encroachment is reducing habitat suitability for Woodlark and Nightjar. Regular management is essential to maintain and restore the supporting heathland habitat to favourable condition.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
2A	Increase availability of suitable breeding habitat by revising management plans for open habitats.	£20,000	2015-20	Habitat creation / restoration strategy: Habitat restoration	Natural England	Natural England	Forestry Commission, RSPB, Suffolk Coastal District Council, Suffolk Wildlife Trust

3 Deer

A large deer population exerting grazing pressure on habitats will affect quality of nesting habitat. There is also potential for deer to trample nests.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
3A	Determine the impact of deer browsing on breeding habitat.	£5,000	2015-17	Investigation / Research / Monitoring	Natural England	Natural England	Forestry Commission

4 Air Pollution: impact of atmospheric nitrogen deposition

Nitrogen deposition exceeds site relevant critical loads.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
4A	Control, reduce and ameliorate atmospheric nitrogen impacts.	Not yet determined	2015-20	Site Nitrogen Action Plan	Not yet determined	Natural England	Not yet determined

5 Public Access/Disturbance

The need to understand recreational pressure and implement appropriate management is an ongoing issue. Recreational pressure could be increased by new housing developments in the area and by the potential displacement of visitors during the construction of Sizewell C.

Action	*Action description*	*Cost estimate*	*Timescale*	*Mechanism*	*Funding option*	*Delivery lead body*	*Delivery partner(s)*
5A	Determine if there is a disturbance impact from public access.	£10,000	2015-17	Investigation / Research / Monitoring	Natural England	Natural England	Forestry Commission, Local Authority(ies), RSPB, Suffolk Wildlife Trust, Landowner(s)

Site details

The tables in this section contain site-relevant contextual information and links

Qualifying features

#UK Special responsibility

Sandlings SPA	A224(B) *Caprimulgus europaeus*: European nightjar A246(B) *Lullula arborea*: Woodlark

Site location and links

Sandlings SPA

Area (ha) **3391.8**	*Grid reference*	**TM359479**	Map link
Local Authorities			Suffolk
Site Conservation Objectives			European Site Conservation Objectives for Sandlings SPA
European Marine Site conservation advice			n/a
Regulation 33/35 Package			n/a
Marine Management Organisation site plan			n/a

Water Framework Directive (WFD)

The Water Framework Directive (WFD) provides the main framework for managing the water environment throughout Europe. Under the WFD a management plan must be developed for each river basin district. The River Basin Management Plans (RMBP) include a summary of the measures needed for water dependent Natura 2000 sites to meet their conservation objectives. For the second round of RBMPs, SIPs are being used to capture the priorities and new measures required for water dependent habitats on Natura 2000 sites. SIP actions for non-water dependent sites/habitats do not form part of the RBMPs and associated consultation.

Sandlings SPA

River basin	Anglian RBMP
WFD Management catchment	East Suffolk
WFD Waterbody ID (Cycle 2 draft)	GB105035040160, GB105035040190, GB105035046260

Overlapping or adjacent protected sites

Site(s) of Special Scientific Interest (SSSI)	
Sandlings SPA	Sandlings Forest SSSI Leiston-Aldeburgh SSSI Blaxhall Heath SSSI Tunstall Common SSSI Sutton & Hollesley Heaths SSSI Snape Warren SSSI

National Nature Reserve (NNR)	
Sandlings SPA	n/a

Ramsar	
Sandlings SPA	n/a

Special Areas of Conservation (SAC) and Special Protection Areas (SPA	
Sandlings SPA	n/a

Version	*Date*	*Comment*
1.0	13/05/2015	

EC Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora

Citation for Special Area of Conservation (SAC)

Name:	Sandwich Bay
Unitary Authority/County:	Kent
SAC status:	Designated on 1 April 2005
Grid reference:	TR354617
SAC EU code:	UK0013077
Area (ha):	1137.87
Component SSSI:	Sandwich Bay and Hacklinge Marshes SSSI

Site description:
Sandwich Bay is a largely inactive dune system with a particularly extensive representation of fixed dune grassland, the only large area of this habitat in the extreme south-east of England. The vegetation of these dunes and their associated slacks is extremely species-rich. The site includes a number of rare and scarce species, such as fragrant evening-primrose *Oenothera stricta*, bedstraw broomrape *Orobanche caryophyllacea* and sand catchfly *Silene conica*, as well as the UK's largest population of lizard orchid *Himantoglossum hircinum*.

The seaward edge at the northern end of the site displays a good sequence of embryonic shifting dune communities and there is a clear zonation within the extensive dune system, with strandline species on the seaward edge and sand-binding grasses inland. Lyme-grass *Leymus arenarius* is extremely sparse and sand couch *Elytrigia juncea* is the dominant sand-binding species. The shifting dune vegetation contains a good range of characteristic foredune species including sea bindweed *Calystegia soldanella*, sea spurge *Euphorbia paralias* and sea-holly *Eryngium maritimum*.

A small area of dunes with creeping willow *Salix repens* ssp. *argentea* is of interest as it is the only example found in the dry south-east of England and is representative of this habitat type in a near-continental climate.

Qualifying habitats: The site is designated under **article 4(4)** of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I:

- Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*). (Dunes with creeping willow)
- Embryonic shifting dunes
- Fixed dunes with herbaceous vegetation (grey dunes). (Dune grassland)*
- Humid dune slacks
- Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes). (Shifting dunes with marram)

Annex I priority habitats are denoted by an asterisk (*).

This citation relates to a site entered in the Register of European Sites for Great Britain.
Register reference number: UK0013077
[redacted]e 2005
On behalf of the Secretary of State for Environment, Food and Rural Affairs

European Site Conservation Objectives for Sandwich Bay Special Area of Conservation Site Code: UK0013077

NATURAL ENGLAND

With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- **The extent and distribution of qualifying natural habitats**
- **The structure and function (including typical species) of qualifying natural habitats, and**
- **The supporting processes on which qualifying natural habitats rely**

This document should be read in conjunction with the accompanying *Supplementary Advice* document, which provides more detailed advice and information to enable the application and achievement of the Objectives set out above.

Qualifying Features:

H2110. Embryonic shifting dunes

H2120. Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes"); Shifting dunes with marram

H2130. Fixed dunes with herbaceous vegetation ("grey dunes"); Dune grassland*

H2170. Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*); Dunes with creeping willow

H2190. Humid dune slacks

* denotes a priority natural habitat or species (supporting explanatory text on following page)

This is a European Marine Site

This site is a part of the North East Kent European Marine Site. These Conservation Objectives should be used in conjunction with the Conservation Advice document for the EMS. Natural England's formal Conservation Advice for European Marine Sites can be found via GOV.UK.

*** Priority natural habitats or species**

Some of the natural habitats and species for which UK SACs have been selected are considered to be particular priorities for conservation at a European scale and are subject to special provisions in the Habitats Regulations. These priority natural habitats and species are denoted by an asterisk (*) in Annex I and II of the Habitats Directive. The term 'priority' is also used in other contexts, for example with reference to particular habitats or species that are prioritised in UK Biodiversity Action Plans. It is important to note however that these are not necessarily the priority natural habitats or species within the meaning of the Habitats Regulations.

Explanatory Notes: European Site Conservation Objectives

These Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2017 as amended from time to time (the "Habitats Regulations"). They must be considered when a competent authority is required to make a 'Habitats Regulations Assessment', including an Appropriate Assessment, under the relevant parts of this legislation.

These Conservation Objectives and the accompanying Supplementary Advice (where available) will also provide a framework to inform the measures needed to conserve or restore the European Site and the prevention of deterioration or significant disturbance of its qualifying features.

These Conservation Objectives are set for each habitat or species of a Special Area of Conservation (SAC). Where the objectives are met, the site will be considered to exhibit a high degree of integrity and to be contributing to achieving Favourable Conservation Status for that species or habitat type at a UK level. The term 'favourable conservation status' is defined in regulation 3 of the Habitats Regulations.

Publication date: 27 November 2018 (version 3). This document updates and replaces an earlier version dated 30 June 2014 to reflect the consolidation of the Habitats Regulations in 2017.

COUNTY: KENT SITE NAME: SANDWICH BAY AND HACKLINGE MARSHES

DISTRICTS: THANET/DOVER

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: THANET DISTRICT COUNCIL/DOVER DISTRICT COUNCIL

National Grid Reference: TR 353585	Area: 1756.5 (ha.) 4338.6 (ac.)
Ordnance Survey Sheet 1:50,000: 179	1:10,000: TR 35 NE, NW, SE, SW; TR 36 SW, SE
Date Notified (Under 1949 Act): 1951	Date of Last Revision: 1981
Date Notified (Under 1981 Act): 1984 (part) 1985 (part) 1990	Date of Last Revision: 1994

Other Information:
Parts of the site are listed in 'A Nature Conservation Review' and in 'A Geological Conservation Review'[2]. The nature reserve at Sandwich Bay is owned jointly by the Kent Trust for Nature Conservation, National Trust and Royal Society for the Protection of Birds. The site has been extended to include a Kent Trust designated Site of Nature Conservation Interest known as Richborough Pasture and there are several other small amendments.

Reasons for Notification:
This site contains the most important sand dune system and sandy coastal grassland in South East England and also includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. Associated with the various constituent habitats of the site are outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded. Invertebrates are also of interest with recent records including 19 nationally rare[3], and 149 nationally scarce[4] species. These areas provide an important landfall for migrating birds and also support large wintering populations of waders, some of which regularly reach levels of national importance[5]. The cliffs at Pegwell Bay are also of geological interest.

Biological Interest
The sand dunes which stretch from the mouth of the River Stour to Deal comprise the most outstanding botanical habitat within the site. The dunes and associated dune slacks and coastal grassland support a distinctive flora with species including crown garlic *Allium vineale*, viper's bugloss *Echium vulgare*, sea holly *Eryngium maritimum* and restharrow *Ononis repens*, whilst the nationally

rare[3] lizard orchid *Himantoglossum hircinum* and bedstraw broomrape *Orobanche caryophyllacea* have their largest British colonies here. Many continental species have been recorded from the dunes and the dune grassland also support a high diversity of clover *Trifolium* species and many other leguninous plants.

The dunes support a diversity of invertebrates many of which are associated with warm dry conditions and include the nationally rare[3] carthusian snail *Monacha cartusiana* and the nationally scarce[4] grey bush cricket *Platycleis albopunctata.* The nationally rare[3] moths restharrow *Aplasta ononaria*, pygmy footman *Eilema pygmaeola pygmaeola* and brightwave *Idaea ochrata* have also been recorded, whilst one of the damp hollows supports the only British colony of the moth *Stigmella zelleriella*, the larvae of which mine in leaves of creeping willow *Salix repens var. argentea*.

The chalk coastline around Pegwell Bay comprises a considerable diversity of cliff and cave habitats which support a range of marine algal communities. The area is the type locality for one algal genus and three species new to science *Chrysonema*, *C. littorale*; *Chrysotila lamellosa*, *Chrysotila stipitata* and is one of the sites where Anand (1937) undertook pioneer ecological investigations. Typical chalk-cliff zonation comprises a 'Chrysophyte' zone (mainly *Apistonema carterae*) at supralittoral levels. *Enteromorpha* spp. and other green algae and the lichen *Arthropyrenia halodites* at upper littoral levels; a turf of small filamentous red, brown and green algae is predominant at lower levels. The caves contain 'Chrysophyte' communities with species such as *Chrysonema litorale* and *Thallochrysis littoralis*, together with other typical cave species such as *Pilinia rimosa* and *Pseudendoclonium submarinum*.

Foreshore algal communities are typical of wave-washed shores, low in species diversity, although a unique feature (not seen on other chalk platforms in southeast England) of lower littoral levels is the dense population (zone-forming) of the Sand-Mason worm *Lanice conchilega* forming a bank extending for 100 m by the Ramsgate Western Esplanade.

The saltmarsh comprises a diversity of characteristic plants dominated by salt-marsh grasses such as *Puccinellia maritima* and common cord-grass *Spartina anglica.* Other abundant species include sea purslane *Halimione portulacoides*, sea aster *Aster tripolium*, sea lavender *Limonium vulgare* and the nationally scarce[4] golden samphire *Inula crithmoides.* South of the River Stour saltmarsh grades into the sand dune system; this is the only Kent site for the long-bracted sedge *Carex extensa*, and also provides suitable conditions for a dense growth of the nationally scarce[4] sharp rush *Juncus acutus.* Below the cliff at Cliffsend Point, where freshwater springs emerge at the foot of the cliff, the saltmarsh grades into a swampy type of vegetation where common reed *Phragmites australis* and common reedmace *Typha latifolia* predominate.

Further inland, the grazing marsh and associated dykes provide suitable conditions for a wide range of plants and animals. The grassland is dominated by grasses such as meadow barley *Hordeum secalinum*, meadow foxtail *Alopecurus pratensis* and crested dog's tail *Cynosurus cristatus*. Some of the more uncommon broadleaved herbs that have been recorded, especially narrow leave bird's-foot-trefoil *Lotus tenuis*, adder's tongue *Ophioglossum vulgatum*, strawberry clover *Trifolium fragiferum* and divided sedge *Carex divisa*[4]. A more unusual vegetation type found within the site is the relict fen vegetation. This is found in and around the dykes of the farmland and in the marshes at Hacklinge. Fen plants such as ragged robin *Lychnis flos-cuculi*, bog pimpernel *Anagallis tenella* and greater spearwort *Ranunculus lingua* occur here, most of these are now scarce in Kent. In addition the dykes contain a number of scarce aquatic plants including whorled water-milfoil *Myriophyllum verticillatum*[4], fen pondweed *Potamogeton coloratus*[4] and river water-dropwort *Oenanthe fluviatilis*[4]. This area is also the only known locality in SE England for least bur-reed *Sparganium minimum.* The wet alder wood at Ham Brooks also contains uncommon plants including great fen-sedge *Cladium mariscus*.

The ornithological interest of Sandwich Bay and Hacklinge Marshes is centred on the large numbers of waders and wildfowl which use the area in winter and during the Spring and Autumn migrations. Dunlin *Calidris alpina* is usually the most common wader present, found particularly on the mudflats where the rich invertebrate fauna also attracts a wide range of other common species such as oystercatcher *Haematopus ostralegus*, curlew *Numenius arquata*, and redshank *Tringa totanus.* Grey plover *Plurialis squatarola* and sanderling *Calidris alba* both overwinter in nationally important numbers[5], whilst ringed plover *Charadrius hiaticula* also occurs in nationally important numbers[5] during migration. Wildfowl that occur on the site include mallard *Anas platyrhynchos*, shelduck *Tadorna tadorna* and occasionally brent goose *Branta bernicla*.

Many of the birds use more than one habitat, some for example feed on the mudflats at low tide and then move up to roost on the saltmarsh or grazing marsh.

Breeding birds include ringed plover, oystercatcher and little tern *Sterna albifrons*, a species specially protected by law and listed on Schedule 1 of the Wildlife and Countryside Act 1981. Inland areas are also of interest supporting two nationally rare species of breeding birds.

Geological Interest

Parts of the site are also of geological interest. The 16" shell bed at the base of the Reculver Silts (Thanet Formation) contains an important fish fauna. This is preserved as disarticulated fish debris, including a diversity of identifiable shark teeth. There is no other Thanetian site in Western Europe with this diversity of fauna which includes many, as yet, undescribed species plus the earliest records of other known Tertiary forms. The outcrop has very great significance because it is the only outcrop which shows the bottom living fish assemblage which was subsequently destroyed by the North Sea volcanicity, for the ash falls by these volcanoes brought about an extinction event. Interesting conclusions can be drawn from this local extinction and the later recolonisation of the area; for example unspecialised, bottom living sharks survive across the event, presumably because a stock that was living elsewhere at the time was able to migrate back to this part of the basin and recolonise.

At Pegwell Bay the Upper Chalk is overlain by the basal Tertiary beds of the Thanet Sands. The junction is marked by the celebrated 'Bull-head Bed', an *in situ* weathering residue of unabraded flint nodules. This is a key section showing a demonstrable and regionally significant unconformity. Pegwell Bay is also the most important site for loess studies in Britain. The section shows up to 4 m of Devensian loess overlying Upper Chalk and Thanet Beds. The loess, an accumulation of wind-blown dust produced under periglacial conditions during the Ice Age is probably thicker here than at any other site in Britain, and is certainly the most closely studied example. Although leached in its upper part, the loess is calcareous below, with rootlet tubes and small concretions. Where the loess rests on the Chalk, there is often a highly frost-shattered zone with well developed involutions. In one part of the section where an infilled channel is cut into the frost-shattered chalk, the loess overlies chalky-flinty gravels and loams produced by solifluction. Pegwell Bay provides the best exposures of true loess deposits in Britain. They are exceptional in having escaped modification by solifluction; no other site provides such useful sections in highly calcareous loess that has not been reworked.

[1] '*A Nature Conservation Review'*: edited by D A Ratcliffe. Cambridge University Press 1979.

[2] *A Geological Conservation Review*: in preparation.

[3] Species regarded as 'rare' in Britain (recorded from 1–15 10 × 10 km squares) and listed in *British Red Data Books*.

[4] Species regarded as 'scarce' in Britain (recorded from 16–100 10 × 10km squares).

[5] *Wildfowl and Wader Counts* 1988–1989. D G Salmon et al, Wildfowl Trust 1989.

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

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1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD	MM	YY

Designation date

Site Reference Number

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
Cambridgeshire PE1 1JY
UK
Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948
Email: RIS@JNCC.gov.uk

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2. Date this sheet was completed/updated:

Designated: 28 July 1994

3. Country:

UK (England)

4. Name of the Ramsar site:

Thanet Coast and Sandwich Bay

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5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

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6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area:

** Important note: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

i) **hard copy** (required for inclusion of site in the Ramsar List): *yes* ✓ -or- *no* □;
ii**) an electronic format** (e.g. a JPEG or ArcView image) Yes
iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** *yes* ✓ -or- *no* □;

b) Describe briefly the type of boundary delineation applied:
e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

51 18 18 N 01 22 47 E

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

Nearest town/city: Margate and Ramsgate

The site lies on the east Kent coast, between Deal to the south-east and Whitestable to the north-west.

Administrative region: Kent

10. Elevation (average and/or max. & min.) (metres): 11. Area (hectares): 2169.23

Min. -1
Max. 6
Mean 0

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

A coastal site, consisting of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The wetland habitats support 15 British Red Data Book invertebrates, as well as a large number of nationally scarce species. The site attracts internationally important numbers of turnstone *Arenaria interpres*, and nationally important numbers of nationally important wintering populations of four wader species: ringed plover, golden plover, grey plover and sanderling, as well as Lapland bunting. The site is used by large numbers of migratory birds.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

2, 6

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar criterion 2

Supports 15 British Red Data Book wetland invertebrates.

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Qualifying Species/populations (as identified at designation):
Species with peak counts in winter:

Ruddy turnstone , *Arenaria interpres interpres*, NE Canada, Greenland/W Europe & NW Africa	1007 individuals, representing an average of 1% of the population (5 year peak mean 1998/9-2002/3)

Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.

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15. **Biogeography** (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation)**:**

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:
Atlantic

b) biogeographic regionalisation scheme (include reference citation):
Council Directive 92/43/EEC

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16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	basic, neutral, shingle, sand, mud, clay, alluvium, peat, nutrient-rich, nutrient-poor, sedimentary, limestone/chalk
Geomorphology and landscape	lowland, coastal, valley, floodplain, barrier beach, intertidal sediments (including sandflat/mudflat), open coast (including bay), estuary, cave/tunnel, lagoon, cliffs, pools
Nutrient status	eutrophic, highly eutrophic
pH	alkaline
Salinity	brackish / mixosaline, fresh, saline / euhaline
Soil	mainly mineral, mainly organic
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Greenwich, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/greenwich.html) Max. daily temperature: 14.8° C Min. daily temperature: 7.2° C Days of air frost: 29.1 Rainfall: 583.6 mm Hrs. of sunshine: 1461.0

General description of the Physical Features:

Thanet Coast and Sandwich Bay consists of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh.

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17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

Thanet Coast and Sandwich Bay consists of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh.

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18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

Shoreline stabilisation and dissipation of erosive forces

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19. Wetland types:

Inland wetland, Marine/coastal wetland

Code	Name	% Area
G	Tidal flats	56
D	Rocky shores	15.5
4	Seasonally flooded agricultural land	15
M	Rivers / streams / creeks: permanent	10
Xf	Freshwater, tree-dominated wetlands	1
E	Sand / shingle shores (including dune systems)	0.9
F	Estuarine waters	0.8
Tp	Freshwater marshes / pools: permanent	0.6
H	Salt marshes	0.2

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20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

Chalk cliffs and rocky shore: Much of the Thanet coastline consists of chalk cliffs, approx. 75% of which has been subjected to the building of sea defences. Where the cliffs are undefended they contain a large number of sea caves which are are rich in marine algae. The chalk shore platform is the most extensive such area in the UK and supports a range of characteristic biotopes.

Sand/mud flats: There are extensive areas of intertidal mud and sand flat that are attractive to waders.

Saltmarsh: The relatively small areas of saltmarsh integrate in some areas with the sand dune communities. Common species include *Puccinellia maritima*, *Atriplex portulacoides*, and *Limonium vulgare*. Scarce plants include *Inulia crithmoides*.

Shingle beach: The coastline around Sandwich and Reculver is fringed by shingle beach, mostly unvegetated. There are small areas of vegetated shingle with species such as *Glaucium flavum*, and *Crambe maritima*.

Sand dune: Part of the site includes a part of a larger area of dune grassland. Here there are small areas of young *Ammophila arenaria* dune, with large areas of fixed dune, dominated by *Festuca rubra*, *Galium verum* communities. The scarce rush *Juncus acutus* occurs here. Lizard orchid *Himantoglossum hircinum* and bedstraw broomrape *Orobanche caryophyllacea* both occur on the dune grassland.

There are extensive areas of grazing marsh located in some areas on alluvial deposits, and in other areas on thick beds of peat. The peat-dominated areas have the greatest interest, supporting the nationally scarce *Potamogeton coloratus* and *Sparganium minimum* at its only locality in south-east England; the ditches support a wide diversity of aquatic plants typical of south-eastern grazing marsh, other scarce species include *Myriophyllum verticillatum* and *Althaea officinalis*. Much of the grazing marsh has been subject to agricultural improvement. A few fields remain, however, with an unimproved turf and a relatively diverse flora.

Arable: Some areas of grazing marsh have been ploughed and drained. The ditches retain some water, but with an impoverished flora, dominated by emergents such as *Typha latifolia*, *T. angustifolia* and *Phragmites australis*.

Ecosystem services

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21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Nationally important species occurring on the site.

Higher Plants.

Juncus acutus, Potamogeton coloratus, Ceratophyllum submersum, Myriophyllum verticillatum, Carex divisia, Althaea officinalis, Frankenia laevis, Inula crithmoides

Non-wetland higher plants of importance:

Plants of sand dunes: *Himantoglossum hircinum* (90% UK population on dunes at Sandwich Bay); *Orobanche caryophyllacea*.

Plants of chalk cliffs: *Brassica oleracea* var. *oleracea*; *Matthiola incana*; *Matthiola sinuata*; *Limonium binervosum*.

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22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds

Species currently occurring at levels of national importance:

Species with peak counts in spring/autumn:

Ringed plover , *Charadrius hiaticula*, Europe/Northwest Africa	649 individuals, representing an average of 2% of the GB population (5 year peak mean 1998/9-2002/3)
Common greenshank , *Tringa nebularia*, Europe/W Africa	35 individuals, representing an average of 5.8% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Red-throated diver , *Gavia stellata*, NW Europe	57 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3)
Great crested grebe , *Podiceps cristatus cristatus*, NW Europe	218 individuals, representing an average of 1.3% of the GB population (5 year peak mean 1998/9-2002/3)

European golden plover , *Pluvialis apricaria apricaria*, P. a. altifrons Iceland & Faroes/E Atlantic	4190 individuals, representing an average of 1.6% of the GB population (5 year peak mean 1998/9-2002/3)
Sanderling , *Calidris alba*, Eastern Atlantic	598 individuals, representing an average of 2.9% of the GB population (5 year peak mean 1998/9-2002/3)

Species Information

Nationally important species occurring on the site.

Sand lizards *Lacerta agilis* are being reintroduced to the site on the Sandwich & Pegwell Bay NNR, September 2004, as part of a national programme of reintroduction to seven sites across England.

Invertebrates.

Lixus vilis, Stigmella repentiella, Bagous nodulosus, Deltote bankiana, Poecilobothrus ducalis, Emblethis verbasci, Pionosomus varius, Nabis brevis, Euheptauclacus sus, Melanotus punctolineatus, Eluma purpurescens, Ectemnius ruficornis, Alysson lunicornis, Orthotylus rubidus

Non-wetland invertebrates of importance recorded during 2004 survey:

Bees & wasps: *Cerceris quadricincta* (RDB 1; largest UK colony discovered on site in Pegwell area); *Philanthus triangulum* (RDB2, pRDB4); *Hedychrum niemelai* (RDB3); *Smicromyrme rufipes* (Notable b species); *Andrena minutuloides* (Notable a species); *Andrena pilipes* (Notable b species); *Melitta leporine* (Notable b species); *Nomada fucata* (Notable a species).

Moths found on sand dunes at Sandwich: *Idaea ochrata* (BAP priority species); *Aplasta ononaria* (RDB3); *Phibalapteryx virgata* (Nationally Scarce),

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23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic
Archaeological/historical site
Environmental education/ interpretation
Livestock grazing
Non-consumptive recreation
Scientific research
Sport fishing
Sport hunting
Tourism
Transportation/navigation

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No

If Yes, describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	
Local authority, municipality etc.	+	
Private	+	
Public/communal	+	

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	
Tourism	+	
Recreation	+	
Current scientific research	+	
Collection of non-timber natural products: (unspecified)	+	
Fishing: (unspecified)	+	
Fishing: commercial	+	
Fishing: recreational/sport	+	
Marine/saltwater aquaculture		+
Gathering of shellfish	+	
Bait collection	+	
Arable agriculture (unspecified)	+	
Permanent arable agriculture		+
Grazing (unspecified)	+	
Permanent pastoral agriculture	+	
Hunting: recreational/sport	+	
Industrial water supply	+	
Industry	+	
Sewage treatment/disposal		+
Harbour/port		+
Flood control	+	
Mineral exploration (excl. hydrocarbons)	+	
Transport route		+
Domestic water supply	+	
Urban development	+	

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. *Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.*
2. *Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.*

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
Vegetation succession	2	Survey 2003 revealed problem of lack of ditch management in some areas.	+		+
Water diversion for irrigation/domestic/industrial use	1		+	+	+
Eutrophication	1	Subsidence in former colliery areas has created sump effect and contributed to eutrophication.	+	+	+
Pollution – pesticides/agricultural runoff	2	Runoff from agricultural fields.	+	+	+
Recreational/tourism disturbance (unspecified)	1	Disturbance of turnstones *Arenaria interpres*, especially by dog walking and kite surfing/boarding, which can result in loss of condition to birds if unmanaged.	+		+
Unspecified development: urban use	1	Activities connected with ongoing management and new development on the coast cause significant disturbance to wintering birds if unmanaged.	+		+

For category 2 factors only.
What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?
Vegetation succession - Management agreements in place. It is intended that the number of these will increase when Environmental Stewardship Scheme is introduced.
Negotiation is underway with owners to reinstate ditch management in neglected areas.

Pollution – pesticides/agricultural runoff - Environment Agency currently investigating nature and extent of problem with view to implementing appropriate controls.

Is the site subject to adverse ecological change? YES

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	
National Nature Reserve (NNR)	+	
Special Protection Area (SPA)	+	
Land owned by a non-governmental organisation for nature conservation	+	
Management agreement	+	
Site management statement/plan implemented	+	
Special Area of Conservation (SAC)	+	

b) Describe any other current management practices:
The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Fauna.
Numbers of migratory and wintering wildfowl and waders are monitored annually as part of the national Wetland Birds Survey (WeBS) organised by the British Trust for Ornithology, Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee.
A littoral and sublittoral marine life survey of the chalk cliffs, caves and reefs was undertaken by the Natural History Museum in 1997 (Tittley *et al*. 1998); the littoral element was repeated in 2001 (Tittley *et al*. 2004).
A sublittoral diving survey of the chalk reefs took place in Summer 2004.
A survey of the numbers and distribution of the golden plover population was undertaken in 2002-03.
Turnstone research was undertaken from 2001-03.
A sand dune NVC survey was undertaken in 2002 and a ditch flora survey in 2003.
Reintroduction of sand lizards *Lacerta agilis* to Sandwich & Pegwell Bay NNR, September 2004.

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

The Thanet Coast Project was set up in 2001 and operates over most of the site. The Project implements aspects of the North East Kent European marine sites Management Scheme and works with local people, providing a wide range of coastal educational activities for adults and children as well as leaflets and other information.

Sandwich and Pegwell Bay NNR and LNR is managed by Kent Wildlife Trust. Guided walks and events are held on site throughout the year and information leaflets and interpretive boards are provided.

Sandwich Bay Bird Observatory is situated close to the site and provides information and leaflets on birds, as well as guided walks and events. It has conference and laboratory facilities as well as accommodation for visiting groups.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Activities, Facilities provided and Seasonality.

There are a number of beach resorts around this Ramsar site, and the whole coastline is heavily used for recreation. Although there is more use in summer, there are a number of recreational activities that take place year-round on the coast, such as dog walking, and it is these that have most effect on wintering birds.

The inland parts of this Ramsar Site are the only areas that are not heavily used for recreation.

Water-based recreation includes jet-skiing, power-boat use, sailing, water-skiing and kite-surfing at a number of locations around the site. These activities happen mostly in spring, summer and autumn, but there is some year-round use.

Kite-boarding has been noted at two locations and has caused bird disturbance problems. This activity happens intermittently but more often in summer.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Head, Natura 2000 and Ramsar Team, Department for Environment, Food and Rural Affairs, European Wildlife Division, Zone 1/07, Temple Quay House, 2 The Square, Temple Quay, Bristol, BS1 6EB

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Site Designations Manager, English Nature, Sites and Surveillance Team, Northminster House, Northminster Road, Peterborough, PE1 1UA, UK

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see **15** above), list full reference citation for the scheme.

Site-relevant references

Barne, JH, Robson, CF, Kaznowska, SS, Doody, JP, Davidson, NC & Buck, AL (eds.) (1998) *Coasts and seas of the United Kingdom. Region 7 South-east England: Lowestoft to Dungeness*. Joint Nature Conservation Committee, Peterborough. (Coastal Directories Series.)

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Ratcliffe, DA (ed.) (1977) *A Nature Conservation Review. The selection of biological sites of national importance to nature conservation in Britain*. Cambridge University Press (for the Natural Environment Research Council and the Nature Conservancy Council), Cambridge (2 vols.)

Shirt, DB (ed.) (1987) *British Red Data Books: 2. Insects*. Nature Conservancy Council, Peterborough

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Tittley, I, Spurrier, CJH & Chimonides, PJ (2004) Thanet intertidal survey: Assessment of favourable condition of reef and sea-cave features in the Thanet Coast cSAC. *English Nature Research Reports*, No. **568** www.english-nature.org.uk/pubs/publication/PDF/568.pdf

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Wiggington, M (1999) *British Red Data Books. 1. Vascular plants*. 3rd edn. Joint Nature Conservation Committee, Peterborough

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EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Area

Thanet Coast (Kent)

The Thanet Coast proposed Special Protection Area includes a wide variety of coastal habitats including areas of chalk cliff, rocky shore, shingle, sand and mudflats, saltmarsh and sand dunes. As well as its value for breeding and wintering birds, the site supports outstanding communities of terrestrial and marine plant species, a significant number of rare invertebrate species, and is of considerable geological importance.

The Thanet Coast qualifies under Article 4.1 by supporting, in summer, a nationally important breeding population of little tern *Sterna albifrons* (30 pairs - over 1% of the British population).

The site also qualifies under Article 4.1 by supporting a nationally important wintering population of golden plover *Pluvialis apricaria*. During the five year period 1985/86 - 1989/90, an average peak count of 1,980 golden plover was recorded, representing 1% of the British wintering population.

The site qualifies under Article 4.2 by regularly supporting an internationally important wintering population of turnstone *Arenaria interpres*. In the five year period 1986/87 - 1990/91, an average peak count of 1,340 turnstone was recorded, representing 2% of the East Atlantic Flyway population and 3% of the British wintering population. The site also supports nationally important wintering populations of a further four species (average peak counts over the five year period 1986/7 - 1990/91): 370 ringed plover *Charadrius hiaticula* (over 1% of the British wintering population), 530 grey plover *Pluvialis squatarola* (over 2% of British), 700 sanderling *Calidris alba* (over 5% of British), and 40 Lapland bunting *Calcarius lapponicus* (about 11% of British). In addition large numbers of migratory passerine birds pass through the site during the spring and autumn migration periods. These migratory birds have been monitored since 1952 by the Sandwich Bay Bird Observatory.

This citation / map relates to a site entered in the Register of European sites for Great Britain.
Register reference number UK9012071
Date of registration 30 JAN 1996
Signed ....
on behalf of the Secretary of State for the Environment

SPA Citation
HTR/DAS June 1992

European Site Conservation Objectives for Thanet Coast and Sandwich Bay Special Protection Area
Site Code: UK9012071

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- **The extent and distribution of the habitats of the qualifying features**
- **The structure and function of the habitats of the qualifying features**
- **The supporting processes on which the habitats of the qualifying features rely**
- **The population of each of the qualifying features, and,**
- **The distribution of the qualifying features within the site.**

This document should be read in conjunction with the accompanying *Supplementary Advice* document, which provides more detailed advice and information to enable the application and achievement of the Objectives set out above.

Qualifying Features:

A140 *Pluvialis apricaria*; European golden plover (Non-breeding)
A169 *Arenaria interpres*; Ruddy turnstone (Non-breeding)
A195 *Sterna albifrons*; Little tern (Breeding)

This is a European Marine Site

This SPA is a part of the North East Kent European Marine Site (EMS). These Conservation Objectives should be used in conjunction with the Conservation Advice document for the EMS. Natural England's formal Conservation Advice for European Marine Sites can be found via GOV.UK.

Explanatory Notes: European Site Conservation Objectives

These Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations'). They must be considered when a competent authority is required to make a 'Habitats Regulations Assessment' including an Appropriate Assessment, under the relevant parts of this legislation.

These Conservation Objectives, and the accompanying Supplementary Advice (where this is available), will also provide a framework to inform the management of the European Site and the prevention of deterioration of habitats and significant disturbance of its qualifying features

These Conservation Objectives are set for each bird feature for a Special Protection Area (SPA).

Where these objectives are being met, the site will be considered to exhibit a high degree of integrity and to be contributing to achieving the aims of the Wild Birds Directive.

Publication date: 21 February 2019 (version 3). This document updates and replaces an earlier version dated 30 June 2014 to reflect the consolidation of the Habitats Regulations in 2017.

EC Directive 2009/147/EC on the Conservation of Wild Birds

Special Protection Area (SPA)

Name: *Outer Thames Estuary SPA*

Counties/Unitary Authorities: Norfolk, Suffolk, Essex, Kent

Boundary of the SPA:

The seaward and alongshore extent of the Outer Thames Estuary SPA is defined according to the distribution of non-breeding red-throated divers (O'Brien *et al*. 2012). The site includes coastal areas up to Mean High Water up the coast (to Caister-on-Sea) to provide coverage for little terns from Great Yarmouth North Denes foraging from this SPA, and common terns foraging from Breydon Water SPA. The inclusion of the River Yare channel, to abut the eastern boundary of the existing Breydon Water SPA, and the lower River Bure (to approximately Runham village south of Filby), to provide continuous SPA coverage for common terns foraging from this SPA. The inclusion of coastal areas up to Mean High Water down the coast (to just south of Corton), providing coverage for common terns from Breydon Water foraging from this SPA. The inclusion of the River Blyth to encompass Blythburgh Water, a tidal lagoon directly adjacent to the northern parts of Minsmere-Walberswick SPA in addition to the inclusion of Mean High Water areas up the coast (to Southwold) and down the coast (to Leiston) to provide continuous coverage for little terns foraging from this SPA. The inclusion of the estuarine areas up to Mean High Water within the Crouch and Roach Estuaries, overlapping the existing Crouch and Roach Estuaries SPA in the intertidal area and the inclusion of a small marine area along the south Essex coast and overlapping part of the Foulness SPA for foraging common terns.

Size of SPA: The SPA covers an area of 392,451.66 ha.

Site description:

The Outer Thames Estuary SPA is located on the east coast of England between the counties of Norfolk (on the north side) and Kent (on the south side) and extends into the North Sea. The site comprises areas of shallow and deeper water, high tidal current streams and a range of mobile mud, sand, silt and gravely sediments extending into the marine environment, incorporating areas of sand banks often exposed at low tide. Intertidal mud and sand flats are found further towards the coast and within creeks and inlets inland down the Blyth estuary and the Crouch and Roach estuaries. The diversity of marine habitats and associated species is reflected in existing statutory protected area designations, some of which overlap or abut the SPA.

Qualifying species:

SPA site selection guidelines have been applied to the most up to date information for the site.

The site qualifies under **article 4.1** of the Directive (2009/147/EC) as it is used regularly by 1% or more of the Great Britain populations of the following species listed in Annex I in any season:

Species	Season	Count (Period)	% of population
Red-throated diver *Gavia stellata*	Non-breeding	6,466 individuals (1989 – 2006/07)[1]	38.0% of GB population
Little tern *Sternula albifrons*	Breeding	746 individuals (2011 – 2015)	19.64% of GB population
Common tern *Sterna hirundo*	Breeding	532 individuals (2011 – 2015)	2.66% of GB population

Assemblage qualification:

The site does not qualify under SPA selection stage 1.3.

Principal bird data sources:

Colony counts from JNCC Seabird Monitoring Programme, Norfolk Bird & Mammal Reports, Foulness Area Bird Survey Group and contributed by colony managers from RSPB.

Data on ringed common terns from national bird ringing scheme.

Red-throated diver data from aerial surveys 1989 - 2006/07: Natural England (2010): Departmental Brief: Outer Thames Estuary Special Protection Area. *Available at*: http://publications.naturalengland.org.uk/publication/3233957

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[1] Value retained from original Outer Thames Estuary SPA standard data form (http://publications.naturalengland.org.uk/publication/3233957)

STANDARD DATA FORM for sites within the 'UK national site network of European sites'

Special Protection Areas (SPAs) are classified and Special Areas of Conservation (SACs) are designated under:

- the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea) and to a limited extent in Scotland (reserved matters) and Northern Ireland (excepted matters);
- the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) in Scotland;
- the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland; and
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area.

Each SAC or SPA (forming part of the UK national site network of European sites) has its own Standard Data Form containing site-specific information. The information provided here generally follows the same documenting format for SACs and SPAs, as set out in the Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011 (2011/484/EU).

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

More general information on SPAs and SACs in the UK is available from the SPA homepage and SAC homepage on the JNCC website. These webpages also provide links to Standard Data Forms for all SAC and SPA sites in the UK.

https://jncc.gov.uk/

NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE **UK9020309**

SITENAME **Outer Thames Estuary**

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1. SITE IDENTIFICATION

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1.1 Type	1.2 Site code
A	UK9020309

1.3 Site name

Outer Thames Estuary

1.4 First Compilation date	1.5 Update date
2010-08	2017-11

1.6 Respondent:

Name/Organisation:	Joint Nature Conservation Committee
Address:	Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY
Email:	

1.7 Site indication and designation / classification dates

Date site classified as SPA:	2010-08
National legal reference of SPA designation	Regulations 12A and 13-15 of the Conservation of Habitats and Species Regulations 2010 (http://www.legislation.gov.uk/uksi/2010/490/contents/made) as amended by The Conservation of Habitats and Species (Amendment) Regulations 2011 (http://www.legislation.gov.uk/uksi/2011/625/contents/made), and Regulations 12, 16 and 17 of the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (http://www.legislation.gov.uk/uksi/2007/1842/contents/made).

2. SITE LOCATION

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2.1 Site-centre location [decimal degrees]:

Longitude	Latitude
1.545	51.916

2.2 Area [ha]:

392451.66

2.3 Marine area [%]

100.0

2.4 Sitelength [km]:

0.0

2.5 Administrative region code and name

NUTS level 2 code	Region Name
UKZZ	Extra-Regio

2.6 Biogeographical Region(s)

Atlantic (100.0 %)

3. ECOLOGICAL INFORMATION

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3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site						Site assessment			
G	Code	Scientific Name	S	NP	T	Size		Unit	Cat.	D.qual.	A|B|C|D	A|B|C		
						Min	Max				Pop.	Con.	Iso.	Glo.
B	A001	Gavia stellata			w	6466	6466	i		G	A		C	
B	A195	Sterna albifrons			r	746	746	i		G	A		C	
B	A193	Sterna hirundo			r	532	532	i		G	B		C	

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see reference portal)
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information

- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

4. SITE DESCRIPTION

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4.1 General site character

Habitat class	% Cover
N01	98.45
N03	0.05
N02	1.5
Total Habitat Cover	100

Other Site Characteristics

3 Marine: Geology: mud,sand,gravel 4 Marine: Geomorphology: range of mobile sediments,tidal current stream

4.2 Quality and importance

ARTICLE 4.1 QUALIFICATION (79/409/EEC) Over winter the area regularly supports: Gavia stellata (North-western Europe - wintering) - 38% of the population in Great Britain peak mean over the period 1989-2006/07 The area supports breeding populations of: Sternula albifrons (in breeding season) - 19.64% of GB population (2011 - 2015) Sterna hirundo (in breeding season) - 2.66% of GB population (2011 - 2015)

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i|o|b]
M	D03		B
L	G04		b
H	C03		B
L	F02		I
L	H03		B

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i|o|b]

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification,

T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions

i = inside, o = outside, b = both

4.5 Documentation

JNCC's weblink 'http://jncc.defra.gov.uk/page-1414' provides general information on marine SPAs. The weblink 'http://jncc.defra.gov.uk/page-6895' allows access to site specific information for all marine MPAs in UK offshore waters. See the UK Approach document for more information (link via the JNCC website).

Link(s): http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

http://jncc.defra.gov.uk/page-1414
http://jncc.defra.gov.uk/page-6895

5. SITE PROTECTION STATUS (optional)

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5.1 Designation types at national and regional level:

Code	Cover [%]	Code	Cover [%]	Code	Cover [%]
UK04	3.0	UK00	93.0	UK05	4.0

6. SITE MANAGEMENT

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6.1 Body(ies) responsible for the site management:

Organisation:	Maldon Local/District Unitary Authority, Rochford Local/District Unitary Authority, Southend on Sea Local/District Unitary Authority, Swale Local/District Unitary Authority, Canterbury Local/District Unitary Authority
Address:	
Email:	

Organisation:	Crouch Harbour Authority, Port of London Authority, Peel Ports London Medway, Great Yarmouth Local/District Unitary Authority, Waveney Local/District Unitary Authority, Suffolk Coastal Local/District Unitary Authority
Address:	
Email:	

Organisation:	Southwold Harbour Authority – Waveney District Council, Ipswich Port Authority, Felixstowe Dock & Railway Company, Harwich Haven Authority, Brightlingsea Harbour Commissioners, Maldon Harbour Improvement Commissioners
Address:	
Email:	

Organisation:	For information about relevant management offshore please contact JNCC
Address:	
Email:	

Organisation:	Natural England, Marine Management Organisation, Kent and Essex Inshore Fisheries & Conservation Authority, Crown Estate, Great Yarmouth Port Authority, Lowestoft – Associated British Ports (ABP)
Address:	
Email:	

Organisation:	Thanet Local/District Unitary Authority
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

[ ]	Yes
[ ]	No, but in preparation
X	No

6.3 Conservation measures (optional)

For available information on relevant conservation measures of the site, including the Conservation Objectives, see section 4.5.

7. MAP OF THE SITES

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INSPIRE ID:

Map delivered as PDF in electronic format (optional)

☐ Yes ☒ No

Reference(s) to the original map used for the digitalisation of the electronic boundaries (optional).

EXPLANATION OF CODES USED IN THE SPECIAL AREA OF CONSERVATION (SAC) AND SPECIAL PROTECTION AREA (SPA) STANDARD DATA FORMS

The codes in the table below generally follow those explained in the official European Union guidelines for the Standard Data Form (also referencing the relevant page number).

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	SPA (classified Special Protection Area)	53
B	cSAC, SCI or SAC (candidate Special Area of Conservation, Site of Community Importance, designated Special Area of Conservation)	53
C	SPA area/boundary is the same as the cSAC/SCI/SAC i.e. a co-classified/designated site (Note: this situation only occurs in Gibraltar)	53

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippopha• rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, screes and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Habitat representativity (abbreviated to ‘Representativity’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent representatively	57
B	Good representatively	57
C	Significant representatively	57
D	Non-significant presence representatively	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	58
B	> 2%-15%	58
C	≤ 2%	58

3.1 Degree of conservation (abbreviated to ‘Conservation’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global assessment (abbreviated to ‘Global’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to ‘Pop.’ in data form)

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	62
B	> 2%-15%	62
C	≤ 2%	62
D	Non-significant population	62

3.2 Degree of conservation (abbreviated to ‘Con.’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to ‘Iso.’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to ‘Glo.’ or ‘G.’ in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Other species – essentially covers bird assemblage types

CODE	DESCRIPTION	PAGE NO
WATR	Non-breeding waterbird assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code

BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic ressources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK04	Site of Special Scientific Interest (GB)	67
UK05	Marine Conservation Zone	67
UK06	Nature Conservation Marine Protected Area	67
UK86	Special Area (Channel Islands)	67
UK98	Area of Special Scientific Interest (NI)	67
IN00	Ramsar Convention site	67
IN08	Special Protection Area	67
IN09	Special Area of Conservation	67

European Site Conservation Objectives for Outer Thames Special Protection Area Site Code: UK9020309

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- **The extent and distribution of the habitats of the qualifying features**
- **The structure and function of the habitats of the qualifying features**
- **The supporting processes on which the habitats of the qualifying features rely**
- **The population of each of the qualifying features, and,**
- **The distribution of the qualifying features within the site.**

This document should be read in conjunction with the accompanying *Supplementary Advice* document, which provides more detailed advice and information to enable the application and achievement of the Objectives set out above.

Qualifying Features:

A001 Gavia stellata; Red-throated diver (Non-breeding)

A193 Sterna hirundo; Common tern (Breeding)

A195 Sternula albifrons; Little tern (Breeding)

This is a European Marine Site

This SPA is a part of the Outer Thames European Marine Site (EMS). These Conservation Objectives should be used in conjunction with the Conservation Advice document for the EMS. Natural England's formal Conservation Advice for European Marine Sites can be found via GOV.UK.

Explanatory Notes: European Site Conservation Objectives

These Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations'). They must be considered when a competent authority is required to make a 'Habitats Regulations Assessment' including an Appropriate Assessment, under the relevant parts of this legislation.

These Conservation Objectives, and the accompanying Supplementary Advice (where this is available), will also provide a framework to inform the management of the European Site and the prevention of deterioration of habitats and significant disturbance of its qualifying features

These Conservation Objectives are set for each bird feature for a Special Protection Area (SPA).

Where these objectives are being met, the site will be considered to exhibit a high degree of integrity and to be contributing to achieving the aims of the Wild Birds Directive.

Publication date: 21 February 2019 (version 3). This document updates and replaces an earlier version dated 20 December 2017 to reflect the consolidation of the Habitats Regulations in 2017.

Outer Thames Estuary SPA

Last updated: 5 October 2023

Supplementary advice

The Supplementary Advice on Conservation Objectives (SACOs) present attributes which are ecological characteristics or requirements of the classified species within a site. The listed attributes are considered to be those which best describe the site's ecological integrity and which if safeguarded will enable achievement of the Conservation Objectives.

Conservation Objectives relating to extent and distribution of habitat and population abundance are reflected in single attributes within the Supplementary Advice. Structure and function of habitats, and supporting processes for those habitats, are reflected in multiple attributes describing integrity of these ecological characteristics.

The Conservation Objective relating to the distribution of qualifying features (individual species or assemblages) may apply to most or all of the attributes listed in the SACOs and should be considered against them. Ensuring integrity of attributes relating to supporting habitats and processes should allow birds to distribute themselves optimally within (and, sometimes, outside) the SPA boundary. This is perhaps particularly relevant for food availability; extent and distribution of supporting habitat; quality of supporting habitat; predation; and disturbance caused by human activity.

Attributes have a target which is either quantified or qualified depending on the available evidence. The target identifies as far as possible the desired state to be achieved for the attribute. In many cases, the attribute targets show if the current objective is to either 'maintain' or 'restore' the attribute. The targets given for each attribute do not represent thresholds to assess the significance of any given impact in Habitats Regulation Assessments. You will need to assess this on a case-by-case basis using the most current information available.

Where there is no evidence to determine a marine feature's condition, a vulnerability assessment, which includes sensitivity and exposure information for features and activities in a site, has been used as a proxy for condition. Evidence used in preparing the SACO has been cited with hyperlinks included where possible. Where references have not been provided, Natural England has applied ecological knowledge and expert judgement.

Some, but not all, of these attributes can also be used for regular monitoring of the condition of the classified features. The attributes selected for monitoring the features, and the standards used to assess their condition, are listed in separate monitoring documents, which will be available from Natural England. As condition assessment information becomes available, the conservation advice package will be reviewed accordingly.

When to use

You should use this information, along with the conservation objectives and case-specific advice issued by Natural England when developing, proposing or assessing an activity, plan or project that may affect the site.

Any proposals or operations which may affect the site or its features should be designed so they do not adversely affect any of the attributes in the SACO or achievement of the conservation objectives.

Features:
Choose one or more features and/or their sub-features below by selecting the applicable boxes in the tree. This will show the relevant targets. Where a feature has sub-features this will be indicated with a greyed out triangle below, which can be expanded.

- [ ] Common tern (Sterna hirundo), Breeding
- [ ] Little tern (Sternula albifrons), Breeding
- [x] Red-throated diver (Gavia stellata), Non-breeding

Reset | Select all | Show attributes and targets for selected features

Attributes:
You can filter to show only targets for certain attributes by selecting one or more attributes from the list below (use ctrl click to select multiple). Note that only attributes for the features you have chosen are shown.

Disturbance caused by human activity
Non-breeding population: abundance
Structure: pathogens
Supporting habitat: air quality
Supporting habitat: conservation measures
Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season

Feature target

'Maintain' targets do not preclude the need for management, now or in the future, to avoid a significant risk of damage or deterioration to the feature. The supporting and/or explanatory notes in the SACOs set out why the target was chosen and any relevant site based supporting information. This is based on the best available information, including that gathered during monitoring of the feature's current condition.

Feature/Subfeature name	Attribute	Target	Season	Supporting notes

Feature target

'Maintain' targets do not preclude the need for management, now or in the future, to avoid a significant risk of damage or deterioration to the feature. The supporting and/or explanatory notes in the SACOs set out why the target was chosen and any relevant site based supporting information. This is based on the best available information, including that gathered during monitoring of the feature's current condition.

Feature/ Subfeature name	Attribute	Target	Season	Supporting notes
Red-throated diver (*Gavia stellata*), Non-breeding	Disturbance caused by human activity	Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed	Non-breeding (winter and/or passage) season	The nature, scale, timing and duration of some human activities can result in bird disturbance (defined as any human-induced activity sufficient to disrupt normal behaviours and / or distribution of birds in the absence of the activity) at a level that may substantially affect their behaviour, and consequently affect the long-term viability of the population. Such disturbing effects can for example result in changes to feeding or roosting behaviour, increases in energy expenditure due to increased flight, abandonment of nest sites and desertion of supporting habitat (both within or outside the designated site boundary where appropriate). This may undermine successful nesting, rearing, feeding and/or roosting, and/or may reduce the availability of suitable habitat as birds are displaced and their distribution within the site contracts. Disturbance associated with human activity may take a variety of forms including noise, light, sound, vibration, trampling, presence of people, animals and structures. 'Significant' disturbance is defined by AEWA (The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 2016): "Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on (water)birds in such a way as to be likely to cause impacts on populations of a species through either I. changed local distribution on a continuing basis; and/or II. changed local abundance on a sustained basis; and/or III. the reduction of ability of any significant group of birds to survive, breed, or rear their young." (Fox and Madsen, 1997) (Petersen et al., 2006);(Percival, 2010);(Schwemmer et al., 2011) Site-specifics: Red-throated diver are highly sensitive to marine industries and recreational vessels, and have been shown to have a strong stress response to disturbance (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2013) (Dierschke et al., 2017). Approaching ships and smaller vessels have been shown to cause displacement, even when several kilometres away (Dierschke et al., 2017). Commercial and recreational fishing causes disturbance to red-throated diver, which are highly sensitive to at-sea disturbance from boats (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2010). The birds usually avoid boats, which can result in displacement and the forced use of sub-optimal foraging habitats. Additionally, entanglement in fishing gear is one of the main causes of red-throated diver mortality (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2010). Red-throated diver have been shown to be especially sensitive to the construction and maintenance of offshore installations, of which there are many in the southern North Sea. Garthe & Huppop (2004) concluded that red-throated diver is the second most sensitive seabird to offshore wind farms (Garthe and Hüppop, 2004). Strong displacement behaviour arising from disturbance reduces the usable range of red-throated diver, which could result in the utilisation of sub-optimal foraging areas and ultimately causes habitat loss (Dierschke et al., 2017). There is significant marine industry within the Outer Thames Estuary, including one of the busiest shipping lanes in the world, multiple offshore wind farms and a large aggregate industry. Aggregate extraction has the potential to impact red-throated diver directly, or indirectly through changes to sedimentation, turbidity and other factors (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2013). Disturbance to red-throated diver needs to be managed and limited as far as possible to avoid impacting this species. On-going monitoring is required to fully understand and determine the impact of marine industries on this sensitive species. There is indicative evidence of displacement by offshore wind farms within the Outer Thames Estuary (APEM, 2013) (HiDef Aerial Surveying Limited, 2018) (McGovern et al., 2016). Given the expected displacement due to existing (and planned) offshore wind development, further displacement should be avoided. Analysis of the monitoring data currently being collected may allow a re-evaluation of this position. Red-throated diver are especially vulnerable to disturbance arising from marine industry and offshore construction, which is thought to cause displacement and loss of habitat for this species.

Red-throated diver (*Gavia stellata*), Non-breeding	Non-breeding population: abundance	Maintain the size of the non-breeding population at a level which is at or above 18,079 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	Non-breeding (winter and/or passage) season	This will sustain the site's population and contribute to a viable local, national and bio-geographic population. Due to the mobility of this feature and the dynamic nature of population change, the target-value given for the population size of this feature is considered to be the minimum standard for conservation / restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size has significantly increased as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is classified, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account. Maintaining or restoring bird abundance depends on the suitability of the site. However, factors affecting suitability can also determine other demographic rates of birds using the site including survival (dependent on factors such as body condition which influences the ability to breed or make foraging and / or migration movements) and breeding productivity. Adverse human impacts on either of these rates may precede changes in population abundance (eg by changing proportions of birds of different ages) but eventually may negatively affect abundance. These rates can be measured / estimated to inform judgements of likely impacts on abundance targets. Unless otherwise stated, the population size will be that measured using standard methods such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. While we will endeavour to keep these values as up to date as possible, local Natural England staff can advise whether the figures stated are the best available. Site-specifics: When the site was classified in 2010, the best population estimate of the overwintering population was 6,446 individuals (1989 to 2006/07, peak mean estimate) (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2017). Technology and survey techniques have vastly improved since, and digital aerial imagery has become the new survey standard (HiDef Aerial Surveying Limited, 2018). This has allowed more accurate counts of red-throated diver, and suggests that previous counts may have been underestimates. Natural England commissioned monitoring surveys of the SPA in 2012/13 and 2017/18, using digital aerial methods, which have provided a 2 year peak mean estimate of 18,079 individuals (APEM, 2013) (HiDef Aerial Surveying Limited, 2018). The population estimates and confidence levels for each year are provided below: 2012/13 survey: 14,161 individuals (lower 95% limit: 8,230 – upper 95% limit: 22,245); 2017/18 survey: 21,997 individuals (lower 95% limit; 15,351 – upper 95% limit: 29,415). This data has provided robust evidence to revise the red-throated diver baseline abundance figure. The current population abundance figure is calculated by taking the mean peak counts of each of the surveys (APEM, 2013) (HiDef Aerial Surveying Limited, 2018). Recent survey evidence (2012/13 and 2017/18) has shown significant increases in red-throated diver abundance within the SPA. These increases are thought to reflect improved survey methods and techniques, namely the use of digital aerial surveys, which has provided more accurate counts and suggests that previous counts have been significant underestimates. Digital aerial surveys are now the new standard for monitoring this species. As a result, Natural England consider it appropriate to revise abundance baseline upwards, to reflect our improved understanding of red-throated diver population numbers. The baseline has been set using the peak mean counts from surveys in 2012/13 and 2017/18.
Red-throated diver (*Gavia stellata*), Non-breeding	Structure: pathogens	[Restrict OR Reduce] the introduction and spread of pathogens, including Highly Pathogenic Avian Influenza, and their impacts.	Year round	A pathogen causes disease to its host. Pathogens include bacteria, viruses, protozoa, fungi, endo- and ectoparasites (Biology-Online, 2021). Most notably, Highly Pathogenic Avian Influenza (HPAI) is seriously impacting populations in and around protected sites in both inland and coastal areas. Although seabirds, including terns and gulls, and some waterfowl, have been the most seriously affected with some significant reductions in population sizes, a range of other species are also impacted. We do not know what the long term effect of HPAI may be in birds that recover so there could be a population level impact both in terms of immediate mortality or longer term through chronic disease that shortens life expectancy or reduces fertility. (Defra and Animal and Plant Health Agency, 2022),(Defra et al., 2022) Site-specifics: To be completed
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: air quality	Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because the structure and function of habitats which support this SPA feature may be sensitive to changes in air quality. Exceeding critical values for air pollutants may result in changes to the chemical status of its habitat substrate, accelerating or damaging plant growth, altering vegetation structure and composition and thereby affecting the quality and availability of feeding or roosting habitats. Critical Loads and Levels are thresholds below which such harmful effects on sensitive UK habitats will not occur to a noteworthy level, according to current levels of scientific understanding. There are critical levels for ammonia (NH_3), oxides of nitrogen (NO_x) and sulphur dioxide (SO_2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or

				Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. More information about site-relevant Critical Loads and Levels for this site is available by using the 'search by site' tool on the Air Pollution Information System (Centre for Ecology & Hydrology (CEH), 2014). It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Site-specifics: There is a lack of accurate data available for this site in regards to air quality for this species. There is currently no accurate air quality data for this site. This target will be revised when new evidence becomes available.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: conservation measures	Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.	Year round – to ensure the habitat remains suitable for when the feature is present	This target has been included because active and ongoing conservation management is often needed to protect, maintain or restore this feature at this site. Other measures may also be required, and in some cases, these measures may apply to areas outside of the designated site boundary in order to achieve this target. Further details about the necessary conservation measures for this site can be provided by Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and/or management agreements. Site-specifics: Red-throated diver are seabirds and do not come ashore during the overwintering period. At-sea conservation measures are required to minimise the impact of marine industry upon red-throated diver through disturbance and habitat loss. It is envisaged that the main conservation measure required for red-throated divers within the Outer Thames Estuary SPA is to effectively manage activities which lead to disturbance and displacement, as detailed in other attributes. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: extent, distribution and availability of supporting habitat for the non-breeding season	Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) at the following levels: Subtidal sand (220,295.55); Subtidal coarse sediment (73,606.64); Subtidal mixed sediments (62,100.63 ha); Subtidal mud (12,549.14 ha); Circalittoral rock (335.2 ha); and Water column	Year round – to ensure the habitat remains suitable for when the feature is present	This target may apply to supporting habitat which also lies outside the site boundary. Inappropriate management and direct or indirect impacts which may affect the extent and distribution of habitats may adversely affect the population and alter the distribution of birds. Site-specifics: Marine development and construction can result in habitat loss for this sensitive species. Red-throated diver have been shown to be especially sensitive to offshore wind farms (McGovern et al., 2016), and their construction may result in the displacement of red-throated diver from an area of their range (Dierschke et al., 2017). Other activities such as aggregates dredging, fishing and commercial shipping may be adding to the culmulative displacement of red-throated diver from parts of the site (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2013). This results in habitat loss for this species, or the use of sub-optimal foraging areas. The extent of suitable supporting habitat should be maintained. There is indicative evidence of displacement by offshore wind farms within the Outer Thames Estuary (APEM, 2013) (HiDef Aerial Surveying Limited, 2018) (McGovern et al., 2016). Given the expected displacement due to existing (and planned) offshore wind development, further displacement should be avoided. Analysis of the monitoring data currently being collected may allow a re-evaluation of this position. (Unknown, Unknown) (Centre for Environment Fisheries and Aquaculture Sciences (CEFAS), 2008) (Sturt and Dix, 2009) (Unknown, 2008) (Envision Mapping Ltd., 2014) (Channel Coastal Observatory, 2011) (Institute of Estuarine and Coastal Studies (IECS), 1991) (Emu Ltd., 2006) The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: food availability (bird)	Maintain the distribution, abundance and availability of key food and prey items (eg. fish) at preferred sizes.	Year round	The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population. As a result, inappropriate management and direct or indirect impacts which may affect the distribution, abundance and availability of prey may adversely affect the population and alter the distribution of birds. Main food sources can be found within: coastal and offshore waters. (Johnsgard, 1993),(Furness, 1990),(Wanless et al., 1991) Site-specifics: Red-throated diver feed opportunistically, pursuing their prey underwater and exploiting whichever small demersal fish prey are available (McGovern et al., 2016) (Guse et al., 2009). Key prey species include sand eels, sprat, flatfish and members of the cod family, and herring being particularly important in the

				southern North Sea (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2010) (Guse et al., 2009) (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2013). Red-throated diver forage within waters 0-20m deep, including near the shore, the Thames Estuary mouth and surrounding the many subtidal sandbanks within the SPA. The Outer Thames Estuary contains a complex matrix of marine industries, which could result in a reduction in foraging resource. Many fishing boats operate in the southern North Sea which fish for the same species at red-throated diver, such as herring and flatfish (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2010). Overfishing by these vessels could reduce the availability of prey for the red-throated diver. Additionally, marine development and piling, shipping and aggregate extraction can cause the displacement of red-throated diver prey species, thereby reducing the available foraging waters for this species (McGovern et al., 2016). Displacement caused by offshore wind farms and other offshore constructions can reduce the extent of suitable foraging waters for red-throated diver, thereby causing habitat loss for this species (Natural England (NE) and Joint Nature Conservation Committee (JNCC), 2013). This may lead to the use of sub-optimal areas for foraging and roosting activities (McGovern et al., 2016). Prey availability is threatened by direct competition from fishing vessels and displacement from marine industries and habitat loss. The abundance of red-throated diver prey species and the extent of suitable foraging waters should be maintained to ensure sufficient food availability for this species. On-going monitoring is required to fully understand the impact of marine industry upon the foraging and survival of red-throated diver in this SPA. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: water depth	Maintain the depth of inshore waters currently used as feeding or moulting sites.	Year round – to ensure the habitat remains suitable for when the feature is present	This feature is known to require extensive areas of water in which to feed. Birds are visual predators, with some having the ability to dive or to feed from the surface. As they will rely on detecting their prey within the water to hunt, the depth of water at critical times of year may be paramount for successful feeding and therefore their fitness and survival. Site-specifics: Red-throated diver forage within the water column and generally require depths of 0-20m, so tend to stay close to shore or near subtidal sandbanks (McGovern et al., 2016). Aggregate extraction, dredging and other marine industry should consider impacts upon the natural sedimentary and hydrodynamic regime. The depth of inshore waters should be maintained. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: water quality - contaminants	Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Contaminants may have a range of biological effects on different species within the supporting habitat, depending on the nature of the contaminant (Joint Nature Conservation Committee (JNCC), 2004), (UK Technical Advisory Group on the Water Framework Directive (UKTAG), 2008), (Environment Agency, 2014). This in turn can adversely affect the availability of bird breeding, rearing, feeding and roosting habitats, and potentially bird survival. Site-specifics: This target has been set according to Water Framework Directive (WFD) chemical status of overlapping water bodies. The Essex and Kent North WFD water bodies together overlap with 34% of Outer Thames Estuary SPA boundary. These water bodies failed WFD chemical status in the 2019 classification due to measured/assumed elevated levels of polybrominated diphenyl ether (PBDE) and mercury and its compounds. These two chemicals are persistent, bioaccumulative and toxic substances, which present risks to wildlife. In 2013, the EU Priority Substances Directive specified biota (concentrations in whole fish) Environmental Quality Standards (EQS) for these substances rather than water column EQSs, to better represent risks to wildlife. Sampling has only occurred in a subset of water bodies, but in all instances, these chemicals were found at levels above the EQSs, and therefore in the absence of additional data, the classification has been extrapolated across non-monitored waterbodies. These new standards have been used in the 2019 WFD classification for the first time, and therefore show failures where a water body may previously have been classified as good chemical status. This does not represent a decline in water quality, but rather, a result of the new, more stringent standards. The target has been set at 'reduce' due to the high levels of PBDE and mercury and its compounds present. High levels of the priority hazardous substance tributyl tin and its compounds in the 'Kent North' and 'Thames Lower' WFD waterbodies is why the conservation objective has been set to 'Reduce'.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: water quality - dissolved oxygen	Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7 mg L-1 (at 35 salinity) for 95 % of year) avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	Dissolved Oxygen (DO) levels affect the condition and health of supporting habitats. Excessive nutrients and/or high turbidity can lead to a drop in DO, especially in warmer months. Low DO can have sub-lethal and lethal impacts on fish and infauna and epifauna communities (Best et al., 2007) and hence can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. However, there is a significant amount of natural variation that should be considered. Site-specifics: Dissolved oxygen has been recorded at High for 2009-10 and 2012-14.

				The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: water quality - nutrients	Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. This target was set using the Environmental Agency 2019 water body classifications data.	Year round	High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities (Devlin et al., 2007), (Best, 2014) and hence adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. The aim is to seek no further deterioration or improve water quality. Site-specifics: The risk of eutrophication across the site has been assessed as low using the Environment Agency's Weight of Evidence approach. This takes into account assessments of the Water Framework Directive opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools. Adverse effects to integrity should be avoided. Therefore opportunistic macroalgal levels should be maintained so there is no adverse effect to the feature through limited algal cover (<15%) and low biomass (< 500 g m2) of macroalgal blooms in the available intertidal habitat, with area of available intertidal habitat affected by opportunistic macroalgae less than 15 %. There should also be limited (<5%) entrainment of algae in the underlying sediment (all accounting for seasonal variations and fluctuations in growth). Phytoplankton levels should be maintained above a WFD assessment tool score of 0.6, where there is only a minor (a) decline in species richness, and (b) disturbance to the diatom-dinoflagellate succession in the spring bloom compared to reference conditions. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.
Red-throated diver (*Gavia stellata*), Non-breeding	Supporting habitat: water quality - turbidity	Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.	Year round	Water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter from land sources. Turbidity levels can rise and fall rapidly as a result of biological (eg plankton blooms), physical (eg storm events) or human (eg development) factors. Prolonged changes in turbidity may influence the amount of light reaching supporting habitats, affecting the primary production and nutrient levels of the habitat's associated communities. Changes in turbidity may also have a range of biological effects on different species within the habitat, eg affecting their abilities to feed or breathe. A prolonged increase in turbidity is indicative of an increase in suspended particulates. This has a number of implications for the aquatic / marine environment, such as affecting fish health, clogging the filtering organs of suspension feeding animals and affecting sedimentation rates. This in turn can adversely affect the availability and suitability of bird breeding, rearing, feeding and roosting habitats. Site-specifics: In the tidal Thames Estuary, suspended sediment concentration is linked to tidal cycles and freshwater inputs (Mitchell et al., 2012). During dry periods, high levels of suspended sediment occur during flood tide and there is a net movement of sediment up stream (Mitchell et al., 2012). During wet periods with higher freshwater flow, the suspended sediment is less, and there is net sediment movement downstream. Areas further offshore are less influenced by fluvial inputs. Marine industry, such as dredging and aggregates extraction, may cause increased turbidity. This could reduce prey availability for this species if prey are displaced from an area. The level of turbidity should be maintained at natural levels. The target has been set using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring / have occurred on the site.

See further guidance on how to undertake an HRA for a plan or project on a European site.

These tables bring together the findings of the best available scientific evidence which may be updated or supplemented in further publications from Natural England and other sources. You may decide to use other additional sources of information.

These tables do not give advice about SSSI features or other legally protected species which may also be present within the European site.
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Outer Thames Estuary SPA

Last updated: 15 March 2019

Advice on Seasonality

In the table below, the months hatched in green in each row indicate the months in which significant numbers of each mobile designated feature* are most likely to be present at the site during a typical calendar year. Where count data was available, hatched months with significant numbers were defined on the basis of one or both of the following criteria being met in more than three-fifths (60%) of the years within the six years period 2007-2012. The two criteria used were: i) monthly maxima exceed 10% of the highest mean of monthly maxima over the six-year period; ii) monthly maxima exceed the 2012/2013 national significance threshold. These criteria were predominantly used for non-breeding bird features (based on Wetland Bird Survey (WeBS) data). Where insufficient count data were available to use these criteria, months with significant numbers were hatched on the basis of generic information on seasonal patterns of occurrence in published sources.

Applicants considering plans or projects scheduled in the periods hatched in green would benefit from early consultation with Natural England given the greater scope for there to be likely significant effects that require consideration. The months which are not hatched in green are not ones in which the features are necessarily absent, rather that features may be present in less significant numbers in typical years, but there may still be a significant effect. Please note that this period can vary between years and that in any one year considerable numbers of a species may be present (throughout the year or) outside of the months indicated below. Any assessment of potential impacts on the features must be based on up-to-date count data and take account of population trends evident from these data and any other available information. Additional surveys may be required.

*** Please note:** Advice on Seasonality may not be provided for all assemblage features on this page. For instances where this does not appear, advice on assemblage features should be sought on a case-by-case basis from Natural England or other relevant country agencies for cross-boundary sites.

Feature name	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Common tern, Breeding	Breeding												
Little tern, Breeding	Breeding												
Red-throated diver, Non-breeding	Non-breeding												

Abbey Farm Bird Ringing Report

by Graham Barker

Minster Marshes – Weatherlees

with George Cooper

2024

Tree Sparrow, *Passer montanus*

It is horrifying that we have to fight our own Government to save the environment.

Ansel Adams

Abbey Farm

Abbey Farm is approximately 750 acres of arable farmland. Many acres are dedicated to baby leaf lettuce and herb production with some organic. Most of the land is drained marshland.

About 84 acres remains as grazing marsh with Shetland sheep on. One boundary to the farm is provided by the River Stour and there are a number of man made splashes for over wintering birds. There are two reservoirs.

The farm is in the Higher-Level Stewardship Scheme with good acreage of wild bird and bumble bee cover. Woodland is scarce with perhaps around 0.5 acre in total.

Linnet, *Carduelis cannabina*

Hedges have been planted over the past few years totalling around 800m. There are two rail crossings on the land.

There are few wooded or scrub areas but public access, via legal footpaths, is plentiful and it is also known that people stray from these paths either due to losing their way or possibly many years of use and believing there is a 'right' to be there.

Firecrest, *Regulus ignicapillus*

Minster Marsh / Weatherlees

Minster Marshes, which encompasses a vast area including Weatherlees and much of Abbey Farm, remains under threat from the construction by National Grid of a 60,000sqm converter station as part of the SeaLink project.

Willow Warbler, *Phylloscopus trochilus*

Pegwell Bay, Sandwich Bay, Worth Marshes and Minster Marshes, as well as many other areas near by, will all be affected by the ongoing work and beyond completion of the project. If you have an interest see:

https://www.minstermarshes.com/

Chaffinch, *Fringilla coelebs*

Why Bird Ringing?

Ringing tells us about bird behaviour, migration and movement routes, age structure, reproduction rates and survival rates. It tells us an immense amount about the environment we share with them. If they are affected in any way, population shifts, then further investigation is warranted.

The process of ringing is undertaken by trained volunteers. The training process is rigorous and takes some time until a person can show they are confident enough to identify species they are likely to come in to contact with. They are then allowed a permit by the British Trust for Ornithology that organizes and runs the ringing scheme.

the UK.

Starling, *Sturnus vulgaris*

All information is gathered from across the network of ringers in the UK to help inform policy on conservation issues.

Song Thrush, *Turdus philomelos*

There is then a network of ringing organisations across many countries that share information when migrating birds are re-trapped or found there. This also applies to the UK as there is a resident population of birds that do not migrate but may undertake a partial migration though remaining in the UK.

Green Woodpecker, *Picus viridis*

Ringing Activity

During 2024 we have continued to ring as much as possible at various areas on the marshes targeting various species. We have made use of the available habitat across the area.

Blackcap, *Sylvia atricapilla*

We were out most weeks but the two main seasons we aim at are Autumn Migration and Winter ringing.

Spring, Summer, Autumn 2024

Our total for 2024, not including Winter ringing, see below, was 1120 birds of 37 species.

Species	Adult	Juvenile	Total
Blackbird	9	7	16
Blackcap	43	212	255
Blue Tit	7	22	29
Bullfinch	2	1	3
Brambling	2	1	3
Cettis Warbler	15	6	21
Chaffinch	9	12	21
Chiffchaff	134	17	151
Dunnock	10	29	39
Fieldfare	3	1	4
Firecrest	1		1
Garden Warbler	8	5	13
Goldcrest		1	1
Goldfinch	8	19	27
Grasshopper Warbler	1	1	2
Great Spotted Wood.	1		1
Great Tit	22	18	40
Green Woodpecker	1	1	2
Lesser Redpoll		1	1
Lesser Whitethroat	10	14	24
Linnet	12	19	31
Long-tailed Tit	17	16	33
Magpie		2	2
Meadow Pipit	2	1	3
Redwing		2	2
Reed Bunting	9	4	13
Reed Warbler	33	94	127
Robin	7	29	36

Species	Adult	Juvenile	Total
Sedge Warbler	8	57	65
Song Thrush	1	1	2
Starling		1	1
Stonechat		1	1
Tree Pipit	1		1
Tree Sparrow	1		1
Whitethroat	11	89	100
Willow Warbler	5	11	16
Wren	2	30	32
		Total:	**1120**

Winter ringing 2024 (Jan, Feb, Oct, Nov, Dec)

Most of our winter ringing takes place during the night-time on Abbey Farm. Yet again we targeted Woodcock, Jack Snipe and Skylark.

Birds such as Woodcock and Jack Snipe migrate in and out of the country. They arrive mostly during October from the far northern reaches of Europe and the Arctic circle where they breed. There is a breeding population of Woodcock in the UK as well.

Jack Snipe, *Lymnocryptes minimus*

Local numbers will vary from year to year depending on the severity of the winter across mainland and northern Europe.

There was an exceptional number of Jack Snipe caught during the October arrival period. Woodcock have been difficult and Skylark continue to pose some interesting group roosting opportunities.

Common Snipe, *Gallinago gallinago*

Numbers and Comparisons

Comparison for three species trapped and ringed:

	2020 Kent	2021 Kent	2022 Kent	**2022 Abbey**	2023 Kent	**2023 Abbey**	2024 Kent	**2024 Abbey**
Woodcock	1	2	11	**10**	14	**14**	n/a	**6**
Skylark	4	4	45	**24**	30	**30**	n/a	**29**
Jack Snipe	0	0	6	**5**	1	**1**	n/a	**14**

*misprint in 2023 report Skylark reported as 40.

* 2024 Kent numbers currently not available.

In 2023 we ringed 100% of each species in Kent at Abbey Farm.

Other birds we caught at night:

Grey Partridge **1**

Common Snipe **2**

Little Owl **1**

Little Owl, *Athene noctua*

Birds of Interest

We have managed to ring some interesting birds during 2024.

Siberian Chiffchaff

In mid-December this Siberian Chiffchaff made an appearance. This is a subspecies of the common Chiffchaff we see sometimes overwintering but mostly from Spring onwards having migrated from southern Europe and Africa. We ring many common Chiffchaff.

Siberian Chiffchaff, *Phylloscopus collybita tristis*

Siberian Chiffchaff sightings have become more frequent over the past few years here in Kent and across some parts of the UK. These birds migrate from eastern Europe and Siberia.

Tree Sparrow

Tree Sparrow, *Passer montanus*

The Minster Marshes area is an ideal location for a population of this species and perhaps many years ago a good number were present. The severe decline of these birds, thought to be 93% between 1970 and 2008 certainly raised alarm bells.

Potentially several birds have been sighted and it was an immense pleasure to catch one of these elusive .

More recently this species numbers have started to increase and there is hope that they may, one day, be a more common bird to be seen, but there is a long way to go and they need all the assistance possible. It will be interesting to see if these partial migrants, possibly from East Anglia, remain in the area and commence breeding which would be a great addition to the local fauna.

Brambling

If you look amongst a flock of finches, holding mostly Chaffinches, in winter time you may be lucky enough to find a few Bramblings.

These are winter visitors, migrating from northern Europe, Scandinavia and Russia, arrive in the UK in the latter part of Autumn and early Winter, spending their time with their cousins, mostly Chaffinches. Around March they will commence moving back to their breeding areas and April will see them gone.

Brambling, Fringilla montifringilla

Numbers

We ringed 1173 birds during the year. Most of the species were as expected. Others are covered previously in the Birds of Interest section.

Lesser Redpoll, *Acanthis flammea cabaret*

Again this included Lesser Whitethroat that migrate in bigger numbers using the eastern side of the country and we were lucky enough to ring 24. Reed Warblers are usually one of our bigger numbers though the total of 127 was somewhat short of expectations.

Stonechat, *Saxicola rubicola*

However, there was a very good increase in numbers of Sedge Warblers, 65. They do not breed directly on the migration ringing site but do breed across the marshes. Last year by comparison we had very few. What has changed is unknown at the present time, possibly a better breeding season? We can only wait to see what result we get next year.

The resident population of Cettis Warblers remains on Minster Marshes, they can be heard in many areas all year round. Once we have set the site it is not unusual to quickly ring the residents. We can then tell when the migrants start moving through a little later, usually accompanied by local singing birds nearby moving them on.

Magpie, *Pica pica*

Retrapped and Controlled Birds of Minster Marshes - 2024

First, birds we have trapped from other sites:

Species	Ringing Location	Date Ringed	Date we trapped it
Reed Bunting	St Nicholas at Wade	1 November	29 December
Great Tit	Richborough	5 November	16 November
Blackcap	Richborough	28 August	7 September
Blackcap	Itchen Abbas, Hants	19 July	29 August
Garden Warbler	Sandwich Bay Est.	11 August	17 August
Chiffchaff	Sandwich Bay Est.	19 March	20 July

Birds ringed on the marshes by us and trapped on other sites:

Species	Trapping Location	Date Ringed	Date trapped
Woodcock	Shot – Bradfield, Essex	26 Feb 2022	20 January 2024
Reed Warbler	Shorne Marsh, Gravesend	6 July 2024	14 July 2024
Blackcap	Courcelle-sur-Seine	4 August 2024	8 September 2024
Reed Warbler	Sandwich Bay Est.	20 July 2024	11 August 2024
Reed Warbler	Litlington, E. Sussex	20 July 2024	11 August 2024

Trapping other peoples ringed birds and having the birds we ring trapped at other sites is very important to show where the birds are going and in many cases migrating. The numbers of birds re-caught will always be minimal due to the number of ringers across any given site and the slightest deviation by a bird will mean it will not go anywhere near another site.

Important information includes how far the bird has travelled, direction and how long it has taken.

We have a varied information set above, many birds, migrants, will be trapped again within days or weeks. Other birds may take a little longer, such as the Woodcock.

EA40157 – Woodcock – we ringed this bird on 26 February 2022 as an adult bird, meaning it was already, at a minimum, the best part of two years old (once birds have attained adult feathers no exact year can be attributed to its birth). Considering it was shot 23 months after we ringed it, it was potentially 4 years old (minimum) and had flown many km's during its lifetime. The distance between ringing location and finding location is 70km (direct flight calculation) and took 693 days.

BTC4562 – Blackcap – was ringed on 4 August by us and 35 days later had travelled 239km to Courcelles-sur-Seine, Eure in France and retrapped on 8 September on migration.

BNC7935 – Reed Warbler – was ringed on 20 July on a busy day. 22 days and 102km later it resurfaced at Litlington in East Sussex. In Charlston Reedbed. Coincidence can be amazing when you least expect it. When I first started ringing, 20+ years ago, I was trained by Graeme Dunlop. I ringed with him on various sites over many years and still occasionally do so. At Charlston Reedbed, his site. That's pretty awe inspiring that I should ring this bird and Graeme should control the same bird 22 days later.

Fieldfare, *Turdus pilaris*

Redwing, *Turdus iliacus*

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George Cooper has continued to be help beyond measure and gives his time generously under all sorts of conditions.

Aaron Cooke for allowing access to Weatherlees.

Nowhere is any sound but of our going

On roads strung everywhere with humming wire.

Nowhere is there an end except in smoke.

This is the world that we have set on fire.

Sabbaths (1989), Wendell Berry

GULLS AND PLOVERS

The Ecology and Behaviour of Mixed-Species Feeding Groups

C.J. BARNARD & D.B.A. THOMPSON

STUDIES IN BEHAVIOURAL ADAPTATION

GULLS AND PLOVERS

The Ecology and Behaviour of Mixed-Species Feeding Groups

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Chapter 3

Choosing Where to Feed: Choice of Field

As we have seen in Chapter 1, several factors influence the spatial and temporal distribution of predators around feeding sites. Among birds, variation in the availability of prey, climatic factors, predation risk and social factors have all turned out to be important. The interaction between different factors in socially feeding species may be complex, even in those feeding in single-species flocks. In mixed flocks, the situation may be further complicated by frequency and density-dependent effects of the distribution and behaviour of one species on those of others. As we shall see later, the influence of conspecific and other companions on the behaviour of birds can vary with both flock size and flock-species composition. In this chapter, we examine the factors which determine the distribution and composition of mixed-species charadriiform flocks around our study area and ask why certain feeding sites are occupied more regularly than others.

Choice of Field and the Distribution of Foraging Flocks

The distribution of lapwings, golden plovers and black-headed gulls around feeding sites was recorded over three winters (1980/1981, 1981/1982 and 1982/1983) by making regular circuits of the study area. Circuits of 62 fields along a route from Keyworth, through Wysall to Rempstone and Costock (Figure 2.1) were made weekly between November and March of 1980/1981 and 1981/1982, but more sporadically in 1982/1983 owing to increased farming activity in the area. In addition, more intensive circuits (on 97 days) were made of the Hill Farm area (Figure 2.1). These circuits covered 21 fields and took approximately 30 minutes. Two sets of counts were taken per day between 10.00 and 11.15 and between 14.30 and 15.15 GMT. Counts were made from gateways or other vantage points from which entire flocks were visible. For very large flocks (>100 birds) or flocks in large fields (>6ha), replicate counts were made. Errors in replicate counts were within the 95% confidence limits of ± 5% (cf. margins for wader counts given by Prater 1979). In the few cases where entire flocks were not visible from any vantage point, birds were alarmed and counted in the air. Here, the error margin was greater (± 10%). Since counting in the air was necessary only on large fields, birds usually returned to the same field after alarm (see Chapter 9) and did not confound counts in other fields. During circuits, the number of birds of each species (= species *subflock* size in mixed flocks) in each field was counted and their activity (see below) recorded. Throughout the book, the term 'flock' will be used to refer to *all* the birds within a flock (single- or mixed-species), while 'subflock' will refer to the birds of one species within a mixed flock. In addition to head counts, we also recorded ambient temperature and the maximum and minimum temperatures for the preceding 24 hours, windspeed, rainfall and frost and snow cover on each circuit. All of these climatic factors have been shown to affect survivorship, metabolic rate, feeding rate and/or breeding success in charadriiforms (e.g. Dugan *et al.* 1981, Pienkowski 1981, 1984). Daylength and moonphase were also recorded because: (a) several studies have shown that, during short mid-winter days, some charadriiform species spend a greater proportion of the day foraging and even feed into the night (e.g. Goss-Custard 1969, Baker 1981, Sutherland 1982, and see Chapter 6); and (b) it has been suggested that moonphase influences the temporal distribution of roosting and feeding in some charadriiforms which feed inland (Spencer 1953, Hale 1980, Milsom 1984) and the diurnal activity rhythm of certain earthworm species (Ralph 1957).

From the circuits, it was clear that flocks could be divided into four main categories: foraging, pre-foraging, post-foraging and roosting, although it was usual for a small number of birds in each type of flock to perform activities more characteristic of other types.

Foraging Flocks

Foraging flocks are defined as flocks in which 90% or more of birds are searching for or handling prey. This is easy to determine because foraging lapwings and golden plovers are characterisically widely spaced and individuals variably orientated (long axis of the body) with respect to one another. Foraging birds also move about in clearly recognisable bursts of stepping interspersed with scanning or orientation postures (see Chapters 5 and 6). Table 3.1a,b and Table 3.2 summarise the species composition and the size of foraging flocks across the winter period. The most immediately striking point is that golden plovers hardly ever forage in single-species flocks, but are usually associated with lapwings. Lapwings, on the other hand, are often recorded in single-species flocks, though most occur with golden plovers and/or gulls. Gulls are almost always associated with mixed flocks of both lapwings and golden plovers. Within the study area, therefore, most birds of each species tend to forage in mixed flocks. Furthermore, the number of each plover species increases with the number of species in the flock (Table 3.2). The same is true for gulls in flocks of two and three species ($t = 2.61$, $p < .05$ in 1980/1981, and $t = 5.89$, $p < .001$ in 1981/1982).

Pre- and Post-foraging Flocks

Shortly after dawn birds move from their roosting sites on recently-ploughed fields to fields of newly-sown barley crop. Lapwing and golden plover flocks which build up on sown fields usually contain a small proportion of foraging individuals (6.5 ± 3.72% of lapwings, n = 54 flocks; 4.3 ± 0.62% of golden plovers, n = 37 flocks). Non-foraging birds tend to orientate in one direction (facing into the wind), as in roosting flocks. Birds remain in these *pre-foraging flocks* for up to two hours before moving off to forage on pasture. Table 3.3

Table 3.1: The percentage of foraging lapwings, golden plovers and black-headed gulls in single- and mixed-species flocks in winter. F = the percentage of flocks, I = the percentage of individuals. Data for two winters (see text)

(a) *1980/81*		Species composition of flock						
		L	GP	L + GP	L + B–H G	GP + B–H G	L + GP + B–H G	n
L	F	58.9	—	25.3	04.0	—	11.8	569
	I	32.7	—	38.2	06.6	—	22.5	5488
GP	F	—	00.9	67.8	—	00.0	31.7	211
	I	—	00.2	55.4	—	00.0	44.4	10012
B–H G	F	—	—	—	25.6	00.0	74.4	90
	I	—	—	—	17.6	00.0	82.4	179

(b) *1981/82*		Species composition of flock						
		L	GP	L + GP	L + B–H G	GP + B–H G	L + GP + B–H G	n
L	F	50.2	—	23.8	04.8	—	21.2	189
	I	18.9	—	31.1	06.4	—	43.5	6787
GP	F	—	01.2	51.1	—	00.0	45.5	88
	I	—	00.1	45.6	—	00.0	54.3	4720
B–H G	F	—	—	—	18.4	00.0	81.6	49
	I	—	—	—	5.6	00.0	93.2	161

L = lapwings, GP = golden plovers, B–H G = black-headed gulls.
n = total number of flocks or birds.

Table 3.2: The mean (± standard error) flock/subflock size for lapwings, golden plovers and black-headed gulls in single- and mixed-species flocks

		Species composition of foraging flock							
		L	GP	L+GP	L+ B–H G	L+GP +B–H G	(i)	(ii)	n
L	80/81	14.3 ±00.93	—	34.3 ±03.20	40.2 ±05.31	48.4 ±03.04	*** 3.19	*** 5.99	569
	81/82	17.4 ±01.86	—	43.1 ±09.32	50.1 ±11.30	81.9 ±14.46	1.89	* 2.01	189
GP	80/81	—	25.0 ±00.00	36.2 ±11.30	—	63.7 ±08.31	* 1.97	—	211
	81/82	—	03.0 ±00.00	24.9 ±09.41	—	62.0 ±12.71	* 2.33	—	88
B–H G	80/81	—	—	—	01.30 ±00.11	02.21 ±00.3	—	—	90
	81/82	—	—	—	01.12 ±00.17	03.90 ±00.44	—	—	49

(i) t-test comparisons between L + GP and L + GP + B–H G.
(ii) t-test comparisons beween L and L + GP.
* $p < .05$, ** $p < .01$, *** $p < .001$; t-test. Data from circuits (see text and see Table 3.1).

Table 3.3: The species composition and mean (± standard error) flock/subflock sizes (no. birds) for pre-foraging and post-foraging flocks

	Pre-foraging flocks		Post-foraging flocks	
	Single spp.	Mixed spp.	Single spp.	Mixed spp.
LAPWINGS				
%	43.8	56.3	38.2	61.7
x̄ mean ± s.e.	43.9 ± 10.3	64.9 ± 15.5	48.2 ± 21.6	31.8 ± 4.3
no. flocks	21	27	13	21
% all flocks	58.5		41.4	
GOLDEN PLOVERS				
%	11.1	88.9	0	100.0
x̄ mean ± s.e.	75.0 ± 67.0	44.8 ± 8.64	0	60.9 ± 14.7
no. flocks	3	24	0	20
% all flocks	57.4		42.6	
B–H GULLS				
%	0	100.0	0	100.0
x̄ mean ± s.e.	0	2.63 ± 1.08	0	1.33 ± 0.1
no. flocks	0	11	0	3
% all flocks	78.5*		21.5	

*$p < .05$; X^2 test comparing pre- and post-foraging flocks.
Data for the December-January (1980/81) period only.

shows that pre-foraging flocks are usually mixed associations, but that golden plovers are now more likely to occur in single-species flocks. There are also likely to be two or three gulls associated with the flock.

Towards the end of the day (up to two hours before dusk), birds form *post-foraging flocks* (also called 'sub-roosts' by Spencer (1953) and Hale (1980)), once again on sown fields. Fewer individuals forage in post- than in pre-foraging flocks (4.1 $\pm$ 1.21% of lapwings, n = 18 flocks; 3.2 $\pm$ 0.33% of golden plovers, n = 15 flocks). Foraging by all individuals, as reported by Spencer (1953) at his sub-roosts, was not observed in our post-foraging flocks. Table 3.3 shows that pre- and post-foraging flocks do not differ consistently in terms of the number of plovers, but that post-foraging flocks contain significantly ($p < .05$) fewer gulls. Golden plovers occur only in mixed post-foraging flocks.

Roosting Flocks

Roosting flocks usually occur only in newly-ploughed fields. Birds are almost never observed foraging and are always orientated in the same direction into the prevailing wind (see also Fuller and Youngman 1979). Many birds sleep with the head tucked into the feathers on the back. An interesting feature of roosting flocks is the tendency for lapwings and golden plovers to separate and occupy different areas of the field. Gulls also tend to roost away from plover species. While roosting flocks develop mainly as dusk approaches, they sometimes build up earlier in the day.

Pre- and post-foraging flocks will be discussed again in more detail later (in Chapter 7). Here, we shall consider the distribution of foraging flocks and their preference for certain types of field.

The Distribution of Foraging Flocks

To begin with we simply scored pasture fields, which contained only foraging flocks, for the presence or absence of birds on each circuit day. We then used a preference index similar to that of Heppleston (1971a) except that our data were obtained from regular circuits rather than random counts. For each species we calculated field preference as:

$$I_c = \frac{D_i}{D_o} \tag{3.1}$$

where D_i is the number of circuit days on which at least two individuals of species i were recorded in field n and D_o is the number of circuit days on which field n was observed. The value of I_c therefore varies from 0 (birds never present) to 1 (birds present every day). I_c values for fields observed on the circuits are shown for two winters in Table 3.4. It is clear from the table that there is enormous between-field variation in the probability of birds being present. Some fields regularly contain birds, others seldom do. Are there any physical qualities of the field which correlate with their probability of containing birds?

Foraging flocks and pasture age. As we mentioned in Chapter 2, pasture fields in the study area vary considerably and discontinuously in age. Pastures fall into two categories, which we shall refer to as *young* (< 4 years old) and *old* (> 25 years old) pasture. There are no fields which have been pastures for between five and 25 years. It is reasonable, therefore, to ask whether the length of time for which a pasture has remained undisturbed (except for grazing) correlates in any way with its apparent quality as a feeding site. Figure 3.1a shows the relationship between I_c and pasture age for lapwings and golden plovers. Gulls will be discussed later. The graph shows a significant positive relationship for lapwings, but no significant trend for golden plovers. I_c, however, takes into account only the probability that a feeding flock subflock will be present on a field. It says nothing about the bias in *numbers* towards particular fields. To see whether certain fields tend to contain a disproportionate number of birds, we calculated:

$$I_n = \frac{N_i - a}{(N_i + a) - 2((N_i - a)a)} \tag{3.2}$$

where N_i is the number of individuals of species i in field n divided by the total number of individuals of species i counted in the remainder of the study area and a is the area of field n divided by the total area of other pasture fields in the study area. I_n is similar to the index used by Patterson *et al.* (1971), Fuller

Table 3.4: I_c values for lapwings and golden plovers in fields covered by circuits

Field no. (as encountered on circuit)	I_c for Lapwing 1980/1981	Lapwing 1981/1982	Golden plover 1980/1981	Golden plover 1981/1982
1	.45	.11	.19	.11
2	.84	.61	.47	.39
3*	.88	.60	.02	.01
4	.94	.62	.72	.45
5*	.81	.45	.01	.00
6	.06	.04	.03	.04
7	.77	.50	.36	.02
8	.60	.20	.30	.10
9	.65	.26	.35	.19
10*	.76	.58	.01	.00
11*	.43	.53	.12	.00

*fields smaller than 3.0 hectares.
Data from circuits (see Table 3.1 and text).

and Youngman (1979) and Fuller and Lloyd (1981) and takes into account bias resulting from variation in field size and the number of birds feeding at the time of sampling. If I_n for lapwings and golden plovers is plotted against pasture age (Figure 3.1b), there is again a positive correlation for lapwings and a non-significant relationship for golden plovers. Taken together, therefore, the trends in Figure 3.1a,b show that the greatest concentration of lapwings occurs on old pastures, and that lapwings are seen there more regularly

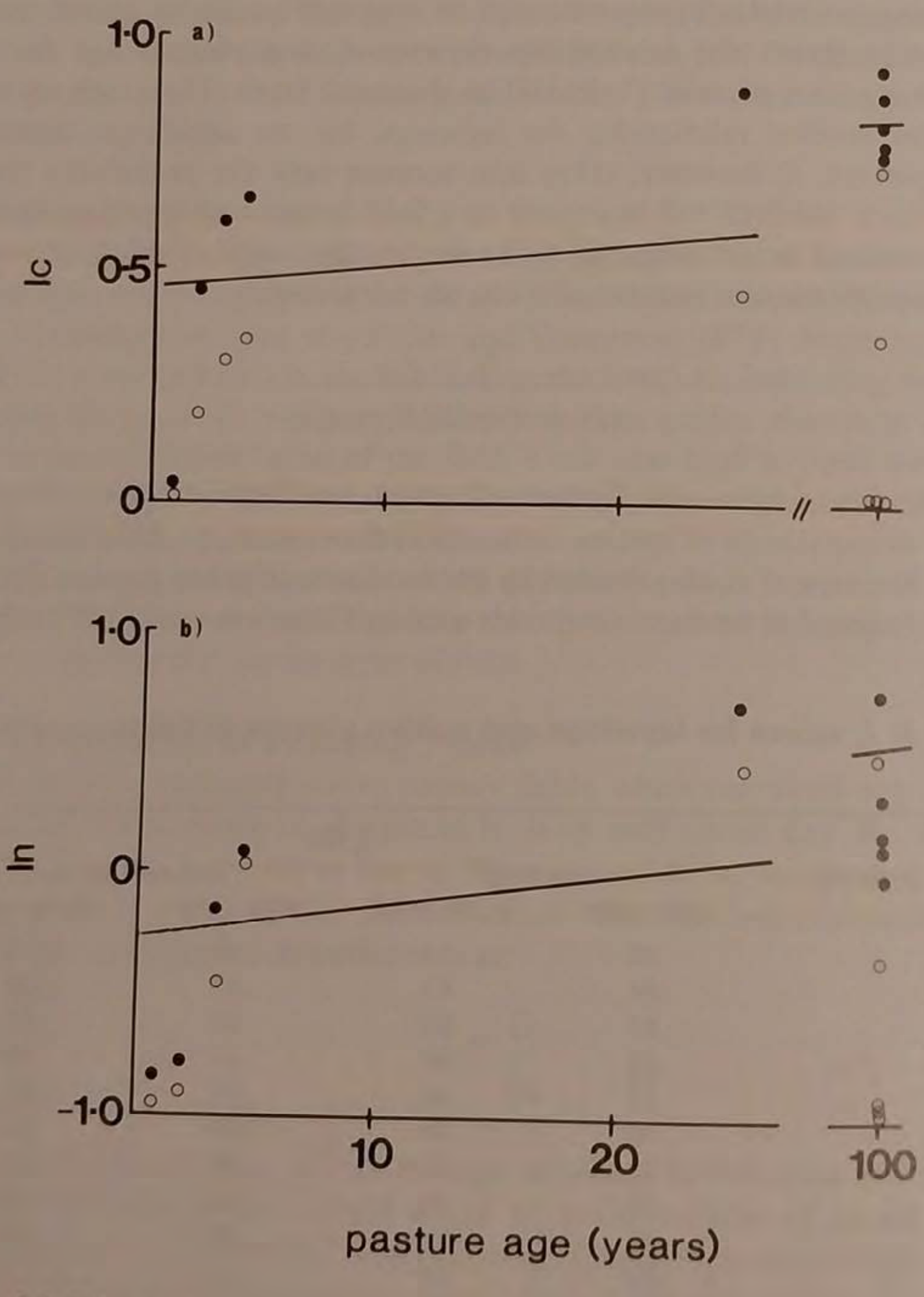


Figure 3.1: The relationships between pasture age and (a) I_c and (b) I_n in lapwings (closed circles) and golden plovers (open circles). F-ratios in (a), $F = 5.34$, $p < .05$ for lapwings and 2.66, n.s. for golden plovers; ratios in (b), $F = 10.73$, $p < .01$ for lapwings and .23 n.s. for golden plovers. Data from 10 fields

than golden plovers. This difference between the two species will become important later. First, we must consider the factors likely to account for the accumulation of foraging birds on old rather than young pastures.

Pasture age and prey availability. One obvious factor which might correlate with pasture age and bias the distribution of birds is prey availability. Plovers in the study take almost exclusively earthworms during the winter (see Chapter 2) and several studies have shown positive correlations between pasture age and earthworm density (e.g. Heppleston 1971a, Waite 1981, 1983, and see Evans and Guild 1948, Guild 1951, MacFadyen 1962). Of these, however, only Heppleston (1971a) has attempted to rank fields in terms of worm density and relate this to site preference in feeding birds (oystercatchers).

We sampled the earthworm community in pasture fields using two methods: (a) randomly-placed 0.25m-square quadrats of turf and (b) 10.2cm-diameter core samples, both to a depth of 3.0cm. Both turf and core samples were hand-sorted for invertebrates and all items found were preserved in a 10% Biofix solution for later analysis. Hand-sorting was used because it is the most effective sampling technique for surface-dwelling earthworm species (Edwards and Lofty 1977). From bill-length measurements, we judged 3.0cm to be the maximum depth to which plovers could penetrate the soil and therefore the vertical limit of worm availability. Other studies (e.g. Satchell 1971, Brown 1983) have used chemical (formalin, potassium permanganate, Biofix) extraction techniques, which result in an overestimate of deep-dwelling species such as *Lumbricus terrestris* that are forced up, and an underestimate of surface-dwellers such as *Allolobophora chlorotica*, *A. caliginosa* and *A. rosea* that tend to move down. The core samples were taken to provide estimates of the vertical distribution of earthworm density, size and species composition in different fields. An important point, however, is that no bias was apparently incurred by worms burrowing away during sampling. Owing to the heavy clay content of the soil and the relatively low temperatures which prevailed during the study periods, worms moved only very slowly through the soil. In some cases, worms were still present on the cut soil surface up to five minutes after a turf sample was removed. Using the worm samples, we compared four aspects of worm availability in young and old pasture and related them to the distribution of foraging birds.

(a) Worm density. Forty-three 0.25m-square turf and 84 core samples from a total of ten fields were examined on two consecutive days in 1980/1981 when the ambient temperature was between 8°C and 10°C and weather conditions more or less constant. Within the turf samples, there was a significant positive relationship between worm density and pasture age (up to 25 years) (Figure 3.2a). The most likely reason is that, as pastures mature, there is a gradual accumulation of the dead organic matter on which worms feed (e.g.

Nordstrom and Rundgren 1974). Furthermore, old pastures are grazed by cattle for a greater part of the year and therefore have a higher organic input from dung. Worm density, however, appears to drop in very old pasture (>100 years) (Figure 3.2a). A possible explanation is that the thick root layer in very old pastures favours large numbers of nematodes, which reduce the amount of oxygen available to earthworms (D.B.A.T. unpubl). In addition, the largest of the earthworm species, *L. terrestris*, is found in old pasture (Edwards and Lofty 1972, Brown 1983), where it can be predatory on other species. Perhaps not surprisingly, therefore, the wet weight biomass of worms increases linearly with pasture age (Figure 3.2b) owing to the increasing predominance of larger species such as *L. terrestris* and *A. longa* (see below). To see whether ploughing itself reduces worm density in any given erstwhile pasture field, we took a number of turf samples from selected fields at the same time (between 5 and 12 March when the ambient temperature was between 8.5°C and 10°C) in three successive years. Figure 3.3a,b shows worm density in two of the fields which were undisturbed in the first two years they were sampled, but ploughed up in the third. Samples taken two months after ploughing show a significant decline in worm density. In another field which was not ploughed, worm density continued to increase in the third year, as expected from Figure 3.2a. There is, therefore, a clear positive relationship between worm density in the surface-soil layer available to plovers and the length of time since a field was last ploughed.

If the abscissa in Figure 3.1a,b is now converted from pasture age to the surface 3.0cm worm density recorded in each field, significant positive relationships for both I_c and I_n emerge. This is reinforced by stepwise partial regression analysis which examines the independent effects of pasture age and worm density on I_c and I_n. In this and all other partial regression analyses referred to, we used the stepwise forward inclusion technique detailed by Nie *et al.* (1975). Data were checked for violations of the assumptions (of normality, homogeneity of variance, linearity of relationships and weak correlation between independent variables) underlying partial regression analysis (see Pedhazur 1982). Where necessary, the frequency distribution of variables was normalised using one of several transformations (e.g. $\log_{10}$ or natural log for ratio variables, arcsin for proportions and percentage variables where their distributions approached 0 and 1 (or 100) and reciprocation where the data were highly skewed: see Sokal and Rohlf 1981 for details). When transformation still failed to satisfy requirements for the analysis, data were analysed using non-parametric methods. Independent variables yielding non-significant F-ratios were not included in partial regression analysis. For the application of partial and multiple regression techniques to other charadriiform data see e.g. Bryant (1979), Goss-Custard *et al.* (1981, 1984), Pienkowski (1983b), Ens and Goss-Custard (1984).

Table 3.5 shows the results of partial regression analysis taking into account both pasture age and mean worm density. In addition, the analysis

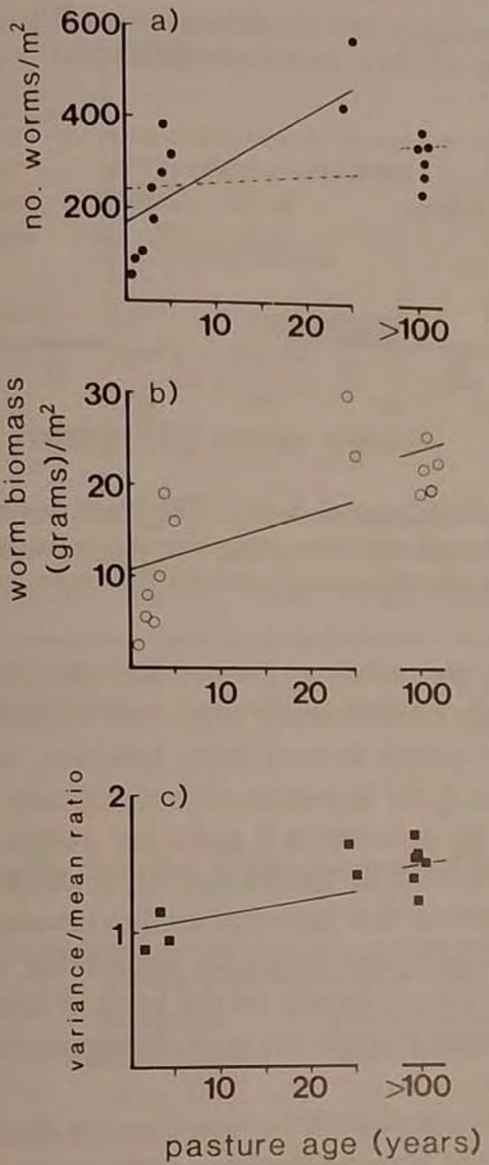


Figure 3.2: Effects of pasture age on (a) worm density, $F = 14.9$, $p < .001$ (pastures up to 25 years, solid line); the relationship is not significant when all pastures are included (broken line); (b) worm (wet weight) biomass, $F = 8.2$, $p < .05$; (c) variance: mean ratio of worm density, $F = 12.96$, $p < .01$. Data for 16 pastures

took into account field area and the number of heterospecifics present in the field; as we shall see in later chapters, both these factors have profound effects on foraging behaviour and species flock/subflock size. Table 3.5a shows that, when other factors are taken into account, the effect of pasture age on I_c for golden plovers disappears and variation in I_c is best explained in terms of variation in worm density and field area. Birds occur most regularly in large fields where worm density is high. Worm density also accounts for a significant amount of variation in I_c in lapwings, but here pasture age still exerts a significant independent effect and there is no effect of field size. When I_n is

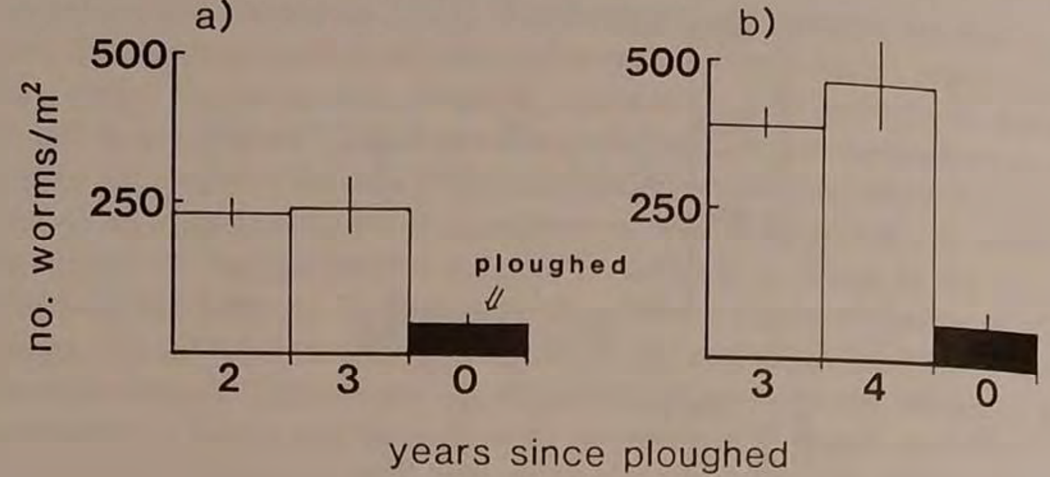


Figure 3.3: Effects of ploughing on worm density. The figure shows the relationship between mean worm density and time since ploughing in two pastures. Shaded columns show densities immediately after ploughing (see text). Bars represent standard errors

examined (Table 3.5b), the effect of pasture age disappears in both species with variation in lapwing number being explicable entirely in terms of worm density. Two important points to note here, however, are (a) I_n for golden plovers depends most on I_n for lapwings, with significant effects on field size and worm density, and (b) variation in I_c and I_n for gulls is best explained by I_c and I_n for golden plovers with no significant effect on other variables. From Table 3.5, therefore, it seems that lapwings tend to choose feeding sites partly on the basis of worm density and partly on some other correlate of pasture age, that golden plovers choose largely on the basis of intensity of use by lapwings, and that preferences in gulls are very closely correlated with those of golden plovers.

The apparent dependence of golden plovers on the distribution of lapwings suggests that they may use lapwing flocks to indicate the best fields in which to feed (see e.g. Krebs 1974, Neuchterlein 1981, Burger 1984 for similar evidence from other species). If they do, their distribution across lapwing flocks should be non-random. This appears to be the case. Significantly fewer lapwing flocks (37.1%) contain golden plovers than expected if the latter distribute themselves indiscriminately across flocks (64.6%, X^2 test comparing observed and expected, $p < .01$, $n = 569$ lapwing flocks). Golden plovers thus appear to be selective in their choice of flock. Indeed, we have observed them flying over four or more lapwing flocks before alighting. What criteria might birds use in choosing a flock? We recorded the size and density (no. birds/ha, see Chapter 6) of lapwing flocks joined or passed over by golden plovers. In each case we also measured the density of worms where lapwings were feeding. The results, summarised in Table 3.6, suggest that golden plovers are attracted to fields containing large flocks of lapwings and high worm densities. This is good evidence that the presence of lapwings acts as a guide to rich feeding areas.

Woodlark

Lullula arborea

Introduction

Very much a bird of wooded heath, the lilting song of the Woodlark can be heard on sunny days throughout the year.

Woodlarks are patchily distributed in the UK, from the heaths of East Yorkshire to East Anglia, the New Forest and Dartmoor. It is not found in on the island of Ireland. During the winter months Woodlarks gather in small flocks, often close to their breeding areas. Sometimes as many as 50-60 birds can be seen feeding together, seeking out seeds and invertebrates.

The Woodlark is one of the few birds in the UK with a supercilium, the stripe above the eye, that meets on the back of the head. It also has a distinctly short tail.

- Our Trends Explorer gives you the latest insight into how this species' population is changing.

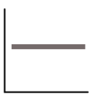
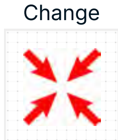
Key Stats

Status	Weight	Eggs	Seasonality	BTO Records
				
Scarce	30g	3-5	<1%	31k records

Population and distribution stats for:

Breeding

Winter

Population Change	Population Size	Distribution Change
		
Stable 1995 to 2023	2,300 pairs	-23% contraction

Identification

Curated resources to aid in the identification of Woodlark

ID Videos

Close ×

This section features BTO training videos headlining this species, or featuring it as a potential confusion species.

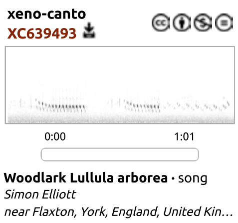
Skylark & Woodlark

Songs and Calls

Close ×

Listen to example recordings of the main vocalisations of Woodlark, provided by xeno-canto contributors.

Song:



Call:

502 Bad Gateway

nginx/1.29.2

Status and Trends

Population size, trends and patterns of distribution based on BTO and partnership surveys and atlasses with data collected by BTO volunteers.

Conservation Status

Close ×

This species can be found on the following statutory and conservation listings and schedules.

- UK Birds of Conservation Concern .... Green listed
- Species of European Conservation Concern .... Least Concern
- IUCN Red List of Threatened Species (global) .... Least Concern
- Schedule 1 Licence required (to disturb)* .... Yes
- Birds Directive Annex 1 .... Yes
- Listed on the Annexes of* .... WCA(I,IV), WBD(I), Bern(III), NERC (41)

* A guide only. Check details with the original legislation, especially those marked with an asterisk. See About BirdFacts for more information.

Population Size

Close ×

- UK (breeding) — 2300 pairs (2016) — Source
- BOU Category — A — Source
- First Record* — Recorded in Medieval times

* First documented occurrence. Most species undoubtedly occurred before this. See About Birdfacts for more information.

Population Change

Close ×

- **UK breeding population** — 131% (1995 to 2023) — Source

This species is too rare and restricted in range for population changes to be monitored annually by BTO volunteer surveys. A 62% reduction occurred in the number of 10-km squares occupied between 1968-72 and 1988-91; the species had ceased to breed in Wales and in several southern English counties over this period (Gibbons *et al.* 1993). Sitters *et al.* (1996) report that the UK population increased from c.250 pairs in 1986 to c.600 pairs in 1993. A repeat national survey in 1997 showed that the population had increased further, accompanied by expansion of the range into new areas (Wotton & Gillings 2000). A further repeat in 2006 recorded just over 3,000 pairs: an increase since 1997 of 88% accompanied by major range expansion, with a pair breeding in Wales for the first time since 1981 (Conway *et al.* 2009). However, numbers dropped following the severe winters in 2008/09 and 2009/10 (Holling & RBBP 2012; APEP4). As a result of these population changes, Woodlark was dropped as an RBBP species in 2012 but reinstated in 2016.

Atlas data for 2008-11 indicate losses of range since 1968-72 in southwestern and southern England, and in Wales, offset by expansion in central southern England and northwards in eastern England (Balmer *et al.* 2013). The species' partial recovery in numbers and range resulted in a move from the red to the amber list at the 2009 review (Eaton *et al.* 2009) and on to the UK green list in 2015 (Eaton *et al.* 2015).

There has been an increase across Europe since 1980, although this trend should be treated with caution as the data from early years are based on limited geographical coverage (PECBMS: PECBMS 2020a>).

Visit our Trends Explorer **for trend graphs and country statistics.**

Distribution

Close ×

The core part of the Woodlark's breeding range is Devon, the New Forest, and the heaths of the Thames Basin and East Anglia. Additionally there are new populations in the West Midlands, northern England and South Wales. In the 1980s Woodlarks usually departed their East Anglian breeding areas in winter, but now many remain year round. With these and others wintering near central and northern England breeding areas, the winter range is four times larger than it was in the 1980s.

Occupied 10-km squares in UK

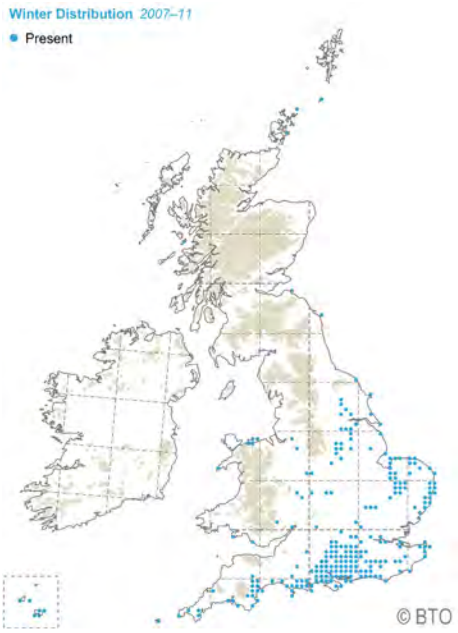
These figures come from *Bird Atlas 2007* and indicate how widespread a species is.

- No. occupied in breeding season — 155
- % occupied in breeding season — 5.1%
- No. occupied in winter — 243
- % occupied in winter — 8%

Visit our Trends Explorer **for trend graphs and country statistics.**

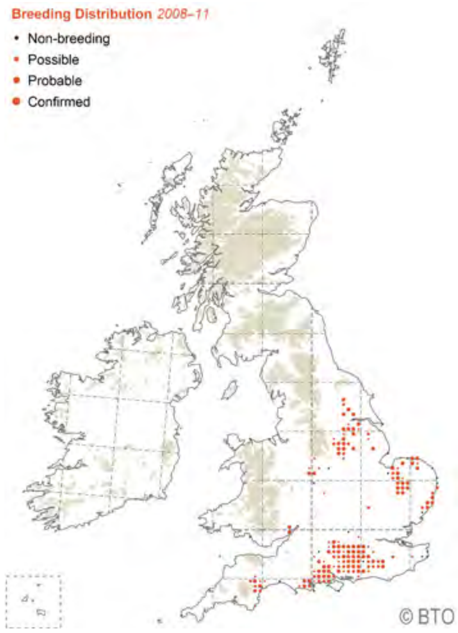
Bird Atlas distribution maps show where bird species breed or winter in Britain and Ireland. For breeding maps, larger dots indicate higher certainty the species bred in that area.

Winter distribution
2007/08–10/11



Click the map to enlarge,
or view it on Bird Atlas Mapstore.

Breeding distribution
2008–11



Click the map to enlarge,
or view it on Bird Atlas Mapstore.

To view and download up-to-date distribution information aggregated from across BTO and partnership surveys and schemes, see our data holdings on the NBN Atlas.

European Distribution Map

- European Breeding Bird Atlas 2

Distribution Change

Close ×

Woodlark distribution has changed considerably since the 1970s. Between 1968–72 and 1988–91 the range contracted by 63%, largely through losses on farmland in Wales and southwest England. Subsequently, a 107% range expansion took place up to 2008–11

Change in occupied 10-km squares in the UK

These figures come from *Bird Atlas 2007-11* and indicate by how much occupied areas have expanded or contracted over recent decades.

- % change in range in breeding season (1968–72 to 2008–11) .... -23%
- % change in range in winter (1981–84 to 2007–11) 296.4%

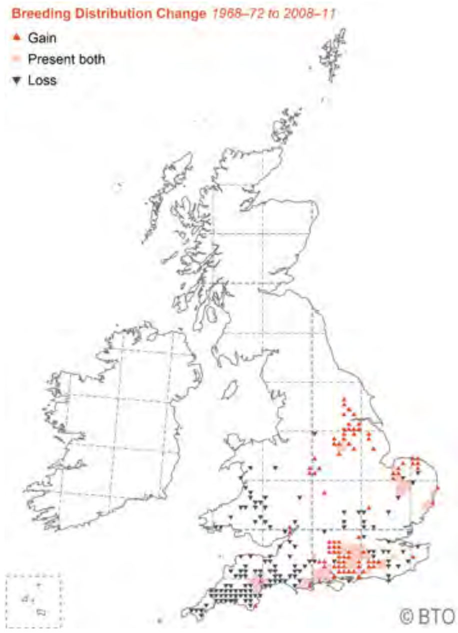
Visit our Trends Explorer **for trend graphs and country statistics.**

Bird Atlas distribution change maps show how bird distributions have change through time. Coloured upward-pointing triangles show places apparently colonised over the period; grey downward-pointing triangles show places apparently vacated. Shading shows squares occupied in all periods.

Winter distribution change
from 1981–84 to 2007–11

Click the map to enlarge,
or view it on Bird Atlas Mapstore.

Breeding distribution change
from 1968–72 to 2008–11



Click the map to enlarge,
or view it on Bird Atlas Mapstore.

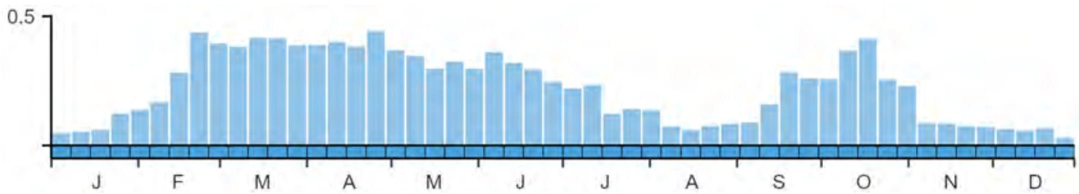
Seasonality

Close ×

Some Woodlarks are present throughout the year but arrivals and song activity means most likely recorded from late winter onwards; a noticeable peak in late autumn of passage birds, most detected in flight.

Weekly pattern of occurrence

The graph shows when the species is present in the UK, with taller bars indicating a higher likelihood of encountering the species in appropriate regions and habitats.



Weekly occurrence patterns (shaded cells) and reporting rates (vertical bars) based on BirdTrack data. Reporting rates give the likelihood of encountering the species each week.

Movement

Information about Woodlark movements and migration based on online bird portals (e.g. BirdTrack), Ringing schemes and tracking studies.

Britain & Ireland movement

Close ×

- View a summary of recoveries in the Online Ringing Report

Foreign locations of birds ringed or recovered in Britain & Ireland

Dots show the foreign destinations of birds ringed in Britain & Ireland, and the origins of birds ringed overseas that were subsequently recaptured, resighted or found dead in Britain & Ireland. Dot colours indicate the time of year that the species was present at the location.

Winter (Nov-Feb) Spring (Mar-Apr) Summer (May-Jul) Autumn (Aug-Oct)

European movements

Close ×

EuroBirdPortal uses birdwatcher's records, such as those logged in BirdTrack to map the flows of birds as they arrive and depart Europe. See maps for this species here.

The Eurasian-African Migration Atlas shows movements of individual birds ringed or recovered in Europe. See maps for this species here.

Biology

Lifecycle and body size information for Woodlark, including statistics on nesting, eggs and lifespan based on BTO ringing and nest recording data.

Productivity and Nesting

Close ×

Nesting timing

Average (range) fo first clutch laying dates	8 Apr (17 Mar-3 Jun)	Source
Typical (exceptional) number of broods	1–2	Source

Egg measurements

Typical length x width	21×16 mm	Source
Mass (% shell)	2.8g (6%)	

Clutch Size

Typical number	3-5 eggs

Average ±1 standard deviation	3.81±0.68 eggs		Source
Observed minimum and maximum	2-6 eggs		

Incubation

Incubation by	Female		
Typical duration	14 days		Source
Observed average ±1 standard deviation	14.27±1.02 days		
Observed minimum and maximum	13-16.5 days		

Fledging

Type of chick	Altricial, downy		
Typical duration	11-13 days		Source
Observed average ±1 standard deviation	11.89±1.19 days		N=695, - Source
Minimum and maximum	10-13.5 days		

Visit our Trends Explorer for trend graphs and country statistics.

Survival and Longevity

Close ×

Survival is shown as the proportion of birds surviving from one year to the next and is derived from bird ringing data. It can also be used to estimate how long birds typically live.

View number ringed each year in the Online Ringing Report.

Lifespan

Typical life expectancy of bird reaching breeding age	3 years with breeding typically at 1 year	Source
Maximum age from a ringed bird	7 years, 2 months, 1 day (set in 2017)	Source

Survival of adults

All adults	0.6±0.03	Source

Survival of juveniles

All juveniles	0.22±0.03 (in first year)	Source

Visit our Trends Explorer for trend graphs and country statistics.

Biometrics

Close ×

Wing length and body weights are from live birds (source).

Visit our Trends Explorer for trend graphs and country statistics.

Ring Size A (pulli B)

Classification, names and codes

Taxonomy, names and species codes for Woodlark

Classification and Codes

Close ×

- Order: *Passeriformes*
- Family: *Alaudidae*
- Scientific name: *Lullula arborea*
- Authority: Linnaeus, 1758
- BTO 2-letter code: WL
- BTO 5-letter code: WOODL
- Euring code number: 9740

Alternate species names

Close ×

Catalan: cotoliu
Czech: skrivan lesní
Danish: Hedelærke
Dutch: Boomleeuwerik
Estonian: nõmmelõoke
Finnish: kangaskiuru
French: Alouette lulu
Gaelic: Uiseag-choille
German: Heidelerche
Hungarian: erdei pacsirta
Icelandic: Trjálævirki
Irish: Fuiseog Choille
Italian: Tottavilla
Latvian: sila cirulis, vilinš
Lithuanian: lygute
Norwegian: Trelerke
Polish: lerka
Portuguese: cotovia-dos-bosques
Slovak: škovránik stromový
Slovenian: hribski škrjanec
Spanish: Alondra totovía
Swedish: trädlärka
Welsh: Ehedydd Coed

Research

Interpretation and scientific publications about Woodlark from BTO scientists.

Causes of Change and Solutions

Close ×

Causes of change

The causes of change are uncertain, but increased habitat available and climate change may both have benefited Woodlark.

Further information on causes of change

The increase from c.250 pairs in 1986 to c.600 pairs in 1993 was probably helped by mild winters and increased habitat availability due to storm damage in plantations, forest restocking, and heathland management ((Sitters *et al.* 1996)).

Farmland setaside, especially close to forest, was valuable additional habitat for the expanding population, although clutch sizes may be lower there than in more traditional habitats (Wright *et al.* 2007). Climate change may benefit Woodlark, because it is able to make more nesting attempts in warmer years (Wright *et al.* 2009). The cold 2008/09 and 2009/10 winters may, however, have brought about the reduction in numbers reported to RBBP for 2010 (Holling & RBBP 2012; Woodward *at al.* 2020: APEP4). The small NRS sample suggests that nest failure rates have become less frequent at the egg stage. There has been no trend, however, in the number of fledglings per breeding attempt. Human disturbance at heathland sites apparently reduces population density, but the effects are partly offset by higher breeding productivity at lower densities (Mallord *et al.* 2007).

Information about conservation actions

The Woodlark has increased in numbers since the 1980s, although it is restricted by its habitat requirements and so remains vulnerable, and is an RBBP species.

Disturbance caused by human recreational activity at heathland sites may reduce population density. In one study, the probability of suitable habitat patches being occupied was reduced to below 50% at around eight disturbance events per hour (Mallord *et al.* 2007). Modelling carried out as part of this study suggested that, where possible, increased visitor numbers should be concentrated on sites which are already disturbed as this would have much less effect on the woodlark population than increased visitor numbers across all sites.

Provision of suitable heathland and woodland habitat could also benefit the Woodlark. The species requires patches with substantial proportions of bare ground and short vegetation (Mallord *et al.* 2007). Annual ground disturbance within c.45 m of woodland successfully increased Woodlark numbers on a lowland grass-heath with closed swards (Hawkes *et al.* 2019). Woodlarks in Polish commercial forests prefer areas with new regrowth (less than five years old) but with some mature trees retained and with a higher proportion of forest edge habitats (Mallord *et al.* 2007). In the Mediterranean, the population has increased following land abandonment which has created a heterogeneous landscape of farmland and shrubland (Sirami *et al.* 2010), given the differing climates it is unclear whether creating set-aside in the UK close to existing populations might have a similar effect; farmland set-aside fields are used in Breckland, but may be sub-optimal to other breeding habitats (Wright 2006).

More Evidence

More evidence from Conservation Evidence.com

- Response of bird communities to silvicultural thinning of Mediterranean maquis
- The effects of grassland management using fire on habitat occupancy and conservation of birds at a mosaic landscape
- Cutting of lowland heathland using a double-chop forage harvester at Trigon, Dorset, England
- Birds and lowland grassland management practices in the UK: an overview

There are a total of 8871 individual studies.

Partners

Birdfacts is based on data collected by volunteers participating in surveys that are organised and funded by BTO, RSPB, Esmée Fairbairn Foundation, JNCC and other partners.

BTO

Esmée Fairbairn Foundation

JNCC

RSPB

Citing BirdFacts

If you wish to cite particular content in this page (e.g. a specific value) it is best to use the original sources as linked in the page. For a more general citation of the whole page please use: BTO (20XX) BirdFacts Species: profiles of birds occurring in the United Kingdom. BTO, Thetford (www.bto.org/birdfacts, accessed on xx/xx/xxxx).

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East Anglia ONE North Limited
Scottish Power Renewables
320 St Vincent Street
Glasgow
G2 5AD

Our ref: EN010077

31 March 2022

Dear Mr McGrellis,

PLANNING ACT 2008: APPLICATION FOR DEVELOPMENT CONSENT FOR THE EAST ANGLIA ONE NORTH OFFSHORE WIND FARM

1 Introduction

1.1 I am directed by the Secretary of State for Business, Energy and Industrial Strategy ("the Secretary of State") to advise you that consideration has been given to the report dated 6 October 2021 of the appointed Examining Authority ("the ExA") – a panel comprising five members, Rynd Smith, Jon Hockley, Caroline Jones, Jessica Powis and Guy Rigby - which conducted an examination into the application ("the Application") submitted on 15 October 2019 by East Anglia ONE North Limited ("the Applicant") for a Development Consent Order ("the Order") under section 37 of the Planning Act 2008 ("the 2008 Act") for the East Anglia ONE North Offshore Wind Farm ("East Anglia ONE North") and associated onshore and offshore development ("the Proposed Development"). The Application was accepted for examination on 22 November 2019.

1.2 The separate applications for an Order granting development consent for East Anglia ONE North and East Anglia TWO offshore wind farms were made and examined simultaneously with an ExA comprised of the same members for both East Anglia ONE North and East Anglia TWO. This enabled parallel examination processes under which common matters and issues were examined together and singular examination processes where distinct matters relevant to an individual application could be examined separately if required. The Secretary of State has decided each application for development consent on its own merits.

1.3 On 17 March 2020, in response to the Coronavirus (COVID-19) pandemic, the start of the examination was postponed. The Secretary of State notes that the examination has been conducted by the ExA in the challenging times of the COVID-19 pandemic when the

Government introduced public health measures including a ban on large public meetings and a direction for people to stay at home as much as possible. He notes that the Planning Inspectorate and the ExA made best endeavours to ensure that no person or party was disadvantaged in participating in the examination process. After measures had been put in place by the Planning Inspectorate to enable participation via virtual events, the examination began on 7 October 2020. All meetings and hearings were conducted as virtual events. Amended site inspection arrangements were made using a procedure to reflect Coronavirus public health controls. The Secretary of State granted a three-month extension to the examination period announced via a Written Ministerial Statement[1], and the examination was completed on 6 July 2021 after a period of nine months.

1.4 The Order would grant development consent for the construction, operation, and maintenance of an electricity generating station comprising an offshore wind farm power station with up to 67 wind turbine generators, together with up to four offshore electrical platforms, an offshore construction, operation and maintenance platform, a meteorological mast, inter-array cables linking the wind turbine generators to each other and to the offshore electrical platforms, platform link cables and up to two export cables to take the electricity generated by the wind turbine generators from the offshore electrical platforms to landfall.

1.5 The onshore works would comprise of the construction and operation of landfall connection works north of Thorpeness in Suffolk, underground cables running from landfall to a new onshore substation located at Grove Wood, Friston, Suffolk, together with a new National Grid substation and National Grid overhead line realignment works including the reconstruction and/or relocation of up to three pylons, construction of up to one additional pylon, and the construction of up to three permanent sealing end compounds.

1.6 Published alongside this letter on the Planning Inspectorate's National Infrastructure Planning website[2] is a copy of the ExA's Report of Findings and Conclusions and Recommendation to the Secretary of State ("the ExA's Report"). The ExA's findings and conclusions are set out in Chapter 5-30 of the ExA Report, and the ExA's summary of conclusions and recommendation is at Chapter 31.

1.7 The principal issues considered during the examination on which the ExA has reached conclusions on the case for development consent are set out in the ExA Report under the following broad headings:

<u>Initial Analysis</u>

- Need

<u>Planning Issues: Onshore</u>

- Flooding and Drainage
- Landscapes and Visual Amenity
- Onshore Historic Environment
- Seascapes
- Onshore Ecology

---

[1] https://hansard.parliament.uk/Commons/2021-05-12/debates/11fb23b0-9653-4569-93d7-f40bdac0939f/WrittenStatements#contribution-66A0AB52-3AD9-417B-955E-228F254B26B7

[2] https://infrastructure.planninginspectorate.gov.uk/projects/eastern/east-anglia-one-north-offshore-windfarm/

- Coastal Processes
- Onshore Water Quality & Resources
- Noise, Nuisance and Health Effects
- Transport & Traffic
- Socio-economic Effects Onshore
- Land Use
- Other Onshore Matters

Planning Issues: Offshore

- Offshore Ornithology
- Marine Mammals
- Other Offshore Biodiversity Effects
- Marine Physical Effects and Water Quality
- Offshore Historic Environment
- Offshore Socio-economic and Other Effects

Habitats, Overarching Analysis, Compulsory Acquisition, Temporary Possession and Development Consent Considerations

- Habitats Regulations Assessment
- Alternatives and Site Selection
- Good Design
- Compulsory Acquisition and Related Matters
- The Draft Development Consent Order and Related Matters

1.8 The ExA's recommendation is that the Secretary of State should make the Order in the form attached to its Report.

2 Summary of the Secretary of State's Decision

2.1 Section 104(3) of the 2008 Act requires the Secretary of State to decide the Application in accordance with any relevant National Policy Statement ("NPS"). The Secretary of State has carefully considered the ExA's Report and all other material considerations, including further representations received after the close of the ExA's examination ("the post-examination representations"). The Secretary of State has decided under section 114 of the 2008 Act to make, with modifications, an Order granting development consent for the proposals in the Application. This letter is a statement of the reasons for the Secretary of State's decision for the purposes of section 116 of the 2008 Act and the notice and statement required by regulations 31(2)(c) and (d) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 ("the 2017 Regulations").

3 The Secretary of State's Consideration of the Application

3.1 The Secretary of State's consideration of the ExA's Report and the post-examination representations is set out in the following paragraphs. All numbered references, unless otherwise stated, are to paragraphs of the ExA's Report ["ER *.*.*"].

3.2 The Secretary of State has had regard to the Joint Local Impact Report ("LIR") submitted by East Suffolk Council and Suffolk County Council [ER 1.4.46], environmental information as

- Herring gull (collision)

16.14 Transboundary ornithological matters raised by Rijkswaterstaat were explored during the examination [ER 18.5.84]. The Applicant's cumulative impact assessment for offshore ornithology refers to seasonal biologically defined minimum population sizes for UK waters which include migratory populations of birds from outside UK waters.

16.15 The ExA was satisfied that the Applicant's assessment of potential effects on ornithological receptors outside of the UK as a result of the Proposed Development is adequate and that the initial concerns expressed by Rijkswaterstaat were satisfactorily addressed [ER 18.6.1].

Conclusions

16.16 The Secretary of State notes that the ExA was content that the provisions of NPS EN-1 (particularly section 5.3) and NPS EN-3 (particularly paragraphs 2.6.58-2.6.71, 2.6.101 and 2.6.108-109) had been satisfied and that all relevant legislative and policy tests for this topic had been met [ER 18.6.1].

16.17 In considering the weight that should be afforded to the significant adverse effects identified above, the ExA considered the precautionary nature of the cumulative impact assumptions; the uncertainties in data for projects that had not been submitted by the end of the examination; and NPS EN-1 which states that:

> *"the benefits of nationally significant low carbon energy infrastructure development may include benefits for biodiversity and geological con*servation interests and these benefits may outweigh harm to these interests". (Para. 5.3.6)

16.18 Overall, the ExA concluded that the effects on offshore ornithology were a medium negative consideration in the overall planning balance. The Secretary of State agrees with the ExA's conclusions on this matter. Adverse effects on protected sites and species are explored further in the Habitats Regulations Assessment below.

17 Habitats Regulations Assessment

17.1 In the UK, the Habitats Regulations apply as far as the 12 nautical miles ("nm") limit of territorial waters. Beyond territorial waters, the Offshore Habitats Regulations serve the same function for the UK's offshore marine area. Following the UK's departure from the European Union, these domestic regulations continue to apply. The Secretary of State notes the Application covers areas within and outside the 12nm limit, so both sets of Regulations apply and hereafter will be referred to collectively as 'the Habitats Regulations'.

17.2 The Habitats Regulations provide for the designation of sites for the protection of habitats and species of international importance. These sites are called Special Areas of Conservation ("SACs"). The Regulations also provide for the classification of sites for the protection of rare and vulnerable birds and for regularly occurring migratory species within the UK and internationally. These sites are called Special Protection Areas ("SPAs"). SACs and SPAs together form part of the UK's National Site Network.

17.3 The Convention on Wetlands of International Importance 1972 ("the Ramsar Convention") provides for the listing of wetlands of international importance. These sites are called Ramsar sites. Government policy is to afford Ramsar sites in the United Kingdom the same protection as sites within the National Site Network (collectively referred to here as "protected sites").

17.4 In the UK, the Conservation of Habitats and Species Regulations 2017 and the Wildlife and Countryside Act 1981 transposed the Habitats and Birds Directives into national law as far as the 12nm limit of territorial waters. Beyond territorial waters, the Conservation of Offshore Marine Habitats and Species Regulations 2017 serve the same function for the UK's offshore marine area. Following the UK's departure from the European Union, these domestic regulations continue to apply. The Secretary of State notes the Application covers areas within and outside the 12nm limit, so both sets of Regulations apply.

17.5 Regulation 63 of the Conservation of Habitats and Species Regulations 2017 provides that: *"….before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which (a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in-combination with other plans or projects), and (b) is not directly connected with or necessary to the management of that site, [the competent authority] must make an appropriate assessment of the implications for that site in view of that site's conservation objectives."*

17.6 And that: *"In the light of the conclusions of the assessment, and subject to regulation 64 (considerations of overriding public interest), the competent authority may agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site or the European offshore marine site (as the case may be)."*

17.7 Regulation 28 of the Conservation of Offshore Marine Habitats and Species Regulations 2017 contains similar provisions: *"Before deciding to undertake, or give any consent, permission or other authorisation for, a relevant plan or project, a competent authority must make an appropriate assessment of the implications of the plan or project for the site in view of that site's conservation objectives."*

17.8 And that: *"In the light of the conclusions of the assessment, and subject to regulation 29 (considerations of overriding public interest), the competent authority may agree to the plan or project only if it has ascertained that it will not adversely affect the integrity of the European offshore marine site or European site (as the case may be)."*

17.9 The Habitats Regulations require that, where the project is likely to have a significant effect ("LSE") on any such site, alone or in-combination with other plans and projects, an appropriate assessment ("AA") is carried out to determine whether the project will have an adverse effect on the integrity of the site in view of that site's Conservation Objectives.

17.10 Where an adverse effect on the integrity of the site cannot be ruled out, the Habitats Directive provides a derogation under article 6(4) which allows such plans or projects to be approved provided three tests are met:

- There are no feasible alternative solutions to the plan or project which are less damaging.
- There are "imperative reasons of overriding public interest" ("IROPI") for the plan or project to proceed.
- Compensatory measures are secured to ensure that the overall coherence of the network of European sites is maintained.

17.11 The above tests, which are also set out in both the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017, must be interpreted strictly and developments which may result in an adverse effect on the integrity of a European Site can only be authorised once the above tests have been met.

17.12 The complete process of assessment is commonly referred to as a Habitats Regulations Assessment ("HRA"). While noting that it is for the Secretary of State to carry out the HRA, the ExA concluded:

- Adverse effects on the integrity of the breeding lesser black-backed gull feature of the Alde-Ore Estuary SPA/Ramsar site could not be excluded because of the predicted collision related mortalities from the Proposed Development in combination with other offshore wind farms;
- Adverse effects on the integrity of the breeding gannet, kittiwake, razorbill, and guillemot features of the Flamborough and Filey Coast SPA could not be excluded because of the predicted collision and/ or displacement related mortalities from the Proposed Development in combination with other offshore wind farms; and
- Adverse effects on the integrity of the non-breeding red-throated diver feature of the Outer Thames Estuary SPA could not be excluded because of the predicted displacement effects of the Proposed Development alone and in combination with other offshore wind farms.

17.13 The ExA concluded that the compensation measures proposed for each species and the overall package, including the secondary measures are feasible and appropriate and are adequately secured in the recommended Order/Deemed Marine Licence ("DML"): however, the ExA recommended that the Secretary of State may wish to seek further information on whether an alternative design could avoid the adverse effects on the lesser black-backed gull feature of Alde-Ore Estuary SPA and the red-throated diver feature of the Outer Thames Estuary SPA.

17.14 The Secretary of State's HRA is published alongside this letter. The following paragraphs, which summarise the HRA, should be read alongside the HRA which is the full statement of the Secretary of State's consideration of these matters.

17.15 The Secretary of State has carefully considered the information presented before him and during the examination, including the Report on the Implications for European Sites ("RIES"), the Environmental Statement, representations made by Interested Parties, and the ExA's Report itself. He considered that the Proposed Development had the potential to have an LSE on 15 National Site Network sites when considered alone and in-combination with other plans or projects. These sites are listed below:

- Alde-Ore Estuary SPA
- Alde-Ore Estuary Ramsar site
- Breydon Water SPA
- Breydon Water Ramsar site
- Broadland SPA
- Broadland Ramsar site
- Flamborough and Filey Coast SPA
- Greater Wash SPA
- Humber Estuary SAC
- North Norfolk Coast SPA
- North Norfolk Coast Ramsar site
- Outer Thames Estuary SPA
- Sandlings SPA
- Southern North Sea SAC
- The Wash and North Norfolk Coast SAC

17.16 The Secretary of State has now undertaken an AA in respect of the conservation objectives of the sites to determine whether the Proposed Development, either alone or in-combination with other plans or projects, will result in an adverse effect on the integrity of the above sites.

17.17 The Secretary of State has considered the available information, including the mitigation measures secured through the Order and DMLs, and has concluded that the Proposed Development will not have an adverse effect on integrity on the following sites:

- Breydon Water SPA
- Breydon Water Ramsar site
- Broadland SPA
- Broadland Ramsar site
- Greater Wash SPA
- Humber Estuary SAC
- North Norfolk Coast SPA
- North Norfolk Coast Ramsar site
- Sandlings SPA
- Southern North Sea SAC
- The Wash and North Norfolk Coast SAC

Consideration of Further Tests under the Habitats Regulations

17.18 The Secretary of State cannot rule out an adverse effect on integrity beyond reasonable scientific doubt in relation to:

- In-combination impacts on lesser-black backed gull from collision mortality, a qualifying feature of the Alde-Ore Estuary SPA and Ramsar site;
- In-combination impacts on kittiwake from collision mortality, a qualifying feature of the Flamborough and Filey Coast SPA; and
- Alone and in-combination impacts on red-throated diver from displacement/ disturbance, a qualifying feature of the Outer Thames Estuary SPA.

17.19 The Secretary of State has therefore reviewed the Proposed Development in the context of Regulations 64 and 68 of the Conservation of Habitats and Species Regulations and Regulation 28 of the Offshore Habitats Regulations to determine whether it can be consented.

17.20 Consent may only be given under Regulation 64 and 28 of the Habitats Regulations where no alternative solutions to the project are available which are less damaging to the affected European site and where Regulation 68 is satisfied.

17.21 Regulations 64 and 29 of the Habitats Regulations allow for the consenting of a project even though it would cause an adverse effect on the integrity of a European site ("AEOI") if it is required for IROPI.

17.22 Regulations 68 and 36 of the Habitats Regulations require the appropriate authority to secure any necessary compensatory measures to ensure that the overall coherence of National Site Network is protected.

17.23 In accordance with guidance on the application of HRA published by the Planning Inspectorate (Advice Note 10) and DEFRA, the Secretary of State reviewed the Proposed Development following a sequential process, considering:

- Alternative solutions to the Proposed Development that have been sought;
- Whether there are IROPI for the Proposed Development to proceed; and
- Compensation measures proposed by the Applicant for ensuring that the overall coherence of the National Site Network is protected have been assessed.

Alternative Solutions

17.24 The objectives for the Proposed Development are:

- Reducing greenhouse gas emissions;
- Increasing energy generation from low carbon sources to replace high carbon energy sources such as coal and gas;
- Increasing energy security of supply for the UK market, including:
- Securing safe, affordable, reliable energy, preferably generated in the UK; and
- Replacing existing ageing energy generation infrastructure;
- Meeting expected electricity demand whilst meeting climate change commitments;
- Maximising social and economic opportunities for the UK from energy infrastructure investment (responded to the Clean Growth Strategy (DBEIS 2017) and the UK “Offshore Wind Sector Deal” (DBEIS 2019); and
- Increasing the UK’s offshore wind capacity to 30GW by 2030.

17.25 In accordance with guidance published by DEFRA, the Secretary of State does not consider the development of alternative forms of energy generation to meet the objectives for the Proposed Development. Alternatives to the Proposed Development considered by the Secretary of State are consequently limited to either “Do Nothing” or “alternative wind farm projects”.

- Offshore wind farms not in UK Exclusive Economic Zone (“EEZ”);
- Offshore wind farms within UK EEZ, including:
    - Within Scottish Territorial Waters;
    - At other locations available to the Applicant;
    - Within other Zones leased from The Crown Estate by other developers; and
    - Within Zones to be leased by The Crown Estate under the Licensing Round 4.

17.26 Natural England’s advice was that a minimum of a 10km buffer between the array and the SPA would be required to avoid the displacement effects on red-throated diver. Following a review of the additional information submitted by the Applicant and Natural England, the Secretary of State considers that whilst a larger buffer distance between the Outer Thames Estuary SPA and Proposed Development array would reduce (>2km and <10km) or avoid (>10km) the adverse effect on integrity of the SPA from disturbance and displacement effects upon the red-throated diver feature, any increase in distance between the Project array and the SPA could reduce the generation capacity of the Proposed Development and would therefore not meet its objectives and would not satisfy the alternatives test.

17.27 The Secretary of State therefore concludes that alternative solutions are not available that would meet the objectives of the Proposed Development, and IROPI must be considered.

Imperative Reasons of Overriding Public Interest

17.28 A development, having an AEOI on a European site may proceed (subject to a positive conclusion on alternatives and provision of any necessary compensation) if the project must be carried out for IROPI. The Secretary of State has therefore considered whether the Proposed Development is required for IROPI.

17.29 The Secretary of State is satisfied that there are imperative reasons of overriding public interest for the Proposed Development to proceed subject to adequate compensatory measures being implemented.

17.30 In arriving at his conclusion, the Secretary of State has reviewed how the Proposed Development provides a public benefit which is essential and urgent despite the adverse effects upon the integrity of three protected sites that will result from the Proposed Development alone and in combination with other operational, consented and planned developments.

17.31 The conclusion is predicated by the principal and essential benefit of the Proposed Development as a significant contribution to limiting the extent of climate change in accordance with the objectives of the Paris Agreement. The consequences of not achieving those objectives would be severely deleterious to societies across the globe, including the UK, to human health, to social and economic interests and to the environment.

17.32 The need to address climate change is the principal tenet behind the Climate Change Act 2008, and subsequently published NPSs for energy (NPS EN-1)[30], renewable energy infrastructure (NPS EN-3)[31] and electricity networks (NPS EN-5)[32] provide a framework for delivering the UK’s international commitments on climate change.

17.33 Measures set out in the NPSs have been given further impetus to reflect evolving understanding of the urgency of actions to combat climate change, including the legally binding commitment to reduce greenhouse gas emissions to net zero by 2050, made in July 2019.

17.34 The Government’s strategy for decarbonisation to achieve this commitment relies on contributions from all sectors delivered through multiple individual projects implemented by the private sector. The Government has also set up schemes to facilitate the deployment of such projects and to provide the public with value for money, such as via the Contracts for Difference scheme.

17.35 The Government anticipates that decarbonisation will lead to a substantially increased demand for electricity as other power sources are at least partially phased out or transformed. Simultaneously the supply of electricity must decarbonise. This will require the establishment of a reliable and secure mix of low-carbon electricity sources, including large-scale development of offshore wind generation.

17.36 Offshore wind generation schemes can only be developed through the mechanism put in place by The Crown Estate for leasing areas of the seabed in a structured and timely way. Projects, like the Proposed Development, which make a significant contribution to meeting the target capacity in the timeframe required are therefore both necessary and urgent.

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[30] Department of Energy & Climate Change. Overarching National Policy Statement for Energy (EN-1). TSO, 2011.

[31] Department of Energy & Climate Change. National Policy Statement for Renewable Energy Infrastructure (EN-3). TSO, 2011.

[32] Department of Energy & Climate Change. National Policy Statement for Electricity Networks Infrastructure (EN-5). TSO, 2011.

Compensatory Measures

17.37 The Applicant submitted an Offshore Ornithology Without Prejudice Compensation Measures report for the National Site Network Sites where adverse effects were predicted i.e., Alde-Ore Estuary SPA, Flamborough and Filey Coast SPA, Outer Thames Estuary SPA.

17.38 The Alde-Ore Estuary SPA without prejudice compensation measures propose to enhance the breeding success of lesser black-backed gull within part of the SPA. This would be achieved by enclosing 4 ha of suitable nesting habitat with fencing to exclude mammalian predators. This scale of enclosure could support the 14,000 pairs required to restore the population and over-compensates for the predicted 0.3 birds per year that the Proposed Development is predicted to kill through collisions.

17.39 Management and monitoring would include regular checks of the fence integrity, and habitat management to maintain suitable nesting habitat. Furthermore, the breeding population within the enclosure will be monitored. If initial take up of the nesting opportunities is slow then adaptive management measures, such as playback of calls and use of decoys may be considered to attract birds to the site.

17.40 The Flamborough and Filey Coast SPA without prejudice compensation measures for kittiwake propose the construction of artificial nest sites to increase the productivity of kittiwake in the southern North Sea. The proposed structure could accommodate 100 pairs of kittiwakes, which would provide enough over-compensation to address any uncertainties around this compensation measure for the 0.7 birds that the Proposed Development is predicted to kill through collisions. The success of the compensation measures would be monitored, and adaptive management measures adopted where required.

17.41 The compensation measures for lesser black-backed gull and kittiwake would remain in place and be maintained as fit for purpose until the later of (i) the decommissioning of the windfarm or (ii) a determination by the Secretary of State that the compensation measure is no longer required, following consultation with the relevant statutory nature conservation body.

17.42 The Outer Thames Estuary SPA without prejudice compensation measures for red-throated diver propose to reroute vessels to and from East Anglia Three Offshore Wind Farm to reduce disturbance and displacement of red-throated divers within the SPA during the non-breeding season.

17.43 A secondary compensatory measure proposed to identify suitable shipping areas (or areas from which pleasure craft could be restricted) in areas of otherwise suitable habitat for red-throated divers and agree to reroute these vessels.

17.44 Natural England agreed that fencing to exclude mammalian predators was an acceptable measure to compensate for the impacts on lesser black-backed gull.

17.45 With regards to the proposed compensation for kittiwakes, Natural England stated that more information was required on the size, location, timing, and design of the compensation measures to provide confidence in their deliverability and efficacy.

17.46 With regards to the displacement of red-throated divers in the Outer Thames Estuary SPA, Natural England advised that re-routeing vessels from East Anglia Three Offshore Wind Farm would not provide adequate compensation for three reasons: firstly, because periodic disturbance from transiting vessels does not equate to the persistent displacement effect exerted by a windfarm array; secondly, the impacts of the East Anglia Three Offshore Wind Farm, including vessel movements, were not assessed as having an adverse effect on the integrity of the SPA during the determination of that project; and East Anglia Three Offshore Wind Farm vessel movements are already minimised through its Best Practice Protocol.

The Examining Authority's Conclusions

17.47 The ExA considered that the potential alternative solutions to delivering the objectives of the Proposed Development and the case for imperative overriding public interest met the requirements of Regulation 29 of the Offshore Habitats Regulations. The ExA also recommended that the compensation measures proposed for each species and the overall package, including the secondary measure related to ornithological by-catch reduction, were feasible and appropriate and were adequately secured in the recommended Order/DML, therefore met the requirement of Regulation 36 of the Offshore Habitats Regulations.

Post-Examination Consultation

17.48 During the determination period the Secretary of State's consultation letters invited the Applicant to provide further evidence to support the proposed compensatory measures for the SPAs. In relation to the red-throated diver feature of the Outer Thames Estuary SPA, additional information was sought on the specific areas of the SPA where red-throated divers are known to be displaced by vessel movements and evidence that the Applicant could secure a reduction in vessel movements to reduce the displacement of red-throated divers in these areas.

17.49 In response to this request, the Applicant confirmed that restricting vessel movements by unrelated third parties was beyond its control and re-iterated that it could secure a reduction in vessel movements for the East Anglia Three Offshore Wind Farm.

17.50 The Secretary of State requested that the Applicant in consultation with Natural England provide an updated project layout that included a sufficient buffer between the array and the SPA boundary to remove displacement impacts on red-throated divers within the SPA. In response to the Secretary of State's request, the Applicant presented alternative project layouts with a 6.5 km buffer and an 8 km buffer. The Applicant also increased the area of compensation available by including the re-routeing of vessels from East Anglia One Offshore Wind Farm in addition to re-routeing vessels from East Anglia Three Offshore Wind Farm.

17.51 Having reviewed the estimates of red-throated diver habitat loss presented by the Applicant for schemes with 6.5 km and 8 km buffers, Natural England maintained that the displacement effects of the Proposed Development would not be removed until the array was at least 10km from the SPA.

17.52 The Applicant stated that a 10 km buffer between the array and the Outer Thames Estuary SPA would make the Proposed Development unviable. It estimated that a 10km buffer would result in a reduction in installed capacity of 50%.

Further Clarifications

17.53 In March 2022 the Applicant expanded their commitments to monitoring and modelling the distribution of red-throated diver within the SPA. This included the use of aerial digital surveys of the abundance and distribution of red-throated divers within the SPA and a 10km buffer. The Applicant also committed to extending the period in which it would restrict vessel movements within the SPA to 1 November to 31 March.

17.54 The Applicant also committed to creating and hosting a partnership of the relevant parties to identify and implement opportunities for reducing the disturbance effects on red-throated diver at a strategic level.

17.55 The Applicant further advocated in correspondence to BEIS in March 2022 that proposed compensation was adequate for the full effects of the Proposed Developments and clarified that any buffer of a greater distance than 8km would make the Project undeliverable due to spatial constraints and that a Project buffer beyond 8km would not be viable. Natural England stated that 'cognisant of the reduced impacts an 8km buffer between EA1N and the SPA would achieve, Natural England concludes that the package of measures provides a reasonable prospect of the coherence of the national site network being maintained'. This advice was provided in the specific scenario of a 8km buffer for the Proposed Development and a 10km buffer for the proposed East Anglia TWO Offshore Wind Farm. The Applicant clarified that it did not offer a development layout with a buffer of 8 km and that this was provided only for the purposes of considering the adequacy of compensation.

Conclusions

17.56 The Secretary of State is satisfied that the necessary compensatory measures to ensure that the overall coherence of the National Site Network can be secured with regards to The Flamborough and Filey Coast SPA kittiwake feature; and the Alde-Ore Estuary SPA lesser black-backed gull feature.

17.57 The Secretary of State notes the advice of Natural England that the updated package of compensation measures provides a reasonable prospect of coherence of the national site network being maintained. The Secretary of State notes that this advice is provided in the specific scenario of a reduction in the impacts of the Proposed Development via a 8km buffer and an avoidance of the impacts of East Anglia TWO Offshore Wind Farm via a 10km buffer and should not be taken as Natural England's advice on other permutations. However, the Secretary of State considers that, given the compensation ratio of 9:1 the shared package of compensatory measures would adequately compensate for the residual adverse effects on the red-throated diver feature of the SPA with a buffer distance of 8 km between the Proposed Development and the Outer Thames Estuary SPA as well as the full adverse effects of East Anglia TWO Offshore Wind Farm at 8.3km. The Secretary of State acknowledges that whilst such a project layout does not constitute an alternative solution (given the loss in generating capacity), it is nevertheless the only project layout where he can have confidence that the package of compensatory measures will be effective.

18 Marine Mammals

18.1 The ExA notes [ER 19.2.1] that NPS EN-1 sets out that the decision maker should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed so as to reasonably minimise significant disturbance effects on marine mammals. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the decision maker may refuse the application. The ExA also notes [ER 19.2.2 et seq] the relevant policies within NPS EN-3, the UK Marine Policy Statement and the East Inshore and East Offshore Marine Plans.

Natural England Commissioned Report NECR260

Digital video aerial surveys of red-throated diver in the Outer Thames Estuary Special Protection Area 2018

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Executive Summary

1 HiDef Aerial Surveying Limited ('HiDef') were contracted by Natural England to undertake digital aerial surveys of the Outer Thames Estuary SPA with the core objective being to ascertain numbers of red-throated diver *Gavia stellata*. Recording of secondary species was to take place but was not deemed the priority of the project.

2 This report provides information on the methods undertaken through the survey flights on two dates in February 2018 and the collation of data, including object and species identification, and post survey analysis.

3 Flights were undertaken on 4 and 17 February 2018, with two Diamond Aviation ('DA') 42 Twin Star aircraft flying sorties on each date. Results for these surveys are presented in this report alongside comparisons with previous surveys.

4 When this contract was commissioned (autumn 2017) a decision to extend the existing Outer Thames Estuary SPA to include an additional c.95km² of sea, adjacent to its existing southern boundary off the Essex coast, with a revised pSPA boundary was pending. This was approved during the course of the contract. Therefore, two sets of numbers are presented at key points in the report to describe numbers within the new, extended SPA boundary and within the smaller boundary of the 'original' SPA. The latter allows easier comparisons with previous surveys that covered only the original SPA.

5 The new pSPA enlarges the existing Outer Thames Estuary SPA (classified solely for non-breeding red-throated divers) to include three new areas identified as being of importance for foraging terns *Sterna sp*. breeding at other (already classified) SPAs on shore; these are parts of the Rivers Yare and Bure, a small riverine section at Minsmere, and both estuarine and marine areas around Foulness. The pSPA therefore comprises areas for foraging breeding seabirds and non-breeding waterbirds. The feature of the existing SPA is retained, and new qualifying features are added based on a review of up-to-date bird abundance information. The total area of the Outer Thames Estuary pSPA is approx. 391,910 ha (392km²).

6 This report provides a new population estimate for the original Outer Thames Estuary SPA for red-throated diver of 21,997. The estimated total for the new, enlarged SPA (formerly the pSPA) is 22,280. Both these figures are approximately 3.5 times greater than the notified population of the original SPA (6,466 individuals).

7 This increase in the recorded number of red-throated divers, coupled with the numbers of individuals of other species recorded has resulted in a peak waterbird population estimate across the original SPA of 41,918 and across the newly enlarged SPA of 46,056 individuals. This suggests that on occasion the SPA supports an assemblage of wintering waterbirds well in excess of the size (20,000 individuals) required to consider this to be a qualifying feature of the SPA.

8 Red-throated divers appear to use the additional area now included within the larger revised SPA boundary at low densities and at high tide when mudflats are covered.

9 Anthropogenic effects on the distribution of several species were detected, notably strong displacement of red-throated diver was noted from areas within offshore windfarms and from areas of shipping activity. This lead to higher densities of birds at points furthest from anthropogenic activity.

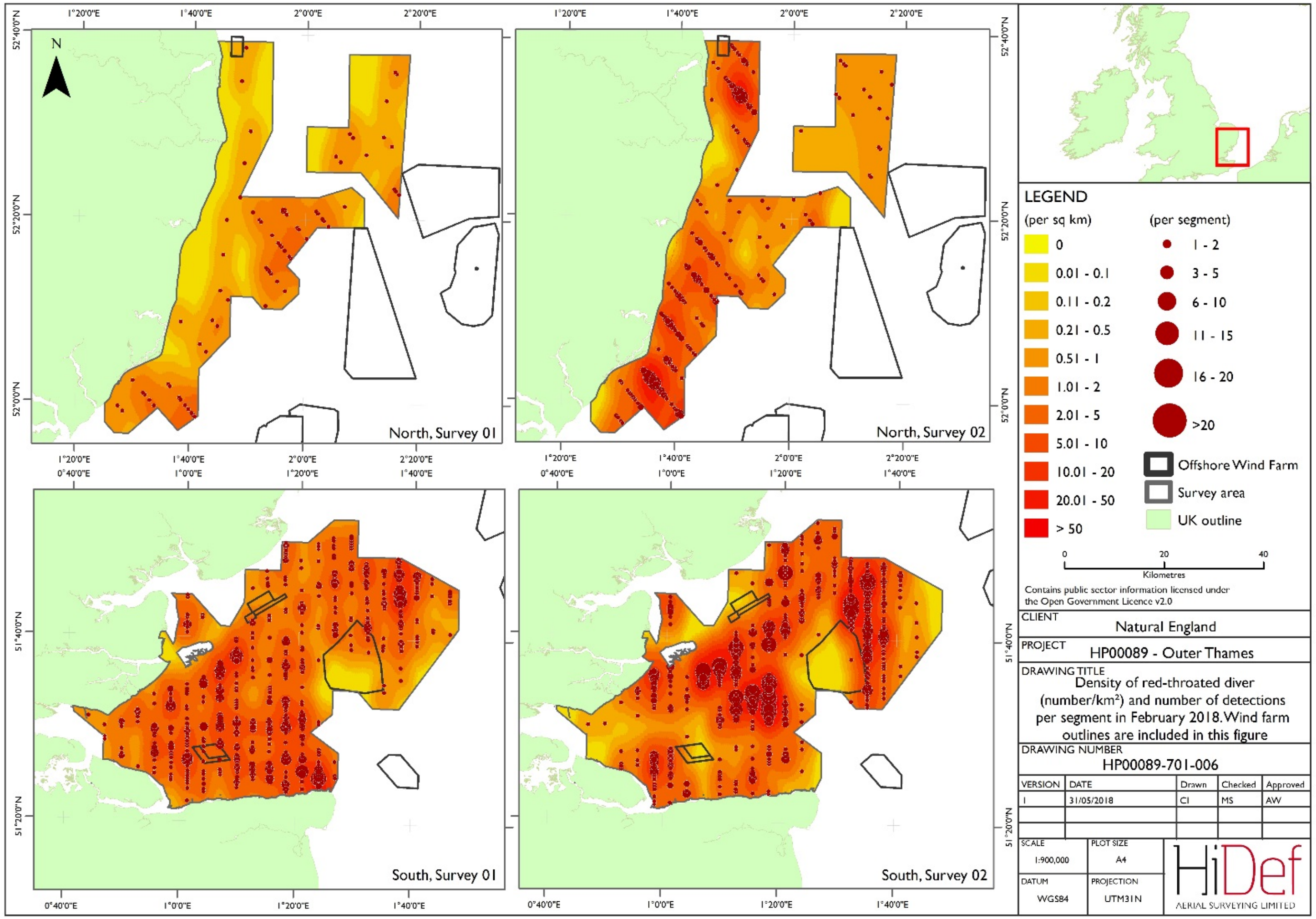

Figure 8 **Density of red-throated diver (number/km²) and number of detections per segment in February 2018. Windfarm outlines are included in this figure**

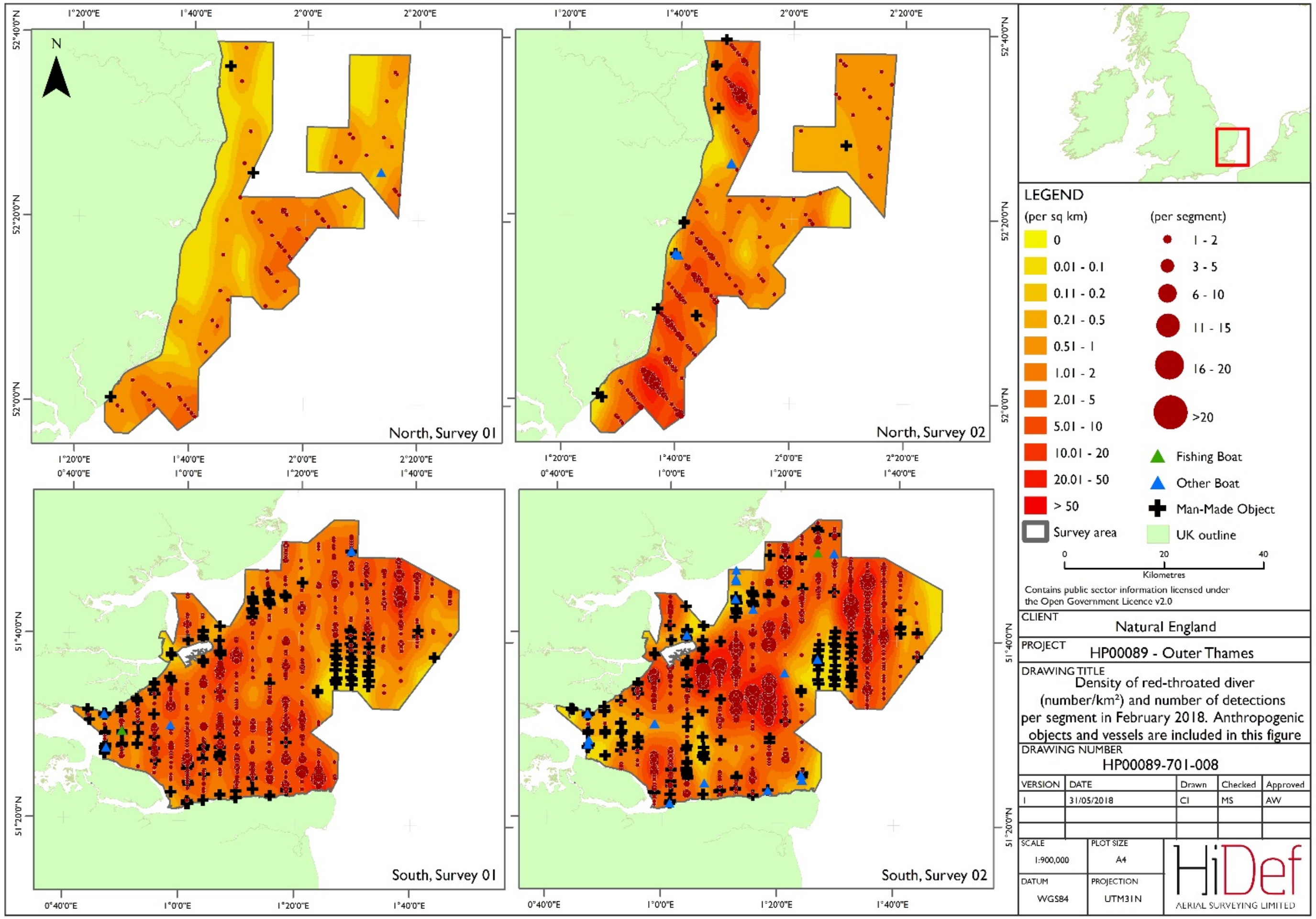

Figure 10 Density of red-throated diver (number/km²) and number of detections per segment in February 2018. Anthropogenic objects and vessels are included in this figure

133 The technique deployed by HiDef differs from that utilised in 2013 in that HiDef uses digital video rather than digital stills technology. In terms of identification this allows 5 – 7 still images of an object to be reviewed from slightly different angles as the aircraft passes. This contrasts with a single, plan view achieved via the digital stills process. Overall, video provides the identifying team with greater opportunity, and thereby increasing certainty, to come to a conclusive identification.

134 Video footage was attained as 2cm GSD, rather than 3cm GSD as in surveys five years previously. Ground Sample Distance (GSD) is the area of ground that is shown per pixel. The lower the GSD, then the better resolution, but there is a trade-off in other areas of photographic quality once GSD moves below 2cm. This step change in resolution, from 3 to 2, allows identifiers to make more accurate identifications and reduces risk related to errors in identification.

135 Prior to the introduction of digital aerial surveys, visual aerial surveys were flown. These comprised of observers viewing from the aircraft as it flew over the survey zone. This method was introduced to overcome the known bias resulting from red-throated divers avoiding boats (for example Schwemmer and others 2011; Camphuysen and others 2004) and so leading to under recording. A drawback of both these methods is the lack of ability to review or audit any data collected: "*what's hit's history, what's missed is mystery*".

136 Overall, digital video aerial survey provides a more robust data source, as the aircraft flies at a height which negates disturbance issues; the low level of divers noted in flight in 2018 surveys suggest these were not flushed due to the aircraft flying at a higher altitude, while providing a higher degree of confidence in identifications, which can be audited at a later date if queries arise. This degree of confidence is higher as video produces multiple images of the same object compared to the single image of digital still.

6.2 Changes in distribution

137 Shipping data were collated at the time of the survey via an AIS device in one aircraft. This allowed shipping movements on the day of survey to be followed (Figure 30). Additional anthropogenic activity was plotted (Figure 31) and compared visually against species distribution patterns. This suggested that the distribution of a number of species appeared to be affected by human activity in the area.

138 Red-throated divers clearly show displacement from wind turbines and shipping lanes (Figure 8 to Figure 10) but quantifying these movements is out with the scope of this contract.

139 Dierschke and others (2017) raised the issue of displacement and energetics and the consequences which may follow for individuals and also at a population level. Given the construction and operation of several offshore windfarms within the Outer Thames Estuary SPA in recent years and the evidence of marked displacement of divers within this study (and as reported in many previous studies) on the one hand and the simultaneous rise in population estimates of red-throated divers across the SPA as a whole on the other hand, further work is needed on this issue.

140 Displacement has been shown to be a factor influencing the distribution of red-throated divers at other sites with wind farm infrastructure in place (Webb and others 2017; Petersen and others 2014; Dierschke and others 2017). Given the increase in wind farms in the southern North Sea, both within and out with UK waters, it may be that birds are being

displaced over a wider area than previously thought and larger, more focussed aggregations are now forming in the remaining areas of suitable habitat.

141 Figure 35 and Figure 36 show preliminary analysis relating to mean density and abundance of divers from the two surveys in relation to distance from shipping lanes. These show some consistency in aggregation of birds in areas away from shipping traffic (and possibly other man-made structures). Highest densities of birds occur c.5-8km from shipping lanes. This initial output warrants further interpretation and modelling. It is interesting to note that the pattern found here of the density of divers increasing over the first few kilometres from shipping lanes to reach a peak at some distance, followed by a decline from those peak densities in areas even further from shipping lanes was also reported in an analysis of similar survey and shipping data in Liverpool Bay SPA (Burt and others 2017) albeit that in that study peak densities occurred at a distance of c 2km.

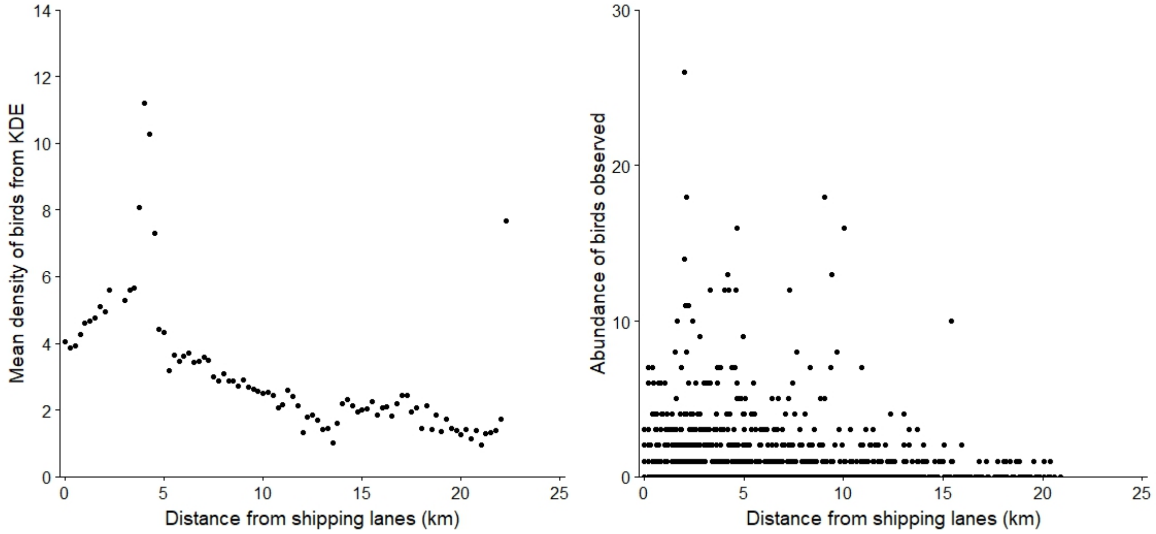

Figure 35 Red-throated diver distance to shipping survey 1. The left graph shows the mean density per grid cell from the KDE surface modelling and on the right is the absolute numbers for each and every transect segment.

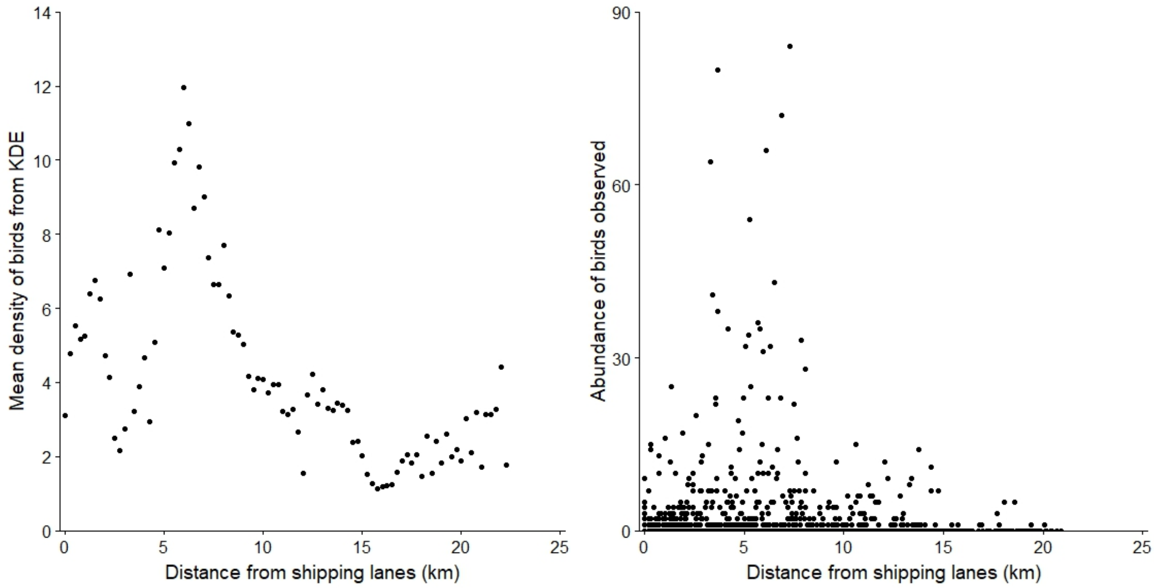

Figure 36 Red-throated diver distance to shipping survey 2. The left graph shows the mean density per grid cell from the KDE surface modelling and on the right is the absolute numbers for each and every transect segment.

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An experimental investigation into the effects of traffic noise on distributions of birds: avoiding the phantom road

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Many authors have suggested that the negative effects of roads on animals are largely owing to traffic noise. Although suggestive, most past studies of the effects of road noise on wildlife were conducted in the presence of the other confounding effects of roads, such as visual disturbance, collisions and chemical pollution among others. We present, to our knowledge, the first study to experimentally apply traffic noise to a roadless area at a landscape scale—thus avoiding the other confounding aspects of roads present in past studies. We replicated the sound of a roadway at intervals—alternating 4 days of noise on with 4 days off—during the autumn migratory period using a 0.5 km array of speakers within an established stopover site in southern Idaho. We conducted daily bird surveys along our 'Phantom Road' and in a nearby control site. We document over a one-quarter decline in bird abundance and almost complete avoidance by some species between noise-on and noise-off periods along the phantom road and no such effects at control sites—suggesting that traffic noise is a major driver of effects of roads on populations of animals.

1. Introduction

Roads are prevalent across vast stretches of the Earth and 83% of the USA is within 1 km of a road [1]. Although some studies have shown positive effects of roads on wildlife, the cumulative effects across taxa are overwhelmingly negative (reviewed by [2]). A recent meta-analysis of 49 datasets including 234 species of mammals and birds across four continents demonstrated that bird and mammal populations decline within 1 and 5 km of human infrastructure—including roads—respectively [3]. Despite myriad studies regarding the effects of roads on wildlife, the primary mechanism underlying these effects remains unknown. Effects of roads include habitat fragmentation, road mortality, sensory disturbance and chemical pollution, among others (reviewed by [2]). Therefore, a given road probably impacts wildlife in several ways—making it exceedingly difficult to estimate the strength of any single effect.

Several lines of evidence suggest that traffic noise is a major factor explaining declines in populations of wildlife near roads. Perhaps the best tests of the effects of noise on animal distributions come from studies of noise produced by natural gas compressors. For example, Bayne *et al.* [4] found a one-third reduction in songbird density at noisy gas compressor stations in Canada compared with nearby well pads that were almost identical in habitat, but were much quieter. Francis *et al.* [5] used a similar system of noisy gas compressors and quiet well pads in New Mexico to show that species richness of birds is greatly reduced at noisy sites, with 14 species avoiding areas surrounding gas compressors. Evidence from gas fields indicates that species remaining in noisy areas are those that vocalize within frequencies less masked by anthropogenic noise [6,7]—a phenomenon probably occurring in areas exposed to traffic noise. For example, birds that vocalize at frequencies similar to those of road noise are more likely

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to avoid roads than species that vocalize at higher frequencies [8,9]. Species of frogs, birds and mammals are known to change the characteristics of their vocalizations in the presence of traffic and other anthropogenic noise, presumably to avoid the effects of masking (reviewed by [10]).

Behavioural evidence and studies of other anthropogenic noise sources suggest that road noise should be a major driver of observed road effects. However, although road ecology studies attempting to directly address the effect of traffic noise on wildlife have suggested that noise is a major cause of negative effects, they are typically conducted in the presence of other effects of roads [11]. For instance, Halfwerk *et al*. [12] demonstrated that great tits (*Parus major*) have reduced reproductive success in areas exposed to high levels of road noise. Several studies from The Netherlands have shown that bird distributions near roads are negatively associated with noise levels (reviewed by [2]). A study in the USA [13] found that distributions of grassland birds were negatively associated with traffic volume (vehicles per day)—an effect that was attributed to increased noise levels. However, Summers *et al*. [11] found that the effect of distance to a road was stronger than the effect of noise level and suggested that road mortality, not noise, was probably underlying the negative effects of roads. As Summers *et al*. [11] suggest, these past studies attempting to assess the effects of road noise on wildlife are certainly informative, but are confounded by other effects which are present at any road. Put another way, the current study paradigm in road ecology of comparing roadless areas to sites near roads or using observational data to examine correlations between road noise and animal abundance is perhaps yielding diminishing returns.

Noise playback is an effective method of testing the effects of noise in the absence of other factors but has been underused in road ecology because of the difficulty of applying noise across a landscape [14]. Recently, however, experimental application of noise has become more common in studies of road ecology. For example, Crino *et al*. [15] used playback to examine the effects of road noise on stress in nestling white-crowned sparrows (*Zonotrichia leucophrys*). Arroyo-Solís *et al*. [16] experimentally demonstrated that the spotless starling (*Sturnus unicolor*) and the house sparrow (*Passer domesticus*) shift the timing of their morning songs in response to urban noise. Blickley *et al*. [14] used experimental playback to test the effects of noise on the distribution of the greater sage-grouse (*Centrocercus urophasianus*)—demonstrating reduced lek attendance at sites experimentally exposed to road and gas-compressor noise. Here, we assess the effects of road noise in the absence of the other effects of roads by adding road noise to a roadless landscape—allowing us to experimentally test the effects of road noise on an entire community of migrating birds. We applied noise using a 0.5 km array of speakers—which we term the ‘phantom road’—situated at an autumn migratory stopover site in the Boise Foothills in south-western Idaho. We use a modified before–after-control-impact experimental design to assess changes in the abundance of migrating birds near the phantom road with the speakers turned on and off in repeating 4 day intervals in relation to a nearby control site.

We chose to apply our study design to migrating birds for two reasons. First, because migrating birds stay at stopover sites for short durations, the bird community is constantly changing. This constant change in the bird community means that as we turn the phantom road on and off over the course of the migratory period we sample different individuals and populations of birds. Second, populations of migratory birds have declined sharply in recent decades [17–20] and identification, preservation and maintenance of stopover habitat is a research priority [21–24]. To our knowledge, the effects of anthropogenic noise on birds during migration have never been examined. Accordingly, our study fills an important gap in our knowledge of the use of stopover habitat. We therefore test the hypotheses that animals avoid roads because of disturbance by noise and that anthropogenic noise degrades migratory stopover habitat. We predicted that fewer birds would be present near the phantom road when speakers were turned on than when they were off, and that bird abundance would be negatively correlated with sound levels.

2. Material and methods

(a) Phantom road

We constructed the phantom road on an east–west oriented ridge extending southeast from Lucky Peak, Idaho roughly 0.8 km from the Idaho Bird Observatory’s field site. This ridge was typical of most ridges along the Boise front in that the vegetation on north-facing slopes was dominated by mature Douglas fir forest (*Pseudotsuga menziesii*), whereas on the south-facing slopes bitter and choke cherry bushes (*Prunus virginiana* and *emarginata*) were prevalent on drainages and sagebrush steppe dominated ridges. We erected 15 pairs of speakers in Douglas fir trees along the crest of the ridge—with one speaker oriented towards the evergreen forest, and the other oriented towards the cherry/sage. Each set of speakers was approximately 4 m above the crest of the ridge. We amplified the speakers (Dayton Audio—Springboro, OH, USA—RPH16 Round 16′ PA Horns paired with MCM Electronics—Centerville, OH, USA—40 W midrange compression drivers ($\pm$5 dB(A), 400–3000 Hz)) with Parts Express (Springboro, OH, USA) 2 W x 2channel, 4-ohm, Class D amplifiers and played back sound files (MP3, 128 kbps) using Olympus (Center Valley, PA, USA) LS-7 and Roland (Los Angeles, CA, USA) R-05 audio players. We powered amplifiers and audio players with arrays of $LiFePO^4$ (Batteryspace, CA, USA) batteries housed in waterproof plastic containers. The geometry of a sound source can have profound impacts on the scale of noise exposure—point sources (e.g. generators, gas-compressor stations, a single car) lose sound energy at approximately 6 dB per doubling of distances, whereas line sources (e.g. a busy roadway, train) fall off at approximately 3 dB per doubling of distance. We therefore placed speakers roughly 30 m apart to ensure that, when playing noise, the individual speaker point sources fused into a line-source at our bird count locations. The phantom road was therefore roughly 0.5 km in length (figure 1*a*).

We applied noise along the phantom road at 4 day intervals—alternating between noise-on and noise-off periods throughout autumn migration. We alternated every 4 days because almost all species stopover at our site for fewer than 8 days on average during autumn migration [25]. Therefore, individual birds were probably only present during one noise-on and one noise-off period, and thus each set of noise-on/off periods was probably independent. Alternating between noise-on and noise-off periods also ensured that noise-on and noise-off periods were not correlated with potentially confounding factors, such as seasonally variable phenology of migrating birds, fruit or insect availability and weather fronts. We attempted to mimic normal traffic patterns by beginning noise playback at 04.30 and ending it at 21.00 local time each day during noise-on blocks. We gradually increased the volume of the noise over

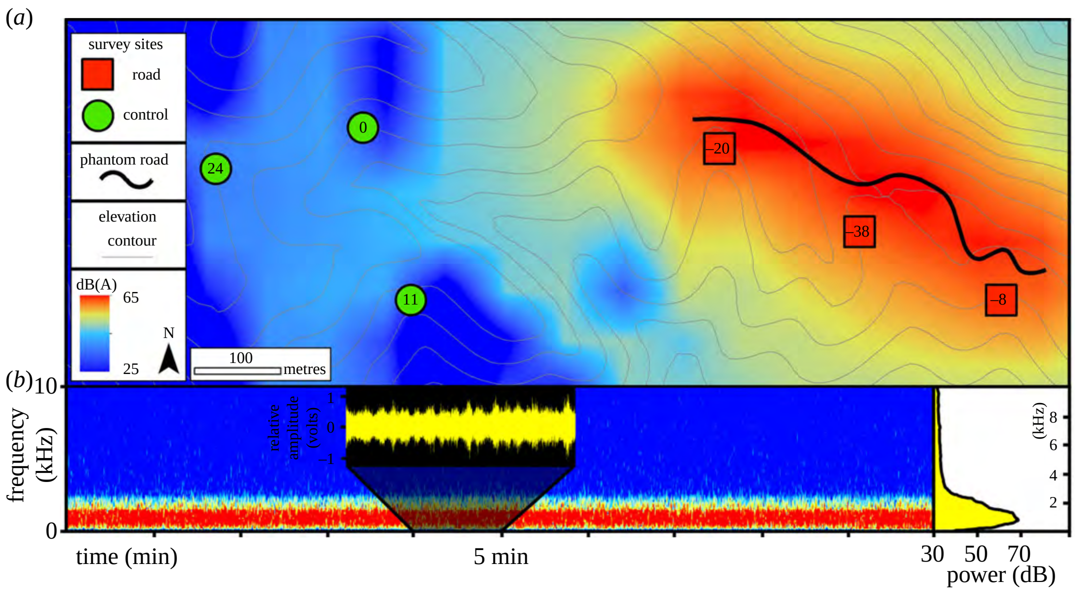

Figure 1. (*a*) Estimated background sound levels (dB(A) 1 h LEQ) during periods when speakers were turned on at our study site in the Boise Foothills in southwestern Idaho. Background sound level was modelled using NMSim (Noise Model Simulation; Wyle Laboratories, Inc., Arlington, VA) where inputs were chosen to match observed values at point count locations. Numbers represent the per cent change in birds present at a survey site between 4 day noise-on and noise-off periods which alternated continuously from 19 August through to 9 October 2012. (*b*) Ten minute spectrogram, 1 min waveform and power spectrum of noise file (recorded 35 m from the phantom road at a point count location) played from 04.30 to 21.00 along the phantom road during noise-on periods.

30 min in the morning so as not to elicit a startle response from any birds along the phantom road and also gradually decreased the volume over 15 min at the end of each noise-on day.

(b) Playback files

We played traffic noise recorded within Glacier National Park. To create the playback file, we combined files of 12 individual cars recorded at known distances, decibel levels and speeds. We choose car pass-by events based on clarity of recording, decibel level and speed. We created a 1 min file of 12 car pass-by events and repeated this file without shuffling. Because any possible habituation would have only reduced our ability to detect distributional changes, we see this as a minor concern. Our playback file therefore contained 720 pass-by events per hour of cars travelling at approximately 45 miles h^{-1}—traffic levels and speeds found along roads in some of the most visited national parks, national forests and other protected areas globally. Our playback file further simulated the frequency profile of typical traffic noise with most of the energy of the noise between 0 and 3 kHz with a peak around 1 kHz (figure 1*b*). We manipulated the source level of each set of speakers to produce a background decibel level of roughly 55–60 dB(A) hourly level-equivalent (LEQ) at each of the three point count locations along the phantom road. Hourly LEQ values are the level of a constant sound over an hour that has the same energy of the actual, fluctuating energy over that hour [26]. The background noise level during noise-on periods therefore approximated the thresholds hypothesized by Reijnen *et al*. [27] at which road noise negatively affects densities of birds (also see [26]).

(c) Bird counts

We placed point count locations along the phantom road within the centres of three patches of cherry shrubs. We surveyed patches of cherry shrubs because they contain the highest diversity and abundance of birds of any habitat-type within our study site during migration [28]—allowing us to maximize sample size while examining the effects of noise on the high-quality stopover habitat. Each point count location was at least 150 m from the nearest other location, and between 30 and 50 m from the nearest speaker. Because patches of cherries were within drainages, each point count location was also separated from the other locations by ridges, meaning that an observer was unlikely to detect birds in patches of cherries other than the one they were currently surveying. We also placed control point count locations at three locations roughly 0.8 km away from the phantom road, also within patches of cherries separated by ridges (figure 1). Control point count locations were placed on sites with roughly the same slope and aspect and at roughly the same distance to forest as sites along the phantom road and all point count locations were within 100 m in elevation of each other. We therefore made every effort to ensure that control and experimental sites were placed within the same habitat mosaic and within similar microhabitats.

We conducted point counts at all point count locations along the phantom road and at the control site daily within 5 h after sunrise following a modified protocol of the Rocky Mountain Bird Observatory (D. J. Hanni, C. M. White, R. A. Sparks, J. A. Blakesley, G. J. Levandoski, J. J. Birek 2009, unpublished report). At each point count location, observers conducted three consecutive 5 min point counts [29]. For each individual bird detected during a point count, observers recorded the species and the minute in which it was first detected, as well as the method of detection (visual, call or song). Observers also recorded the distance to a bird when it was first detected using a laser range-finder. To increase our ability to obtain an accurate distance measurement, observers performed point counts in 4 m tall towers which allowed them to more easily detect a bird above the dense shrub layer. Observers also recorded temperature, wind speed (Beaufort Scale) and per cent cloud cover upon arriving at each survey location. Because detection of birds varies by both time and date, we shuffled the order in which points were surveyed every day. We alternated which site (control or phantom road) was surveyed first every 8 days, coinciding with the changes in noise-on/off blocks. Furthermore, the order of point count locations surveyed within each site was randomly determined for each day.

Two trained observers conducted point counts during our study, with one observer conducting all counts on a given day. Because probability of detection is probably different between observers, we scheduled observers so that they surveyed the same number of days during the season ($n = 26$) and both observers conducted at least one survey during each noise-on and noise-off block. Our sampling scheme therefore ensured that all locations were surveyed at different times of the morning by different observers throughout the study season.

Because background noise levels exceeding 45 dB have been shown to negatively affect the probability of detection of birds within 60 m [30], observers turned off the speakers surrounding individual point count locations before counts at sites near the phantom road during noise-on blocks. Observers only turned off speakers surrounding the location that they were currently surveying and turned them back on before moving to the next location. Turning off speakers in this manner ensured that dB levels were below 45 dB (confirmed by a dB metre) during point counts, and minimized the time speakers needed to be turned off during noise-on mornings.

(d) Analysis of background sound level

We determined the background sound levels of each point count location during noise-on and noise-off blocks using MP3 audio recordings [31]. During two full noise-on and noise-off blocks, we deployed an MP3 recorder (Roland R05 or R09 recording at 128 kbps) at each point count location, which continuously recorded background sound level during the entire blocks. We then used a custom programme (Damon Joyce, NPS, AUDIO2NVSPL) to convert the MP3 recordings into an hourly sound pressure level format, and then converted those values to hourly LEQ values in dB(A) using another custom programme (Damon Joyce, NPS, Acoustic Monitoring Toolbox). Finally, we averaged the hourly background LEQ during the hours of 05.00 through to 21.00 across the noise-on and noise-off blocks to create the noise-on and noise-off LEQs.

(e) Statistical analysis

To ensure that we only examined birds within the patches of cherries that we intended to survey, we truncated the data to include only birds detected within 50 m of the sample point. Although our sampling scheme was designed to minimize the effects of heterogeneity in probability of detection, we evaluated and corrected our counts for the possibility of imperfect detection using a removal model [32]. A removal model calculates the probability of detecting a present individual during a survey using the minute in which individual birds are detected during surveys. We implemented the removal model using the Huggins closed-capture setting in MARK [33] using the package RMark [34] in R [35]. We built models of detection including combinations of observer, noise-on versus noise-off, control versus experimental sites, and linear and quadratic effects of date. We also built a null model which only included the intercept and a global model that included all factors. We ranked and compared the models using Akaike's Information Criterion (AIC, [36]) corrected for small sample size (AICc, [37]). We then used the estimates from the highest ranked detection model to calculate the probability of detecting an individual if it was present during each survey and corrected the observed count of each survey for detection by dividing the observed count by the probability of detection during that survey [32]. Although inference from this study with and without a correction for detection is qualitatively similar, we present results of the detection-corrected analysis.

Once our counts were corrected for imperfect detection, we modelled the abundance of birds at our survey locations in response to site and seasonal differences as well as changes in background noise levels owing to the phantom road. We modelled abundance using linear mixed-effects models and controlled for the repeated sampling of sites using a random intercept for each point count location. We also controlled for possible temporal autocorrelation by including an autoregressive error structure within each model. Furthermore, plots of bird abundance against background dB(A) levels revealed possible problems regarding heteroskedasticity among residuals. For each species, we therefore tested a null model which included a 'power of the covariate' error structure with dB(A) as the covariate against one with the default error structure. We then ranked the models with competing error structures using AIC and used the error structure within the AIC-best model within all subsequent models for that species. We also normalized abundance values before analysis using a natural log transformation.

We built linear mixed-effects models representing several hypotheses regarding bird abundance. Each model included a random intercept for survey site. We constructed models representing several *a priori* hypotheses (see the electronic supplementary material, appendix S1). Several models included an interaction between factors indicating whether an observation occurred at the control site or along the phantom road and a factor representing noise-on and noise-off periods as well as their main effects. This interaction model represents the hypothesis that abundance along the phantom road changed between noise-on and noise-off periods while there was no difference in abundance between noise treatments at the control site. The main effect of site controls for potential differences in habitat between the control site and the phantom road. Several models contained the dB(A) levels recorded at each site during noise-on and noise-off periods—representing the hypothesis that bird abundance is linearly related to background sound levels. We also controlled for seasonal fluctuations in bird abundance by building models that contained linear and quadratic effects of Julian date. All mixed models were built in R using the package nlme [38] and were fit using maximum likelihood. Because models within $\Delta AIC < 2$ are considered to receive equal support as the best models [39], we considered there to be an effect of noise on bird abundance if models within $\Delta AIC < 2$ contained either an interaction between site and noise factors, or the covariate for background dB(A) levels with 85% CIs of these terms excluding zero [40]. Because of convergence and over-fitting problems inherent with small sample sizes, we only analysed data for species with more than 50 detections.

3. Results

We recorded 8078 detections of birds of 59 species within 50 m of bird survey locations (table 1). Twenty-two species were detected more than 50 times and those species constituted 91% of the total detections within 50 m of the observer (table 1). We integrated a total of 120 h of background noise levels for noise-on and noise-off blocks, separately at each survey site. The noise-on LEQ at point count locations near the phantom road averaged 55 (s.e. = 0.6) dB(A) and was 11 (s.e. = 2.6) dB(A) greater than the average noise-off LEQ along the phantom road. Whereas, noise-on LEQ at control locations averaged 41 (s.e. = 1.8) dB(A) and was 1 (s.e. = 0.2) dB(A) greater than the noise-off LEQ. The range of hourly LEQ values (L_{min}–L_{max}) during noise-on periods were 31 (s.e. = 4.8)–51 (s.e. = 0.7) at control survey locations and 36 (s.e. = 2.5)–63 (s.e. = 1.3) at road survey locations. Whereas during noise-off periods hourly LEQ values ranged from 31 (s.e. = 4.8) to 45 (s.e. = 0.2) at control survey locations and 32 (s.e. = 6.1)–52 (s.e. = 2.5) at road survey locations. The slightly higher background sound level during noise-off periods near the phantom road compared with control sites was probably owing to wind exposure. Overall, our study design produced a gradient of sound levels ranging from roughly 37 to 57 dB(A) under which birds were sampled.

Table 1. Common name, scientific name and number of encounters of birds detected within 50 m of point count locations within the Boise Foothills of southern Idaho 19 August through 9 October 2012. (Unidentified birds are not listed.)

common name	scientific name	no. encounters
American robin	*Turdus migratorius*	1452
ruby-crowned kinglet	*Regulus calendula*	890
spotted towhee	*Pipilo maculatus*	877
dark-eyed junco	*Junco hyemalis*	600
white-crowned sparrow	*Zonotrichia leucophrys*	583
yellow-rumped warbler	*Setophaga coronata*	564
red-breasted nuthatch	*Sitta canadensis*	560
Cassin's finch	*Haemorhous cassinii*	274
Cassin's vireo	*Vireo cassinii*	193
cedar waxwing	*Bombycilla cedrorum*	181
pine siskin	*Spinus pinus*	173
western tanager	*Piranga ludoviciana*	148
chipping sparrow	*Spizella passerina*	143
mountain chickadee	*Poecile gambeli*	129
MacGillivray's warbler	*Geothlypis tolmiei*	119
Townsend's solitaire	*Myadestes townsendi*	81
yellow warbler	*Setophaga petechia*	76
lazuli bunting	*Passerina amoena*	64
golden-crowned kinglet	*Regulus satrapa*	62
dusky flycatcher	*Empidonax oberholseri*	59
Townsend's warbler	*Setophaga townsendi*	52
evening grosbeak	*Coccothraustes vespertinus*	51
brown creeper	*Certhia americana*	49
Wilson's warbler	*Cardellina pusilla*	49
black-headed grosbeak	*Pheucticus melanocephalus*	39
black-capped chickadee	*Poecile atricapilla*	35
warbling vireo	*Vireo gilvus*	31
northern flicker	*Colaptes auratus*	30
orange-crowned warbler	*Oreothlypis celata*	28
Hammond's flycatcher	*Empidonax hammondi*	26
hermit thrush	*Catharus guttatus*	25
Nashville warbler	*Oreothlypis ruficapilla*	24
Steller's jay	*Cyanocitta stelleri*	21
dusky grouse	*Dendragapus obscurus*	12
hairy woodpecker	*Picoides villosus*	10
house wren	*Troglodytes aedon*	9
mountain bluebird	*Sialia currucoides*	9
western wood-pewee	*Contopus sordidulus*	9
sharp-shinned hawk	*Accipiter striatus*	8
American goldfinch	*Spinus tristis*	5
calliope hummingbird	*Selasphorus calliope*	5
red crossbill	*Loxia curvirostra*	5
Swainson's thrush	*Catharus ustulatus*	4
Clark's nutcracker	*Nucifraga columbiana*	3
common raven	*Corvus corax*	3
white-breasted nuthatch	*Sitta carolinensis*	3
western flycatcher	*Empidonax difficilis*	3
black-billed magpie	*Pica hudsonia*	2
Bullock's oriole	*Icterus bullockii*	2
northern pygmy-owl	*Glaucidium gnoma*	2
American kestrel	*Falco sparverius*	1
black-chinned hummingbird	*Archilochus alexandri*	1
Brewer's sparrow	*Spizella breweri*	1
band-tailed pigeon	*Patagioenas fasciata*	1
Cooper's hawk	*Accipiter cooperii*	1
northern harrier	*Circus cyaneus*	1
olive-sided flycatcher	*Contopus cooperi*	1
red-tailed hawk	*Buteo jamaicensis*	1
varied thrush	*Ixoreus naevius*	1

The best models of detection for all birds together contained factors for observer and site (electronic supplementary material, appendix S1). Observer effects were apparent for six individual species (American robin, spotted towhee, white-crowned sparrow, red-breasted nuthatch, lazuli bunting and evening grosbeak) and site effects were apparent for five species (American robin, spotted towhee, red-breasted nuthatch, Cassin's finch and evening grosbeak; electronic supplementary material, appendix S1). Detection of five species varied between noise-on and noise-off periods (dark-eyed junco, white-crowned sparrow, Cassin's finch, and chipping sparrow), and interactions between noise and site as well as noise and observer were within the best models for two species

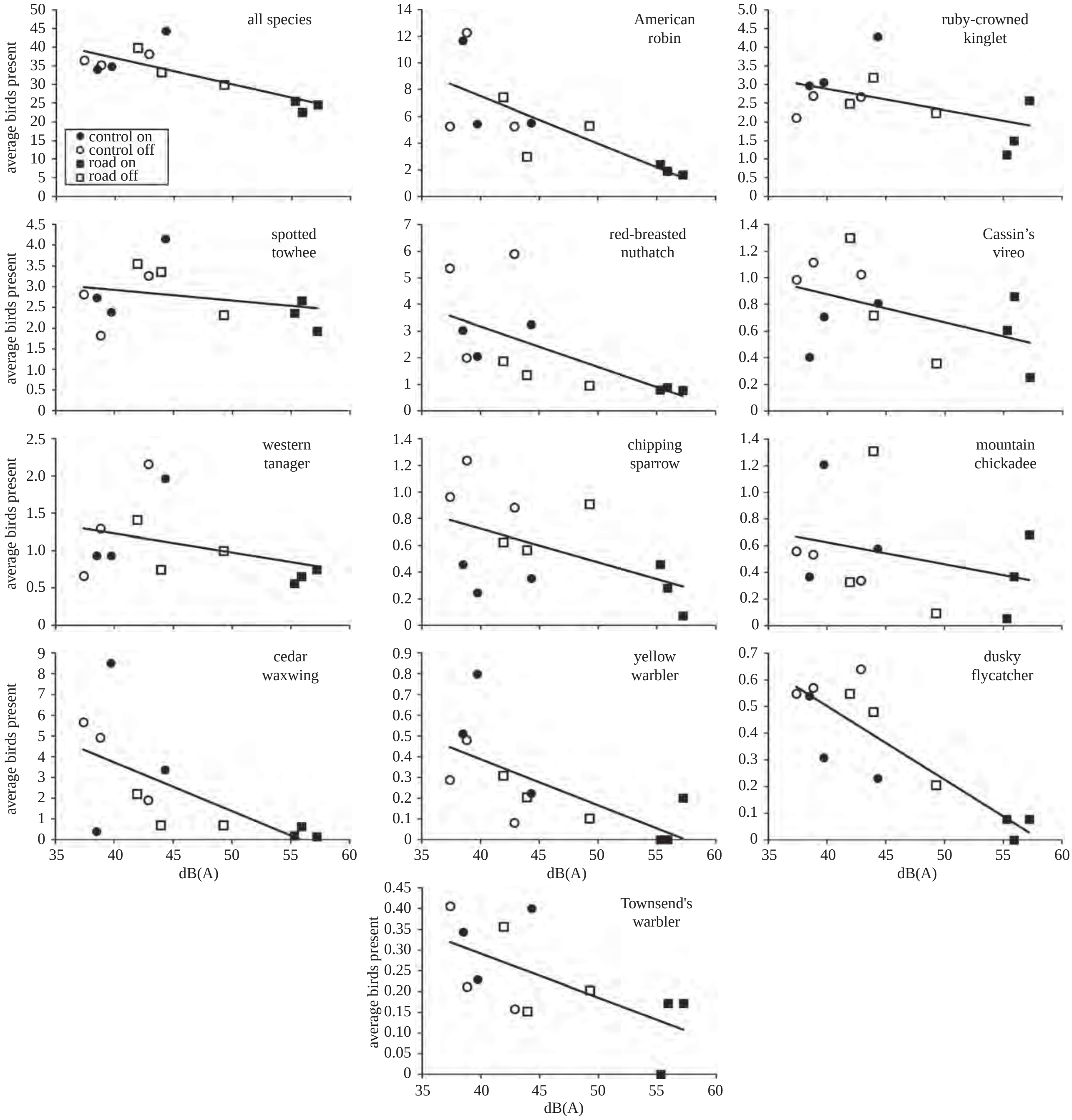

Figure 2. Average numbers of birds present per survey during noise-on and noise-off periods along the phantom road and at control sites in the Boise Foothills in southwestern Idaho. Only species with significant differences in abundance among treatments or background sound levels are shown.

(white-crowned sparrow, Cassin's finch). Finally, detection of four species varied by the day of the season (ruby-crowned kinglet, cedar waxwing, pine siskin and yellow warbler).

Abundance of every species except evening grosbeak changed as the season progressed with either linear or quadratic effects of day of the season being within models $\Delta AIC < 2$ and having confidence intervals excluding zero (electronic supplementary material, appendix S2). The best two models for the abundance of all birds within our study site received 99% of the model weight and contained a negative association with dB(A) and with the interaction between site and noise-on periods—indicating that when the noise was on, fewer birds were present near the phantom road (figure 2 and electronic supplementary material, appendix S2). Furthermore, over half of the individual species analysed responded negatively to the noise produced by the phantom road with 13 of 22 species being negatively associated either with dB(A) levels, or the interaction between site and noise-on periods, or both (figure 2). Eight species did not seem to be affected by noise because their best models were either the null or only contained covariates relating to the day of the season (electronic supplementary material, appendix S2). Finally, only one species—the Cassin's finch—was positively associated with the interaction of site and noise-on periods—indicating a positive effect of noise on abundance of this species. The number of birds present along the phantom road during noise-on periods was 28% (s.e. = 8%) lower than that during noise-off periods. Whereas, the number of birds present at the control site during noise-on periods was 3% (s.e. = 7%) higher than that during noise-off periods (figures 1 and 2). Furthermore, cedar waxwing and yellow warbler almost completely avoided the phantom road during noise-on periods (figure 2).

4. Discussion

This study is, to our knowledge, the first to experimentally demonstrate an effect of road noise on distributions of an animal community. To date, the most persuasive demonstrations of the effects of road noise on distributions of wildlife relied on comparing roadless areas to areas near roads [27,41–43]. Although suggestive, results from most road ecology studies are confounded by the other effects of roads such as collisions, visual disturbance and habitat alteration—and thus their interpretations have been questioned [11]. Our phantom road—an array of speakers broadcasting road noise into a roadless landscape—allowed us to isolate the effects of noise. The decline of bird abundance by over one-quarter along the phantom road, and the almost complete avoidance of two species by our treatments, suggests that road noise is a major driver of the documented effects of roads on wildlife. Therefore, our results experimentally validate the observational conclusions of past researchers—that negative effects of roads on animals can be driven by traffic noise (reviewed by [2]).

In addition, our study design of applying road noise using a line array of speakers and recording background sound levels using MP3 recorders yielded several benefits. We were able to quantify the bird community at the same sites under both noise-on and noise-off conditions instead of comparing sites that are always noisy to sites away from roads. Furthermore, our method of employing control sites, alternating between noise-on and noise-off blocks throughout the migratory period, and testing models which included covariates for day-of-season allowed us to assess and control for natural fluctuations in bird abundances and any potential differences in habitat among survey sites.

Accurate and thorough quantification of background sound levels is imperative for studies of effects of anthropogenic noise on animals [44]. Our use of MP3 recorders also allowed us to assess the LEQ over 16 days (two noise-on and noise-off blocks)—thereby performing, to our knowledge, the most thorough assessment of background sound levels in relation to distributions of terrestrial animals yet undertaken. For example, Summers *et al*. [11] quantified traffic noise over a 5 min period, Proppe *et al*. [45] quantified sound levels over four 11 min periods and several studies did not directly sample noise levels [13,41,43,44]. Because background sound level at a site can fluctuate strongly [26] and formulae estimating dB levels based on traffic volume ignore ambient sound levels, using continuous sound recordings provides a more accurate assessment of background sound levels. Our method of deploying MP3 recorders at survey sites is therefore efficient, thorough, accurate and cost effective [31].

Although our results demonstrate that traffic noise can severely affect bird abundances, other effects of roads (reviewed by [2]) will probably add to or multiply the effects of noise. Negative effects of roads are also likely to be driven by different aspects of roads depending on the taxon examined [2], and therefore taxa other than birds may be less affected by noise. Furthermore, migrating birds might strongly avoid noise because of their inherent mobility—they can easily avoid a noisy site, given there are other suitable, quieter areas nearby. Therefore, territorial breeding birds or less mobile taxa may be less willing or able to avoid noisy areas. However, our results demonstrate that noise alone is enough to cause some birds to avoid a site—suggesting that road noise might be, in some instances, the main driver of the effects of roads on animals.

Populations of migratory birds are in decline for myriad reasons including loss and degradation of migratory stopover habitat [21,23]. In fact, migration might be the most dangerous time of a migratory bird's annual cycle. For example, 85% of the yearly mortality of the black-throated blue warbler (*Dendroica caerulescens*) occurs during migration [46]. We substantially depleted the population of migratory birds and caused entire species to almost completely avoid an otherwise high-quality stopover site [25,28,47] using only traffic noise—demonstrating that anthropogenic noise can alter the amount of habitat available to migratory birds during stopover. For example, the yellow warbler—a species with declining range-wide populations [48]—was essentially absent from sites near the phantom road during noise-on periods. Because 83% of the USA is within 1 km of a road [1], it is likely that noise-sensitive species such as the yellow warbler avoid substantial areas of otherwise suitable habitat simply because they are too loud. Even within protected areas, roads can produce sound exposures similar to those produced by our phantom road across large areas [26]. Anthropogenic noise should therefore be considered when preserving and managing habitat, including stopover habitat for migratory birds.

Of course, management actions should also be informed by identifying the mechanisms underlying avoidance of noisy sites [49]. Background noise may mask important sounds, such as con- and heterospecific songs and calls, as well as sounds made by both predators and prey [10]. Increases in background noise are therefore known to increase predator vigilance in California ground squirrels (*Spermophilus beecheyi*, [50]), pronghorn (*Antilocapra americana*, [51]) and chaffinches (*Fringilla coelebs*, [52]). Because increased predator vigilance generally leads to less food intake [51,52], it is possible that noise degrades stopover habitat because migrants are less able to gain fat needed to fuel migration, but more study is needed.

An animal's ability to vocalize within frequencies which are not masked by background noise probably influences its response to increased noise [10]. For example, Francis *et al*. [7] and Rheindt [9] demonstrated that birds with higher frequency songs are less likely to avoid sites exposed to gas-compressor and road noise, respectively—probably because they are less affected by masking at lower frequencies. Furthermore, Francis *et al*. [6] demonstrated that of two closely related tyrant flycatchers, one species shifted its song to a higher frequency in response to gas-compressor noise, but did not avoid noisy areas, whereas the other species did not shift its song but was less likely to occupy noisy sites—suggesting that tolerance of noise is influenced by the ability of a species to avoid masking of its song. It is likely that the differing responses to noise among species within our study are, in part, owing to different abilities to avoid masking. However, past work has focused on masking of songs, whereas the migrating birds that we surveyed sing infrequently and to varying degrees. Future work should therefore examine the effects of masking of conspecific calls and which species possibly shift call-frequency in the presence of noise. Further, in addition to masking, other effects of noise such as disturbance, increased stress levels and distraction might have contributed to our results [49], and future studies should examine their relative contributions to changes in animal distributions.

Owing to logistical constraints regarding the difficulty of maintaining a phantom road, our design consisted of a single experimental and control site each containing three point count locations. That our point count locations were subsamples of the control and experimental sites might complicate the generalization of our results to other sites [53]. However, we took great care to ensure that our survey locations were as independent as possible—ridges separated survey locations and our analysis only included birds detected within 50 m. More large-scale playback studies are needed to assess the generality of our results among roads.

Generally, a deep understanding of large-scale ecological phenomena, such as those encountered in road ecology, requires both manipulative experiments and observational studies. Manipulative experiments provide strong inference into causal relationships that produce the widespread (in the case of road ecology, global) correlations demonstrated by observational studies [54,55]. Our study provides experimental demonstration of one of the primary causes underlying the correlations presented in past studies of effects of roads on animals. Future studies should employ a system similar to our phantom road to examine the effects of noise on direct measures of habitat quality such as individual fitness as well as examine the effects of noise on other taxa.

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Data accessibility. We have uploaded our data as an electronic supplementary file.

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Research article

Operational offshore wind farms and associated ship traffic cause profound changes in distribution patterns of Loons (*Gavia* spp.)

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ABSTRACT

Seabirds select suitable habitats at sea, but these habitats may be strongly impacted by marine spatial planning, including the construction of offshore wind farms (OWFs) and the associated ship traffic. Loons (*Gavia* spp.) are particularly vulnerable to anthropogenic activities and are also of high conservation status, making them particularly relevant to marine planning processes. We investigated the effects of OWF construction and ship traffic on Loon distributions in the German North Sea on a large spatial scale, using a 'before–after' control impact analysis approach and a long-term data set. Many OWFs were built in or close to core areas of Loon distributions. Loons showed significant shifts in their distribution in the 'after' period and subsequently aggregated between two OWF clusters, indicating the remaining suitable habitat. The decrease in Loon abundance became significant as far as about 16 km from the closest OWF. Ship traffic also had a significant negative impact on Loons, indicating that OWFs deterred Loons through the combined effect of ship traffic and the wind turbines themselves. This study provides the first analysis of the extensive effects of OWFs and ships on Loons on a large spatial scale. The results provide an essential baseline for future marine spatial planning processes in the German North Sea and elsewhere.

1. Introduction

Shallow-shelf sea areas have long been used by humans. The North Sea is amongst the most-intensively utilised sea areas worldwide for activities including fishing, transport, oil and gas drilling, and gravel extraction (Emeis et al., 2015; Halpern et al., 2008). The installation of offshore wind farms (OWFs) in many sea areas throughout Europe and elsewhere represents a relatively new human use requiring considerable attention in terms of the marine planning process. In order to meet their climate goals, many European governments have started to install and plan further OWFs within relatively large sea areas (e.g. Breton and Moe, 2009; Langston, 2010). Germany intends to extend its offshore power generation to 6,500 MW by 2020 and to 15,000 MW by 2030, leading to a large increase in the number of OWF sites, mainly in the German North Sea, making Germany one of the countries with the most extensive plans for OWF installations (Beiersdorf and Radecke, 2014). Seventeen OWFs are currently (2018) in operation, with five further ones under construction and several more being approved in German sea areas (BSH, 2017).

In terms of the process of marine spatial planning, these permanent installations at sea represent a major addition to other types of marine human activities, whilst competing with sea areas assigned for nature conservation (Emeis et al., 2015; Moksness et al., 2009; Nolte, 2010) and potentially overlapping with areas used by resting and foraging seabirds. Previous studies have pointed out contrasting effects (negative or positive) of OWFs on seabirds that vary strongly among areas and species (Dierschke et al., 2016; Drewitt and Langston, 2006; Fox and Petersen, 2006; Furness et al., 2013; Garthe and Hüppop, 2004; Masden et al., 2009). In addition, the construction and maintenance of OWFs is further associated with a strong increase in shipping activities in and around OWFs (Exo et al., 2003).

OWFs may have direct effects on birds such as collision of individuals with the turbines, with subsequent impacts on the whole population (Fox et al., 2006; Goodale and Milman, 2014; Masden et al., 2009). Furthermore, the energy budget and condition of individual birds may also be affected indirectly through the effects of OWFs on habitat loss and reduced food availability (Drewitt and Langston, 2006; Fox et al., 2006; Stienen et al., 2007), though the long-term effects of these indirect effects at the population level are hard to estimate (Fox et al., 2006; Goodale and Milman, 2014; Searle et al., 2017). However,

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birds have been shown to lose suitable resting and foraging habitats or to select less suitable sea areas (Stienen et al., 2007). Furthermore, they may need to increase their flight time by flying around OWFs on their way to suitable foraging sites (Drewitt and Langston, 2006; Masden et al., 2009). This study aimed to quantify the indirect effects (i.e. habitat loss by OWFs and associated ship traffic) on Loons (*Gavia* spp.) to provide baseline data for future studies that might address population consequences.

Loons belong to the most sensitive species group with respect to the avoidance of OWFs, as shown for single OWF sites in the North Sea (e.g. Dierschke et al., 2012, 2016; Leopold et al., 2010; Mendel et al., 2014; Petersen et al., 2006a, b; Welcker and Nehls, 2016). Furthermore, Red-throated Loons (*Gavia stellata*) are also very sensitive to ship traffic, demonstrating long flush distances in front of approaching vessels (Bellebaum et al., 2006) and significantly lower densities in areas with permanently higher ship traffic (Hüppop et al., 1994; Schwemmer et al., 2011). Their sensitive nature and the fact that a significant proportion of the biogeographic population occurs in European waters means that Loons are listed in Annex I of the EU Birds Directive and are considered to be particularly threatened with respect to human activities (e.g. Furness et al., 2013; Garthe and Hüppop, 2004). Negative effects on Loons at both the individual and population levels as a result of avoidance of OWFs cannot be ruled out (Dierschke et al., 2016, 2017), and Loons are therefore currently rated as a species group requiring particular consideration with respect to marine spatial planning in Germany and the UK (Busch et al., 2013).

Most Loons in the North Sea are Red-throated Loons (90%), with a minor proportion of Black-throated Loons (*G. arctica*; 10%) (Dierschke et al., 2012; Garthe et al., 2007). The German North Sea represents one of the most important resting sites for Loons with internationally important numbers, especially during spring migration (Garthe et al., 2007, 2015; Mendel et al., 2008; Skov et al., 1995), when around 20,200 Loons use German waters (Garthe et al., 2015). The 'Eastern German Bight' Special Protection Area (SPA) has been established to acknowledge the importance of this resting site and the high sensitivity of Loons with respect to human disturbances (Fig. 1). However, there is a potential conflict with the 'Butendiek' OWF, which was approved before but installed after the establishment of the SPA (Garthe et al., 2012), while further OWFs ('Helgoland Cluster') are located just south of the border of the SPA (Fig. 1).

Information on the long-term and large-scale effects of OWFs on Loons is currently limited and there has been no long-term comparison of their distributions before and after the installation of OWFs. Furthermore, the effects of increasing construction- and maintenance-related ship traffic have rarely been considered (Boon et al., 2010; Christensen et al., 2003).

We therefore hypothesized that Loons would avoid OWF areas and that their distribution patterns would differ before and after the installation of OWFs. We also hypothesized that the ship traffic associated with OWF sites would cause avoidance reactions among Loons. Against this background, this study aimed to shed light on five specific topics. (1) We had access to a long-term dataset covering the 14-year period before the installation of the OWFs ('before'). We therefore aimed to compare this information directly with the distribution of Loons after the installation of OWFs ('after'), using a long-term perspective not achievable in most previous studies. Mandatory operational monitoring of the four offshore windfarms in focus is still ongoing. (2) Most previous studies of the potential effects of OWFs on Loons have focussed on the effects of single OWF sites and their direct vicinities (see Dierschke et al., 2016). These therefore only allowed the reactions of Loons to be studied on a relatively small spatial scale, and could only show that Loon numbers were impacted within the respective site but could not show where they had moved to (Rexstad and Buckland, 2012). In contrast, the current study aimed to analyse the large-scale effects of multiple OWFs on Loon distribution, considering potential shifts between the 'before' and 'after' periods. (3) There is currently a need to

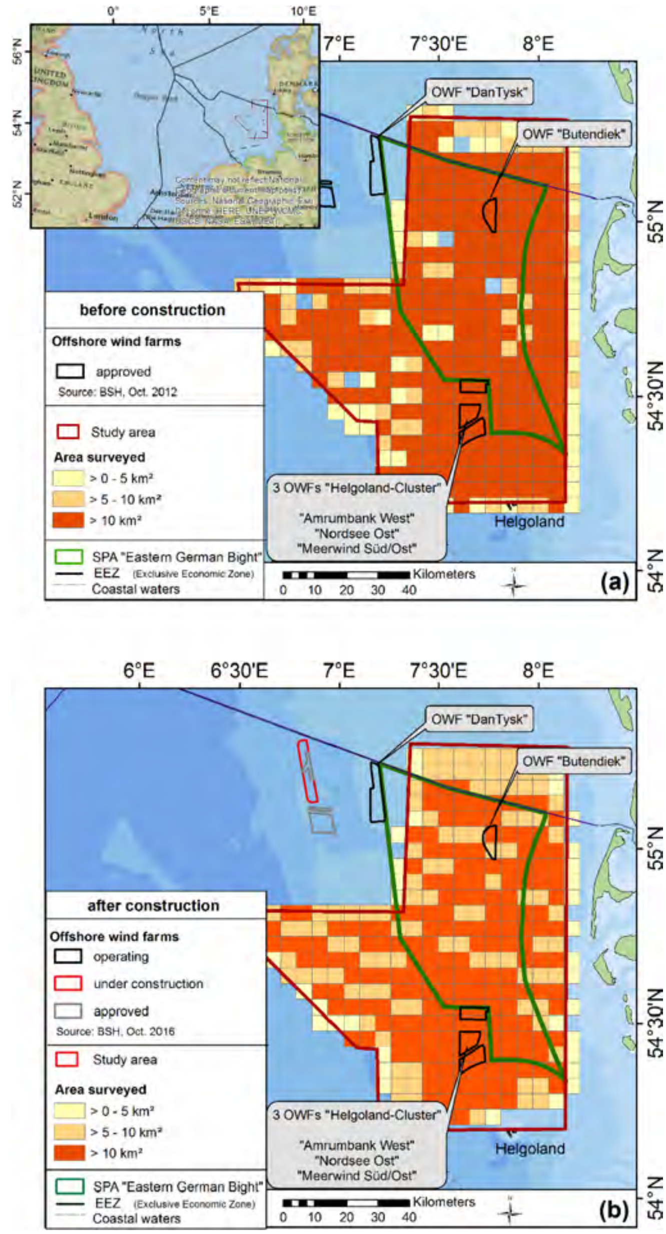

Fig. 1. Location of the study site within the south-eastern North Sea (inserted map in Fig. 1a) and in the eastern German Bight (North Sea) with locations of the different OWFs and the area surveyed for Loon abundance (yellow to red squares) across the 'Eastern German Bight' Special Protection Area (SPA; bold green line) for the 'before' (a) and 'after' periods of the analysis (b). Start of construction: 'Nordsee Ost' OWF during summer 2012; end of all construction works: 'Butendiek' OWF during summer 2015. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

disentangle the potential effects of OWFs from the effects of natural habitat characteristics that determine the distribution of Loons (Garthe, 1997; Winiarski et al., 2014). We therefore developed a model including stable natural parameters such as water depth and distance to land, as well as anthropogenic predictors such as distance to closest OWF and shipping traffic. (4) Given that the installation and maintenance of OWFs is associated with large increases in ship traffic, the effects of shipping need to be quantified and separated from the effects of the OWFs themselves. To date, this only has been analysed based on general ship densities (e.g. APEM, 2013; 2016; Leopold et al., 2014), while OWF ships present a dynamic source of disturbance for Loons.

This study therefore aimed to relate Loon and ship distributions at very high spatial and temporal scales by relating ship distributions derived from the Automatic Identification System (AIS) with Loon abundance assessed during aerial surveys. (5) Given a negative effect of OWFs on Loons, we aimed to quantify the avoidance distance to OWFs to draw conclusions about the degree of resulting (permanent) habitat loss.

In this study, we adopted two different approaches to analyse different aspects of the effects of OWFs on Loons: we used 'before' data to demonstrate the importance of the OWF areas before construction, and also focused on the simultaneous effects of OWFs and ships associated with OWFs after construction. The combined interpretation of these approaches allowed a comprehensive evaluation of the effects of OWFs on Loons.

2. Methods

2.1. Study area

The study was conducted within the eastern part of the Exclusive Economic Zone of the German North Sea, south of 55°17′ N, north of 54°11′, east of 6°30′ E, and west of 8°9′ E (Fig. 1a). The study site was located within an area 8–100 km off the Wadden Sea islands of northern Germany. The water depth ranged from 10 to 40 m. Loon distribution was recorded within the SPA 'Eastern German Bight' and beyond, and the study site therefore covered the core area of highest Loon densities within German waters (Garthe et al., 2015). The 'Butendiek' OWF is located in the core area of the SPA, while the 'Helgoland Cluster' OWFs are located at the border of the SPA and south of the core Loon distribution (Fig. 1a).

2.2. Recording Loon distribution and data processing

Loon distribution was recorded, both, in the period prior to OWF construction and in the period after construction:

(1) Before construction: These data cover the months of spring migration (i.e. March to April) of the years 2000–2013 and are the similar database as used by Garthe et al. (2015). The records originated from environmental impact assessment studies required for licensing procedures of offshore wind farms in the German EEZ and from seabird monitoring and research programmes (for details see Garthe et al., 2015; Fig. 1a). The data were recorded using visual aerial and ship-based surveys. Briefly, Loons were counted along transects of a known area, which allowed the densities to be computed (see Diederichs et al., 2002; Garthe et al., 2002 for a full description of both recording methods).

(2) After construction: These data also cover the months of spring migration (i.e. mainly March to April, but including the last week of February and the first week of May to enhance the sample size of surveys) of the years 2015–2017. Data originated from ongoing mandatory monitoring of the wind farms during operation, and from the 'Helbird' research project funded by the German Federal Ministry for Economic Affairs and Energy. Overall, data for the after period were based on 10 digital aerial surveys in 2015–2017 (Fig. 1b). Those data were obtained by video-based digital recordings instead of visual observations. Briefly, an aircraft sampled a transect of a known area using a video camera and all seabirds found were recorded and used to compute overall densities (for a detailed description of the method see Buckland et al., 2012; Thaxter and Burton, 2009). A change from visual to digital survey methods was mandatory for safety reasons because the flight altitude needed to be higher during the construction and operational phases of the turbines (168 m, instead of 91 m for visual observations), which excluded visual recordings.

(3) During construction: No data were considered in this study, as disturbance during the construction of the OWF is temporary and mainly associated with construction ships, and its contribution to the overall effect of the OWF on the Loon population was assumed to be of low importance in relation to the expected lifetime of the OWF (Christensen et al., 2003).

Visual observations of seabird distributions are known to underestimate birds in parts of the transect further from the observer (Buckland et al., 2001, 2015). We therefore applied a species-specific correction factor for aerial and ship-based observations, respectively (see Garthe et al., 2015 for details). However, no distance correction was necessary for the video-based digital surveys because the probability of detecting a bird was equal across the whole transect.

All three recording methods relied on the principle that transect sampling of birds could be used to compute densities. However, we did not compare absolute density values between the 'before' and 'after' periods, because the visual and digital methods have not been confirmed to produce the same absolute values (Buckland et al., 2012; Skov et al., 2016); this could only be tested by performing both methods at the same time, and no such dataset is currently available. Thus, both periods were compared by computing the relative deviance from the maximum density in each period in %, and using this to compare the distributions and locations of high-density areas of Loons between the two periods.

Data were spatially pooled in a grid with cells of 2.5 × 2.5 km for the 'before' and 'after' periods, for each of the three methods (visual aerial and ship-based surveys, video-based digital recordings), respectively. Bird numbers and monitored areas were each summed per grid cell, and eventually used to compute mean densities for each period, while geographical coordinates were averaged for each cell.

2.3. Integrating covariates for the 'before–after' control impact (BACI) approach

We related the average distribution data for Loons with environmental variables using ArcGIS (version 10.3; Environmental System Research Institute, 2016). The environmental variables included: (1) *dist_coast* = minimum distance to the mainland and larger islands (except Helgoland); (2) *dist_helgoland* = minimum distance to Helgoland; (3) *dist_owf* = minimum distance to the border of the OWF; and (4) *mean_depth* = mean water depth.

This first model, hereafter named the BACI approach, did not consider the effect of ships because ship data at a sufficiently high spatio-temporal resolution were only available for the 'after' period. To distinguish between the effect of the OWFs and the effect of ship traffic on Loons, we therefore developed a second model (ship model) using only the data from the 'after' period.

To merge the environmental variables with the bird-count data in an optimal way, we first pooled the covariates to a spatial grid of 2.5 × 2.5 km, and then fitted each covariate with a generalised additive model (GAM) using the function gam() in the R-package mgcv (R Core Team, 2017; R version 3.4.2; Wood, 2006). We used only latitude and longitude as a smooth 2D-predictor based on cubic splines with the maximal degree of freedom, so that the result represents a cubing interpolation on the given (possibly irregular) grid. Thirdly, we used the predict() function to predict the values straight to the coordinates as given in the pooled bird-count data. Finally, the additional categorical variable *owf_zone* for 'inside OWF-affected area' vs. 'outside OWF-affected area' was defined for two different zones: 1) inside: ≤ 3 km vs. outside: > 3 km (measured from the nearest turbine), given that OWF-associated ships operate mainly within a 3 km radius around the OWF and this distance class has been used in previous studies of the impact of single OWFs (Vanermen et al., 2015a; Welcker and Nehls, 2016); and 2) inside: ≤ 10 km vs. outside: > 10 km, because an initial analysis showed the greatest decrease in Loon densities up to a distance of 10 km from the turbines.

2.4. Set up and validation of regression models for the BACI approach

The BACI approach is based on surveying a potentially impacted situation and a control situation before the impact (variable '*period*'), and relative comparisons of spatial and temporal differences can then be used to extract the unbiased impact (Schwarz, 2014; Smith, 2002). We formulated the BACI approach within the framework of generalised additive mixed models (GAMMs), which are known to describe biological count data appropriately (Zuur et al., 2007, 2009; 2012). We used a continuous linear or smooth predictor measuring the distance to the border of the next OWF. This allowed us to estimate how the abundance of Loons changed in relation to the distance from the OWF and to estimate avoidance distances. Notably, we introduced a variable for the observation method ('visual ship-based surveys' vs. 'visual aerial surveys' vs. 'digital aerial surveys') as a random intercept to account for differences in detection among these methods. We were aware that this variable was partially collinear with the variable 'period' because only digital aerial surveys were used 'after' and only visual surveys were performed 'before'. Importantly, the estimation of the interaction term 'period x wind_farm' (see below) representing the BACI approach was not influenced by this, because only relative differences in Loon densities were evaluated.

This approach produced the following full model for the BACI approach (not yet thinned regarding its predictors; see below):

$$\begin{aligned}\log(y_{ij}) = \beta_0 + u_i + \mathrm{f(mean\_depth_j)} + \mathrm{f(dist\_coast_j)} + \mathrm{f(dist\_helgoland_j)}\\ + \mathrm{s(latitude,longitude)} + [\mathrm{wind\ farm_j}] + \mathrm{period_j}\\ + [\mathrm{wind\ farm_j}] \times \mathrm{period_j} + \mathrm{offset}(\log(\mathrm{area_j})) + \varepsilon_{ij}\end{aligned} \quad (1)$$

where $\varepsilon_{ij} \sim N(0, \sigma^2)$ and $u_i \sim N(0, \sigma_u^2)$ were independent and identically distributed. Here, y_{ij} is the vector of bird numbers, where the index j refers to the observation number and i is related to the method-ID. *f*() depicts either a linear term or a cubic regression spline *s*() (tested during predictor selection), where, in the case of a spline, the optimal number of knots was estimated via cross-validation. The variable [*wind_farm$_j$*] was either considered as a linear term, *dist_owf$_j$* measuring the distance to the next wind turbine, as an additive smoother, *s*(*dist_owf$_j$*), or as a bivariate variable, *owf_zone$_j$*, the latter distinguishing between 'inside OWF-affected area' and 'outside OWF-affected area'. For each model, an appropriate probability distribution was selected for y_{ij} via Akaike Information Criterion (AIC; Akaike, 1973) analysis (see below).

We modified the common selection and validation strategies to validate the optimal GAMM model (Field et al., 2012; Korner-Nievergelt et al., 2015; Zuur, 2012; Zuur et al., 2009, 2010; 2012) using the following steps: (1) Based on the entire model (1), we selected an appropriate probability distribution/stochastic part of the model using the AIC. Namely, we compared Poisson-, negative binomial-, Tweedie-, zero-inflated Poisson distribution, and observation-level random intercept Poisson models. All five probability distributions are known to describe the stochastic part in regression models of (overdispersed) count data reasonably well (Kokonendji et al., 2004; Korner-Nievergelt et al., 2015; Linden and Maentyniemi, 2011; Zuur et al., 2012). (2) The optimal model regarding the set of fixed-effect predictors was selected from the full model by comparing 16 different models. (3) Model validation was carried out by visual inspection of the residual plots to assess all the required model assumptions (Zuur et al., 2010). Corresponding auto-correlation structures were added to the model if required.

AIC favoured a negative-binomial distribution, and subsequent predictor selection produced the following final model:

$$\begin{aligned}\log(y_{ij}) = \beta_0 + u_i + \beta_1 \mathrm{dist\_coast_j} + \mathrm{s(latitude,longitude)} + [\mathrm{wind\_farm_j}]\\ + \mathrm{period_j} + [\mathrm{wind\_farm_j}] \times \mathrm{period_j} + \mathrm{offset}(\log(\mathrm{area_j})) + \varepsilon_{ij}\end{aligned} \quad (2)$$

Residual analysis revealed no violation of linearity, homogeneity, independence, or normality of the random intercept.

2.5. Integrating covariates for the ship model

Ship traffic has been shown to have a significant effect on Loon distribution (Bellebaum et al., 2006; Schwemmer et al., 2011), and ship traffic in the study area has increased greatly due to the construction and maintenance of OWFs. It is therefore important to disentangle the effects of these two sources of anthropogenic activities (OWFs and ship traffic) on Loons. Ship traffic shows temporal inhomogeneity, with more traffic in the morning and evening hours, and it was therefore necessary to consider the data spatio-temporally instead of purely spatially, as with the BACI approach. Data were only used for five digital-survey flights from the 'after' period because no real-time ship data were available for the 'before' period or for any other survey days during the 'after' period. Bird data were spatially assigned to an optimal grid of 2.5 × 2.5 km for each survey day separately and treated as described above. To consider the time, we also calculated the mean time at which the Loon observations were recorded for each grid cell.

Data on ship distributions were recorded in parallel with the digital-survey flights to record Loon distribution using an AIS spotter (www.aisspotter.com). Because the ship data consisted of irregular position data in terms of time and space, they were linearly interpolated to obtain positions at least every minute. To merge the ship data with the Loon-distribution data, it was assumed that all ships within the time interval $[t - \delta_t, t]$ and within a circle around (x, y) with radius r may influence bird density, for each time point t and each pair of spatial coordinates (x, y). Given that the optimal values δ_t and r are not known *a priori*, we tested all existing combinations between δ_t ε {2, 60, 120, 180, 250, 300, 350, 400, 600, ∞} sec and r ε {1, 2, 3, 4, 5, 6, 7, 8, 9, 10} km, and created a separate variable counting all ships within the given time and space interval for each of the 100 combinations. Here, $\delta_t = \infty$ depicts a case where all available ship data have only been spatially correlated to bird-count data without considering temporal distance to the observations. We subsequently compared 100 resulting regression models (see below) to find the optimal values of δ_t and r. However, the AIC value was not appropriate for selecting the optimal model because the ship densities and OWF-related variables were collinear, and the model with only one of both variable types would be favoured due to the parsimony of the AIC-based selection. In contrast, we aimed to consider both (collinear) variables to distinguish explicitly between the unique effects of ships and wind turbines on Loon abundance. An appropriate measure should thus relate the effect size of the ship-dependent variable with its reliability. Hence, we selected the model with the highest $|\beta|/SE_\beta$ value, where β is the ship-related regression coefficient and SE_β is its standard error.

2.6. Set up and validation of regression models for the ship model

The GAMMs were set-up as described above for the BACI approach. Notably, the ID of the digital-survey flight was introduced as a random intercept to account for different numbers of birds or different monitoring conditions between surveys.

This produced the following GAMM structure of the ship model (not yet thinned regarding its predictors):

$$\begin{aligned}\log(y_{ij})\beta_0 + u_i + \mathrm{f(mean\_depth_j)} + \mathrm{f(dist\_coast_j)} + \mathrm{f(dist\_helgoland_j)}\\ + [\mathrm{wind\_farm_j}] + [\mathrm{ship\_number_j}] + \mathrm{offset}(\log(\mathrm{area_j})) + \varepsilon_{ij}\end{aligned} \quad (3)$$

where $\varepsilon_{ij} \sim N(0, \sigma^2)$ and $u_i \sim N(0, \sigma_u^2)$ were independent and identically distributed. Here, y_{ij} is the vector of bird numbers, where the index j refers to the observation number and i is related to the survey flight ID. *f*() depicts a linear or smooth predictor (tested during AIC-based predictor selection). The variable [*wind_farm$_j$*] was either considered as a binomial predictor ('inside' vs. 'outside'), a linear term (distance to the

OWF border), or a cubic regression spline depending on the latter. The variable [$ship\_number_j$] was considered as the total number of temporally and spatially related ships, additionally depending on the *a priori* defined parameters δ_t and r (see above). In contrast to the BACI approach, we did not consider a spatial smooth because this predictor would interfere with the correct estimation of [$wind\_farm_j$]. GAMM-model selection and validation strategies were performed as described for the BACI approach (see above), including integration of the appropriate autoregression structures (if required).

AIC-based selection of the probability distribution again favoured a negative-binomial distribution. The optimal values of δ_t and r required to blend the observation and ship data showed that the highest (β/SE)-values (indicating high precision of the ship-related regression coefficient) were $\delta_t = 5$ min and $r = 5$ km. Subsequent predictor selection revealed the following final model:

$$\log(y_{ij}) = \beta_0 + u_i + \mathrm{f(mean\_depth_j)} + \beta_1 \mathrm{dist\_coast_j} + \mathrm{s(dist\_helgoland_j)} + \mathrm{[wind\_farm_j]} + \mathrm{[ship\_number_j]} + \mathrm{offset(log(area_j))} + \varepsilon_{ij} \tag{4}$$

where $s()$ depicts the cubic regression splines with optimal degrees of freedom estimated via cross-validation.

Analysis using different sizes of the underlying spatial grid for spatio-temporal pooling revealed an optimal grid size of 2.5 × 2.5 km, leading to a temporal autocorrelation of model residuals of order 2 (in contrast to the model based on raw data, where the autoregressive order (AR order) was > 30). Model-validation plots indicated no violation of linearity or homogeneity, spatial residual plots and a semi-variogram indicated no violation of spatial independence, and a plot of the partial autocorrelation function (pACF-plot) revealed a temporal autocorrelation of approximately order 2, which was integrated as an AR(2)-structure into the model.

3. Results

3.1. Loon abundance before and after OWF installation

The spatial distribution patterns of Loons changed profoundly between the 'before' and 'after periods (Fig. 2). During the 'before' period, the core area with the highest Loon densities clearly overlapped the area of the planned 'Butendiek' wind farm, while moderately high densities stretched out to the area of the planned 'Helgoland Cluster'. In contrast, there was a clear shift to the area located between these two OWF sites during the 'after' period (Fig. 2). The areas of the OWFs themselves, as well as the immediate vicinities, showed extremely low abundances of Loons during the 'after' period. The core area of Loons during the 'after' period was thus still located in the centre of the SPA, but the birds were more aggregated within the still-undisturbed sea area.

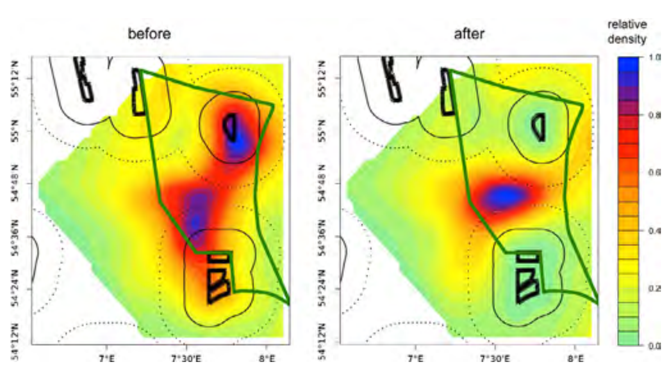

Fig. 2. Spatial density plots of predicted Loon distributions 'before' vs. 'after' the construction of OWFs, based on the BACI-GAMM. Bold black lines: OWFs; thin black lines: 10 km distance buffer; dotted black lines: 20 km distance buffer; bold green line: Special Protection Area.

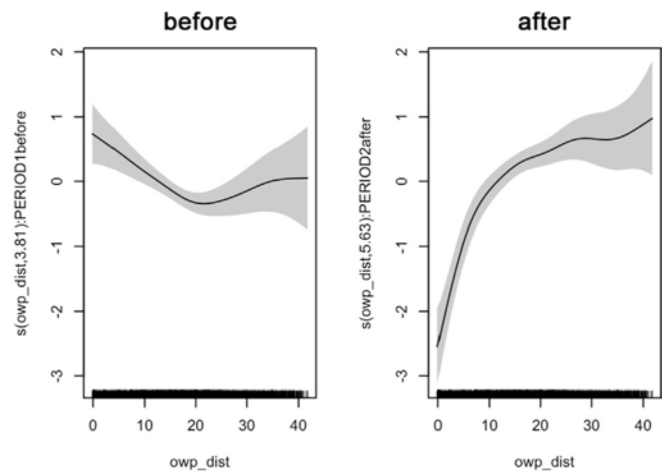

Fig. 3. Change in Loon abundance in relation to distance from the closest OWF site 'before' (left) and 'after' construction of the OWFs. Smoothed curve: predicted number of Loons at a given distance from the closest OWF; shaded area: 95% confidence interval; small lines on the x-axis: observations of Loons at a given distance from the OWF.

We also introduced the distance from the wind farm as a smooth term, estimated separately for each period. This revealed a striking difference between the two periods (Fig. 3): the 'before' plot suggested that the future wind farm areas were sites with naturally increased Loon abundance, while the 'after' plot showed a strong decline in Loon abundance due to the OWFs (Fig. 3). The start of this decline was already visible at > 20 km from the OWFs (see also dotted black lines in the 'after'-plot in Fig. 2b). To determine the distance from the wind farm at which the decline in abundance was significant, we approximated the first derivative of the corresponding smooth (Fig. 3 'after') by calculating its first finite difference.

To determine the distance at which the change in Loon density became significant, we calculated confidence intervals for the first derivatives via bootstrap analysis and subsequently evaluated where the lower confidence interval intersected with zero. This occurred at around 16.5 km from the OWFs (Fig. 4). However, the greatest decline in density was at distances within 10 km from the OWF (Figs. 3 and 4). Avoidance of wind farms within 10 km was also clearly visible in the distribution maps (solid black lines in Fig. 2b).

Additionally, the binomial wind farm-related variable *owf_zone* was highly significant for both radii (3 or 10 km, respectively). The abundance of Loons decreased highly significantly by 94.5% inside the 3 km zone around the OWFs within the study site (interaction term in Table 1; $\beta = -2.9$, $p < 0.001$), while the abundance was still decreased by 83.7% inside the 10 km zone (Table 2, $\beta = -1.8$, $p < 0.001$). The distance to land (*dist_coast*) had no significant effect on Loon densities (Table 1; Table 2).

3.2. Distinguishing between effects of ships and OWFs

Loon densities were still reduced if ships were included in the overall model as a predictor for the 'after' period, as was the case without considering the effect of ships, as shown above. Applying a 3 km radius around the wind farms, OWFs alone reduced the Loon density by 70.8% compared with the sea areas outside the OWFs ($p < 0.001$; Table 3). If the radius was extended to 10 km around the OWFs, the Loon density was still reduced by 44.5% ($p < 0.001$) by the OWFs alone.

When ships as single predictor were removed from the model, the estimated effect of OWFs (now combined with the effect of the ships) on Loons was 84% using a 3 km radius ($p < 0.001$). This suggested that

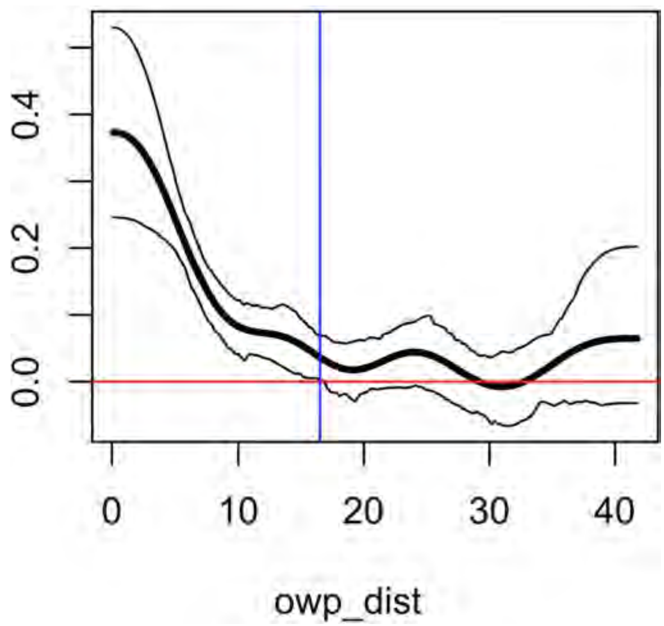

Fig. 4. First finite difference of the smooth depending on the distance from the closest OWF, partially evaluated for the 'after' period. Red line indicates a derivative of zero, blue line indicates distance at which the derivative was significant. Thick black line corresponds to the first derivative; thin black lines depict 95% confidence intervals.

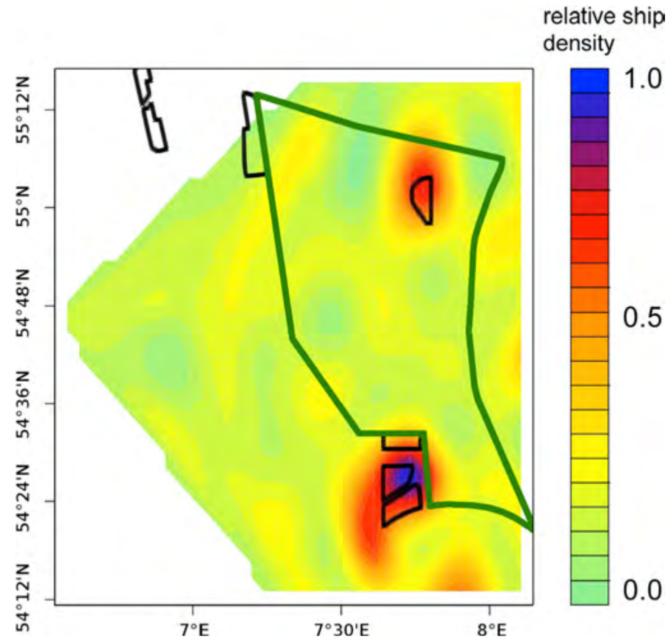

Fig. 5. Spatial density plot of ship distribution in the 'after' period based on AIS data.

Table 1
Regression results of the BACI approach–GAMM using the binomial variable 'inside wind farm' vs. 'outside wind farm' (*owf_zone*) for a radius of 3 km.

	Estimate	Std. Error	z value	Pr(> |z|)
(Intercept)	−1.05	1.17	−0.90	0.37
period[after]	0.40	0.85	0.47	0.64
owf_zone[a][inside]	0.70	0.13	5.07	< 0.001
dist_coast[b]	0.02	0.02	0.70	0.43
period[after]xowf_zone[inside]	−2.90	0.22	−13.16	< 0.001

[a] Offshore wind farm zone.
[b] Distance to coast.

Table 2
Regression results of the BACI approach–GAMM using the binomial variable 'inside wind farm' vs. 'outside wind farm' (*owf_zone*) for a radius of 3 km.

	Estimate	Std. Error	z value	Pr(> |z|)
(Intercept)	−1.41	1.17	−1.21	0.23
period[after]	0.73	0.95	0.76	0.45
owf_zone[a][inside]	0.66	0.12	5.59	< 0.001
dist_coast[b]	0.02	0.02	1.01	0.31
period[after] xowf_zone[inside]	−1.81	0.12	−15.26	< 0.001

[a] Offshore wind farm zone.
[b] Distance to coast.

Table 3
Regression results for the *ship-owf*-approach–GAMM distinguishing between the effect of ships and the effect of OWFs in the 'after' period for a radius of 3 km.

	Estimate	Std. Error	z value	Pr(> |z|)
(Intercept)	0.29	0.58	0.5	0.62
owf_zone[a][inside]	−1.23	0.31	−4.03	< 0.001
dist_coast[b]	−0.01	0.01	−0.55	0.58
n_ships[c]	−0.37	0.08	−4.82	< 0.001

[a] Offshore wind farm zone.
[b] Distance to coast.
[c] Number of ships.

ships also had a strong negative effect on Loon abundance, accounting for at least 14% of the joint OWF–ship effect.

Thus, in the ship model, the effect of OWFs alone was not as strong as estimated by the BACI approach (i.e. without considering ship traffic; > 94% and > 84%, respectively). There are two possible explanations for these different estimations. (1) the ship model was only fitted using data from the 'after' period because no ship data were available for the 'before' period. Hence, the estimated reduction in effect does not take account of the fact that bird densities within the OWFs showed the highest Loon abundances before the construction of the farms (see above), leading to a strong underestimation of the reduction effect. (2) Although the ship model considered the effect of ships, these were at least partially correlated with OWF location (Fig. 5). Thus the BACI approach actually estimated the joint reduction effect of OWFs and ships, whereas the ship model evaluated both impacts separately, which may have led to a reduction in the OWF effect compared with the BACI approach.

Indeed, the ship model showed a significant negative impact of ships on Loon abundance (Tables 3–4), with a highly significant decline of 31% in abundance for each additional ship in the spatio-temporal range of the Loons (i.e. 5 min and 5 km from the Loon sighting; see Methods) ($p < 0.001$). This suggests that one in three Loons left the area as one ship approached. The spatial component of ship disturbance was much stronger than the temporal component; i.e. our regression models selecting for the optimal δ_t and r revealed that ships within 5 km had a strong impact on Loon abundance, whereas the time lag between

Table 4
Regression results for the *ship-owf*-approach–GAMM distinguishing between the effect of ships and the effect of OWFs in the 'after' period for a radius of 10 km.

	Estimate	Std. Error	z value	Pr(> |z|)
(Intercept)	0.73	0.58	1.26	0.20
owf_zone[a][inside]	−0.59	0.17	−3.51	< 0.001
dist_coast[b]	−0.01	0.01	−1.00	0.32
n_ships[c]	−0.48	0.07	−6.44	< 0.001

[a] Offshore wind farm zone.
[b] Distance to coast.
[c] Number of ships.

the Loon sighting and the AIS signal of the ship was less relevant (with an optimum at approx. 5 min). This suggests that ships may affect Loons most strongly at a distance of $\leq$5 km.

As seen with the BACI approach, the distance to land had no significant influence on Loon abundance (Tables 3–4).

4. Discussion

4.1. Distribution patterns before and after OWF installation

Our results demonstrated that the distribution patterns of Loons, which had remained stable over a period of many years (Garthe et al., 2015), were substantially altered at both small and large spatial scales by the installation of OWFs in the German North Sea. We developed our BACI approach on a solid database including 14 years of large-scale surveys in the period 'before' OWF installation. To the best of our knowledge, all previous reports have been based on a maximum of 1–3 years of data prior to the construction of OWFs, and have mostly focused on the effect of a single OWF (e.g. Leopold et al., 2013; Petersen et al., 2014). Although we were unable to compute absolute differences in Loon populations between the two periods due to a change in survey methods, our results demonstrated profound large-scale shifts in distribution patterns, as well as significant avoidance of the OWF areas.

We observed a shift in the Loon-abundance hotspot to the western–central area of the SPA that remained undisturbed by OWFs in the 'after' period. This hotspot is located about 20 km distant from all surrounding OWFs. Several previous studies have highlighted the environmental parameters that are most important for determining Loon distribution patterns. Frontal systems are expected to increase prey availability for Loons (Skov and Prins, 2001), while nearshore and shallow sandy sea areas also play a major role (O'Brien et al., 2008; Skov and Prins, 2001; Skov et al., 2016). Our results suggest that the area of the 'Butendiek' OWF, which was installed in the northern part of the SPA, was of particular importance for Loons before the construction of this OWF, given that this was the area of maximum Loon abundance during the 'before' period. The 'Helgoland-Cluster' OWFs are located south-west of the border of the SPA, and our results showed that, in contrast to the 'Butendiek' area, Loon abundances in the 'before' period were significantly lower compared with abundances within the SPA. However, Loons are known to occur here regularly (Garthe et al., 2015).

One aim of this study was to disentangle the importances of natural habitat structures and anthropogenic pressures on Loons. Our modelling approach showed that natural habitat predictors, such as distance to the coast/Helgoland and water depth did not play major roles compared with the effects of OWFs and shipping (see below). This suggests that anthropogenic pressures are the most important factors driving the distribution patterns of Loons within their natural hot spots.

Still, we cannot completely rule out that undetected changes in ecological conditions might have additionally led to the shift in distribution patterns. For instance, it could be assumed that Loons might have followed shifts in their prey community. However, given that Loons are known to feed on a variety of fish species (Guse et al., 2009), a shift in fish distribution that could account for the change in Loon distribution seems highly unlikely. The reef effect is even known to likely increase benthic and fish communities inside OWFs (e.g. Vandendriessche et al., 2015; Vanermen et al., 2015a) which in turn may enhance the quality of these sites for piscivorous seabirds. However, given that these sites were avoided by Loons, despite of a likely higher fish availability and as Loon distribution patterns had been stable over a period of many years in the 'before' period (Garthe et al., 2015), it seems to be convincing that OWFs and associated ship traffic are the main factors explaining the shifts in distribution patterns.

Incorporating distance from the nearest OWF as a smoothed term in the model allowed us to highlight the fact that Loons reacted as far as 20 km from OWFs, with significant changes in densities at a distance of 16.5 km and the greatest changes in abundance within 10 km. These values were higher than those reported in previous studies (summarized in Dierschke et al., 2016; Welcker and Nehls, 2016). However, most previous studies only investigated local avoidance effects (often only up to 4 km distance; Leopold et al., 2013; Petersen and Fox, 2007, Petersen et al., 2006a,b; Welcker and Nehls, 2016) and were therefore unable to detect any larger-scale avoidance reactions. This highlights the importance of a sufficiently large-scale approach and the inclusion of multiple OWF sites (Rexstad and Buckland, 2012), as in the current study. To emphasize the importance of scale, we quantified the effects of OWFs on Loons by defining the affected sea areas by both 3 km and 10 km radii.

The 3 km distance class was chosen based on previous studies that showed avoidance distances for single OWFs up to this value (Vanermen et al., 2015a; Welcker and Nehls, 2016). However, our results suggest that this distance was too short, based on the effects of multiple OWFs on a larger spatial scale.

The reason for the relatively large-scale effect of OWFs on Loons detected in the current study is not completely clear. It is possible that visual cues are not the only reason for the large disturbance distance. Previous studies showed that OWFs not only affected seabirds and other marine wildlife directly (Bergström et al., 2014; Goodale and Milman, 2014; Lindeboom et al., 2011), but may additionally cause changes in the abiotic environment, such as sediment properties and water stratification due to turbulence caused by the piles (Carpenter et al., 2016; Nagel et al., 2018). Carpenter et al. (2016) pointed out that an individual OWF may enhance mixing of the water column, with a cascade of effects on the whole ecosystem in an area of 10–20 km from the OWF, though the physical–biological interactions remain unclear. This was in accordance with the disturbance distance of Loons found in the current study. Petersen et al. (2014) also showed significantly lower Loon abundances up to 13 km from OWFs, which also matched the results of the current larger-scale approach.

Finally, it is important to critically explore the question of the power of the data used in this study. For the type of data used, previous investigations have shown that high survey intensities are required to safely trace declines in seabird populations, mainly as a result of high variability in distribution patterns (e.g. MacLean et al., 2013; Vanermen et al., 2015b). However, compared to our study that was conducted over a large sea area, both studies mentioned above focussed on rather small study sites, likely enhancing small-scale variability in counting data. According to Vanermen et al. (2015b) the statistical power after 10 years of survey was sufficiently high to detect reliable changes. For the 'before' period, 13 years of data were available for our BACI approach, indicating a valid data base. In contrast, the 'after' period only consists of 10 aerial surveys over a period of three years, suggesting that the data base for the 'after' period may still be too weak. However, the significant negative and consistent effects of OWFs and associated ship traffic on Loon distribution during all surveys of the 'after' period indicates that the data base is sufficient to yield valid results. Nevertheless, it will be necessary to enhance the data base for the 'after' period by future surveys to confirm the results and to enhance the statistical power.

4.2. Distinguishing between the effect of ships and OWFs

The installation of OWFs causes a substantial increase in ship traffic in the surrounding area due to maintenance and service activities (Exo et al., 2003). Although ship traffic is known to affect the distribution patterns of seabirds and particularly of Loons (Bellebaum et al., 2006; Schwemmer et al., 2011), the combined effect of OWFs and their associated ship traffic has rarely been reported; however, the few available studies noted a significant impact of ship traffic on Loon distribution (APEM, 2013, 2016; Leopold et al., 2014; Skov et al., 2016). Loons have been shown to exhibit a behavioural response to approaching ships, and flight distances of up to 2 km have been documented (Bellebaum et al., 2006; Schwemmer et al., 2011). This corresponds to the current results, which suggested a significant reduction in Loon densities within a radius of up to 5 km from the vicinity of ships, with the temporal aspect of ship distribution having little effect.

Inclusion of ship abundance in the model showed a reduced density of Loons of up to 70% based on the 3 km distance zone. This reduction could be considered to reflect the effect of the OWFs alone. In contrast, the joint effect of OWFs and ships led to a reduction of 84%, indicating the additional negative impact of ships on Loon densities. The exact reduction in densities due to ships alone could not be computed reliably because of the collinearity of ship traffic and OWFs. Importantly, their mobile nature means that ships are both spatially and temporally variable predictors, and a reliable estimation of their overall effects on birds will always be biased. This issue will remain difficult to address even in future studies, given that ships aggregate strongly in the vicinity of OWFs and present no fixed predictor.

The greater reduction in Loon densities following inclusion of ship traffic in the model demonstrates the importance of reviewing the cumulative impact of multiple anthropogenic pressures in the marine environment. Previous studies have focussed on cumulative effects simply by investigating the combined effects of multiple OWFs (Busch et al., 2013; Desholm, 2009; Dierschke et al., 2003, 2006, Fox et al., 2006; King et al., 2009; Mendel and Garthe, 2010). However, given the strong effect of ships on Loon abundance, it seems necessary to include other anthropogenic pressures in estimates of cumulative effects on Loon abundance in general.

4.3. Conclusions

The large-scale avoidance effects of OWFs (and ships) on Loons suggest that Loons are unlikely to suffer from enhanced direct mortality, e.g. because of collisions (Leopold et al., 2010; Petersen et al., 2006a,b; this study). Furthermore, a low flight altitude of only up to 10 m above the sea surface (Van Bemmelen et al., 2011) reduces the collision risk for Loons. Indirect effects, such as habitat loss, are thus likely to be key factors affecting Loons in relation to OWFs. However, the consequences of such indirect effects e.g. on population levels of seabirds, and density-dependent effects are hard to assess, and appropriate methodologies are largely lacking (Green et al., 2016; Horswill et al., 2017). When assessing the consequences of habitat loss due to the installation of OWFs and the associated enhancements in ship traffic, it is essential to consider which alternative sea areas could be used as resting and foraging grounds. In the current case, alternative sites seemed to be very limited because the SPA was virtually surrounded by OWFs. This might explain why Loons tended to concentrate in the centre of the SPA rather than moving outside it.

Although it was not possible to compute absolute differences in abundance between the 'before' and 'after' periods in this study, it is hoped that this issue will be resolved when enough data become available from parallel digital and visual surveys of sea areas where visual observations are still allowed. However, the relative reduced densities of Loons with respect to OWFs and ship traffic as well as the avoidance distances provided in the current study will serve as a baseline for further studies. A suitable approach for quantifying the overall habitat loss for Loons would involve computing the relative proportion of habitat loss within a certain area (e.g. within the SPA). Dierschke et al. (2006) suggested summing the total OWF areas and adding an additional buffer zone to assess the overall habitat loss. Applying this approach to the current study allowed the minimum habitat loss due to the OWFs in the SPA to be computed, indicating that complete loss of the sea area within a 3 km radius around the OWFs for Loons (as strongly supported by the current study) would equate to a loss of 8.8% of the SPA (overall size 3,135 km^2) for Loons. This should be regarded as an absolute minimum, given that our results clearly showed that the density of Loons was greatly reduced beyond 3 km from the nearest OWF.

Although we are not able to compare absolute density values between the 'before' and 'after' periods, our results indicated that Loons aggregated in the centre of the SPA after OWF installation, representing an increase in Loon density in a much smaller sea area. Given that Loons tend to occur in comparatively small flocks, only occasionally exceeding 5–10 individuals/km^2 (Garthe et al., 2015; O'Brien et al., 2012), this change in distribution might promote density-dependent effects (Blanc et al., 2006; Horswill et al., 2017; Lewis et al., 2001). A possible shift towards suboptimal habitats may lead to suboptimal body conditions prior to breeding, which could in turn reduce the reproductive success and enhance mortality in adult birds (Coulson et al., 1983; Hüppop, 1995). Even a slight increase in the mortality of adult Loons of only 0.3% can have significant negative effects on population levels (Rebke, 2005).

To assess the role of habitat loss on Loons, it is crucial to know if habituation to OWFs will occur or if the habitat loss will be permanent. Although studies from the UK and The Netherlands have indicated slight (though insignificant) increases in Loon abundances after 4–5 years since construction, studies from Denmark have shown no signs of habituation (Petersen and Fox, 2007; Petersen et al., 2008). Similarly, the current study found no habituation 3 years after construction. However, the monitoring of the operating wind farms is still ongoing and thus results on habituation are preliminary. Given that the degree of habituation remains very unclear, we strongly recommend the need for long-term monitoring to assess any potential large-scale effects of cumulative anthropogenic drivers on Loon distribution, particularly within the most relevant sea areas for Loons (e.g. Vanermen et al., 2015a,b).

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The Great Grid Upgrade

Sea Link

Preliminary Environmental Information Report

Volume: 1

Part 2 Suffolk Onshore Scheme

Chapter 3 Ecology and Biodiversity

Version A

October 2023

nationalgrid

	Preliminary assessment
	reptiles or riparian mammals. All of these are vulnerable to killing or injury without appropriate care being taken.
Preliminary likely significance of effect	Not Significant, with mitigation
Sensitivity Test	Changes in the construction years or periods will not affect the significance assessment.
Confidence in prediction	High
Proposed Project with co-location	
Preliminary sensitivity	As for the Proposed Project without co-location
Preliminary magnitude	As for the Proposed Project without co-location
Preliminary likely significance of effect	As for the Proposed Project without co-location
Sensitivity Test	As for the Proposed Project without co-location
Confidence in prediction	As for the Proposed Project without co-location

2.3.10.12 Table 2.3.22 presents the preliminary assessment of hydrological impacts on designated sites during construction or decommissioning.

Table 2.3.22: Preliminary assessment of hydrological impacts on designated sites during construction or decommissioning

	Preliminary assessment
Receptor	RSPB North Warren Reserve and Leiston-Aldeburgh SSSI, both of which partly depend on a high water table
Potential Impact	Hydrological impacts on designated sites
Proposed Project phase	Construction or decommissioning
Duration	In the location east of Leiston Road, sub-surface works could take up to three years.
Mitigation	GG03, GG04, GH07, W05, GH02
Preliminary sensitivity	National importance.
Proposed Project without Co-location	
Preliminary magnitude	If it occurred the magnitude of impact would be at least moderate adverse, but with mitigation the magnitude would be minor adverse to negligible as effects on water levels would not occur. During trenchless techniques or trenching works east of Leiston Road there is the potential for trench and trenchless techniques launch pit dewatering, or the trenchless techniques themselves, to affect water levels within the SSSI and RSPB Reserve.

	Preliminary assessment
Preliminary likely significance of effect	Not Significant
Sensitivity Test	Changes in the construction years or periods will not affect the significance assessment.
Confidence in prediction	Medium
Proposed Project with co-location	
Preliminary sensitivity	As for without co-location
Preliminary magnitude	As for without co-location.
Preliminary likely significance of effect	As for without co-location
Sensitivity Test	As for without co-location
Confidence in prediction	As for without co-location

2.3.10.13 Table 2.3.23 presents the preliminary assessment of disturbance of designated sites during operation.

Table 2.3.23: Preliminary assessment of disturbance of designated sites during operation

	Preliminary assessment
Receptor	Designated sites
Potential Impact	Disturbance of designated sites during operation.
Proposed Project phase	Operation
Duration	Temporary, whenever maintenance visits occur
Mitigation	GG03, GG04, GG06, GG09, GG21 Consider undertaking potentially disturbing (noisy) maintenance activities during August and September, where practicable, reducing risk of disturbance of breeding or non-breeding birds using RSPB North Warren Reserve or breeding nightjar and woodlark using Sandlings SPA.
Preliminary sensitivity	International for Sandlings SPA, national for Leiston-Aldeburgh SSSI, regional for RSPB North Warren Reserve, Great Wood CWS, Grove Wood CWS and Disused Railway Line (Aldringham – Aldeburgh) CWS.
Proposed Project without Co-location	
Preliminary magnitude	Negligible with mitigation in place Internationally important sites

Post-construction Saltmarsh Monitoring
NEMO Link
Pegwell Bay, Kent

Presented to
NEMO Link ltd

November 2018

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Executive summary

Biocensus were commissioned by NEMO Link Ltd to undertake vegetation monitoring at a site near Ramsgate in Kent. The Nemo Link interconnector project is a joint venture between the National Grid in the UK and Elia in Belgium. The project involved the installation of subsea and terrestrial underground cables connecting convertor stations in the UK and Belgium and allowing flow of electricity between the two countries.

In 2011, a total of thirty-nine quadrats were collected in the broad cable landfall zone by TEP Ltd. This data enabled the saltmarsh vegetation to be categorised in terms of eight zones. Replication of vegetation sampling at the quadrat locations as part of the post-construction monitoring programme aims to investigate what changes may have occurred in the intervening period. In order to increase the sampling effort within the construction corridor additional quadrats (eleven) have been introduced.

Site visits were undertaken monthly between June 2018 and October 2018 inclucive. The location of quadrats was established using a sub-metre accuracy Trimble 7x handheld GNSS receiver. On each visit a description of the vegetation within each predetermined 2m x 2m quadrat was made and photographs taken.

The site visits during 2018 found a number of changes attributable to construction of the cable route. These included the obvious physical impacts to saltmarsh within the construction corridor. Not surprisingly, disturbance has led to a flush of annual species exploiting the availability of open ground. This has led to the development of an interesting and diverse assemblage of pioneer and early colonising species within the saltmarsh and nearby terrestrial habitat. Such colonisation has introduced additional opportunities for invertebrates.

An unexpected consequence of the work appears to be more frequent flooding of the saline lagoon which has led to changes in the composition of its marginal vegetation. This is likely to reach an equilibrium as the vegetation melds to the new dynamics. The change to the vegetation is not considered to be particular negative as the lagoon in itself provides a valuable biodiversity resource for birds as well as aquatic plants such as *Ruppia maritima*.

1. Introduction

Biocensus were commissioned by NEMO Link Ltd to undertake vegetation monitoring at a site near Ramsgate in Kent. The site is located at the southern end of Cliffsend within a part of Pegwell Bay (National Grid Reference TR346638) encompassed by a number of statutory site designations including:

- Sandwich and Pegwell Bay National Nature Reserve (NNR)
- Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI);
- Sandwich Bay Special Area of Conservation (SAC);
- Thanet Coast and Sandwich Bay Special Protection Area (SPA);
- Thanet Coast and Sandwich Bay Ramsar Site.

The objective of the surveys was to provide post-construction saltmarsh monitoring data required as part of the NEMO Link project.

2. Background

The Nemo Link interconnector project is a joint venture between the National Grid in the UK and Elia in Belgium. The project involved the installation of subsea and terrestrial underground cables connecting convertor stations in the UK and Belgium and allowing flow of electricity between the two countries.

The project was given consent by:

- Marine Licence L/2013/00373/1 granted under Part 4 of the Marine and Coastal Access Act 2009 to Nemo Link for the installation of offshore subsea electricity cables between Mean High Water Springs ("MHWS") at Pegwell Bay, Kent and the English territorial 12 nautical mile limit; and
- The Town and Country Planning Act 1990 (as amended), reference F/TH/13/0760 (although the requirements for this consent fall outside of the scope of this document).

Condition 5.2.22 of the Marine Licence required post-construction monitoring as follows:

- The licence holder must submit post construction saltmarsh monitoring reports in the agreed format under licence condition 5.2.15, 1,2,3,4 and 5 years following the completion of licensed activities within the intertidal zone unless otherwise agreed with the MMO.
- Reason: To ensure no adverse effect on the integrity of the interest features of the Thanet Coast and Sandwich Bay Special Protection Area and to inform the MMO as to if any further monitoring is required.

Baseline saltmarsh monitoring to inform an Environmental Impact Assessment of the project was undertaken in 2011 by TEP Ltd. The baseline data included collection of vegetation quadrat samples and assignment of these samples to communities described by Rodwell (2000) in the National Vegetation Classification (NVC).

In 2011, a total of thirty-nine quadrats were collected in the broad cable landfall zone by TEP Ltd. This data enabled the saltmarsh vegetation to be categorised in terms of eight zones, refer to Table 1. Replication of vegetation sampling at the quadrat locations as part of the post-construction monitoring programme aims to investigate what changes may have occurred in the intervening period. However, only one of the original quadrat locations fell within the final construction corridor. In order to increase the sampling effort within the construction corridor additional quadrats (eleven) have been introduced.

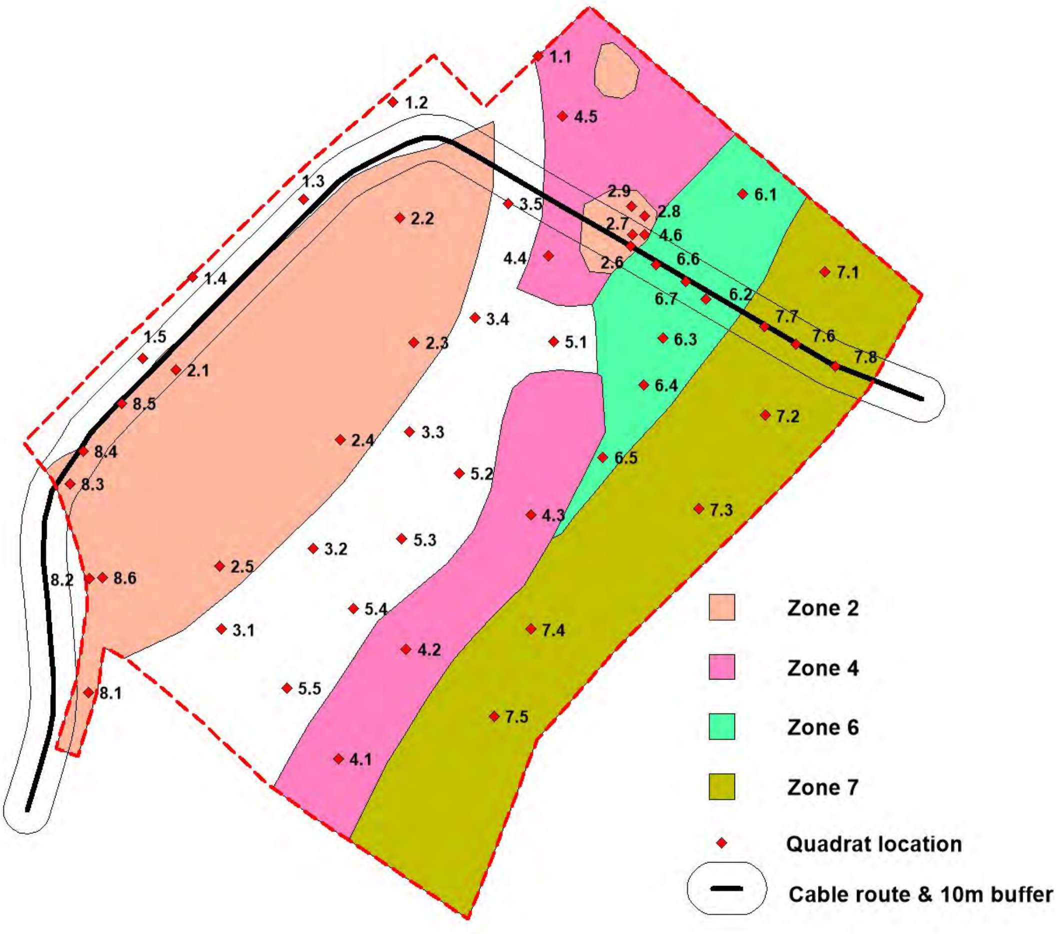
Table 1. Saltmarsh Zonation

Zone	Description	Relevant sample points
Zone 1	Narrow strip between the road and fringes of a dried-out saltpan (Zone 2). Zone 1 supported a dense neutral grassland sward with patches of tall ruderal herbs and sea couch. In terms of NVC, the zone was categorised as an MG1a *Arrhenatherum elatius* grassland (*Festuca rubra* sub-community) / SM24 *Elymus pycnanthus* (*Elytrigia atherica*) saltmarsh mosaic.	1.1, 1.2, 1.3, 1.4, 1.5 (baseline)
Zone 2	Salt-pan (of bare cracked mud at the time of survey) supporting a fringe of common cord-grass (*Spartina anglica*) and sea purslane (*Atriplex portulacoides*). In terms of NVC, vegetation was attributed to the SM6 *Spartina anglica* community interspersed by patches of SM14 *Halimione (Atriplex) portulacoides* saltmarsh.	2.1, 2.2, 2.3, 2.4, 2.5 (baseline) 2.6, 2.7, 2.8, 2.9 (additional)
Zone 3	Sea aster (*Aster tripolium*) and sea purslane dominated fringe at the seaward edge of Zone 2. The vegetation was attributed to the SM12a *Aster tripolium* saltmarsh merging towards SM14 *Halimione portulacoides* saltmarsh.	3.1, 3.2, 3.3, 3.4, 3.5 (baseline)
Zone 4	A species-poor SM24 *Elymus pycnanthus* saltmarsh community (with a richer patch of SM26a *Inula crithmoides* (with *Puccinellia maritima, Salicornia* agg and *Limonium vulgare* at 4.1).	4.1, 4.2, 4.3, 4.4, 4.5 (baseline) 4.6 (additional)
Zone 5	A sea purslane dominated community attributed to SM14a *Halimione portulacoides* saltmarsh interspersed by patches of SM26b *Inula crithmoides* saltmarsh (*Elymus pycnanthus* sub-community).	5.1, 5.2, 5.3, 5.4, 5.5 (baseline)
Zone 6	Vegetation attributed to SM13a *Puccinellia maritima*	6.1, 6.2, 6.3, 6.4, 6.5 (baseline)

	saltmarsh with patches of SM14c *Halimione portulacoides* (*Puccinellia maritima* sub-community).	6.6, 6.7 (additional)
Zone 7	Leading seaward edge of the saltmarsh area comprising a broad but fragmented fringe of common cord-grass and glasswort (*Salicornia* spp) and intertidal mud. The vegetation was attributed to a mosaic of SM6 *Spartina anglica* and SM8 *Annual Salicornia* saltmarsh.	7.1, 7.2, 7.3, 7.4, 7.5 (baseline) 7.6, 7.7, 7.8 (additional)
Zone 8	A narrow strip of vegetation bordering the north-western fringe of the saltpan. The quadrats sampled included S21 *Scirpus (Bolboschoenus) maritimus* swamp (8.1 & 8.2), a patch of SM16b *Festuca rubra-Juncus gerardii* saltmarsh (*Juncus gerardii* sub-community) (8.3) as well as SM24 *Elymus pycnanthus* saltmarsh (8.4 & 8.5).	8.1, 8.2, 8.3, 8.4, 8.5 (baseline) 8.6 (additional)

* Note: *Elymus pycnanthus* has been renamed as *Elytrigia atherica; Halimione portulacoides* is now *Atriplex portulacoides;* and *Scirpus maritimus* is now *Bolboschoenus maritimus*.

Figure 1: Saltmarsh Zonation and Quadrat Locations



3. Methodology

3.1. Site Survey

Site visits were undertaken monthly between June 2018 and October 2018 inclusive.

The location of quadrats was established using a sub-metre accuracy Trimble 7x handheld GNSS receiver. On each visit a description of the vegetation within each predetermined 2m x 2m quadrat was made and photographs taken. The description included noting the presence and relative abundance of each plant species within the quadrat. Additional notes were made of factors including cover, vegetation height, tidal debris and presence / depth of open water. The data collected conformed with that required to undertake NVC analysis (Rodwell, 2000). However, percentage cover was taken rather than cover being assigned a DOMIN value. The DOMIN scale assigns a number (between one and ten) to percentage cover ranges (e.g. a DOMIN value of 10 = 91-100% cover). The rationale for this was that percentage cover was considered more likely to record minor changes in cover that might otherwise be lost by the rounding effect of DOMIN (given the frequency of visits). In addition, the package used for statistical analysis was able to use percentage cover but not DOMIN values. Appendix 1 presents the quadrat data.

Images were also taken at each quadrat location using a digital camera. A photograph was taken of the vegetation within each quadrat as well as four others to help provide a visual representation of setting. The photographs were all taken facing the sea and the additional images captured views towards the sea and land as well as up and down the coastline. Appendix 2 provides a record of the photographs taken during each visit.

Printouts of aerial imagery were taken to site during the final site visits and notes were taken on the zonation of NVC saltmarsh communities within the study area. These notes were used to update saltmarsh zonation mapping.

Post-collection statistical analysis of quadrat data was undertaken using the Modular Analysis of Vegetation Information System (MAVIS) of the Centre for Ecology and Hydrology (CEH).

Table 2: Survey dates and weather conditions

Date	Weather conditions
25-26 June 2018	25-30°C, clear and sunny with a light breeze.
17 July 2018	24-28 °C, sunny with high level cloud and light breeze.
21 August 2018	24-26 °C, warm and partly cloudy with a light breeze.
27 September 2018	22-24 °C, clear and sunny with a light breeze.
10 October 2018	16-18 °C, clear and sunny with a light breeze.

3.2. Surveyor

The author of this report was Matthew Pickard (BSc., MSc.), an ecologist with over 15 year's environmental consultancy experience, a Chartered Environmentalist (CEnv), full member of the

Chartered Institute of Ecology and Environmental Management (CIEEM). The surveys were undertaken by two competent ecologists: Matthew Pickard; and Barry Stewart. Barry is currently the West Glamorgan vice-county recorder for both bryophytes and vascular plants.

3.3. Survey Limitations

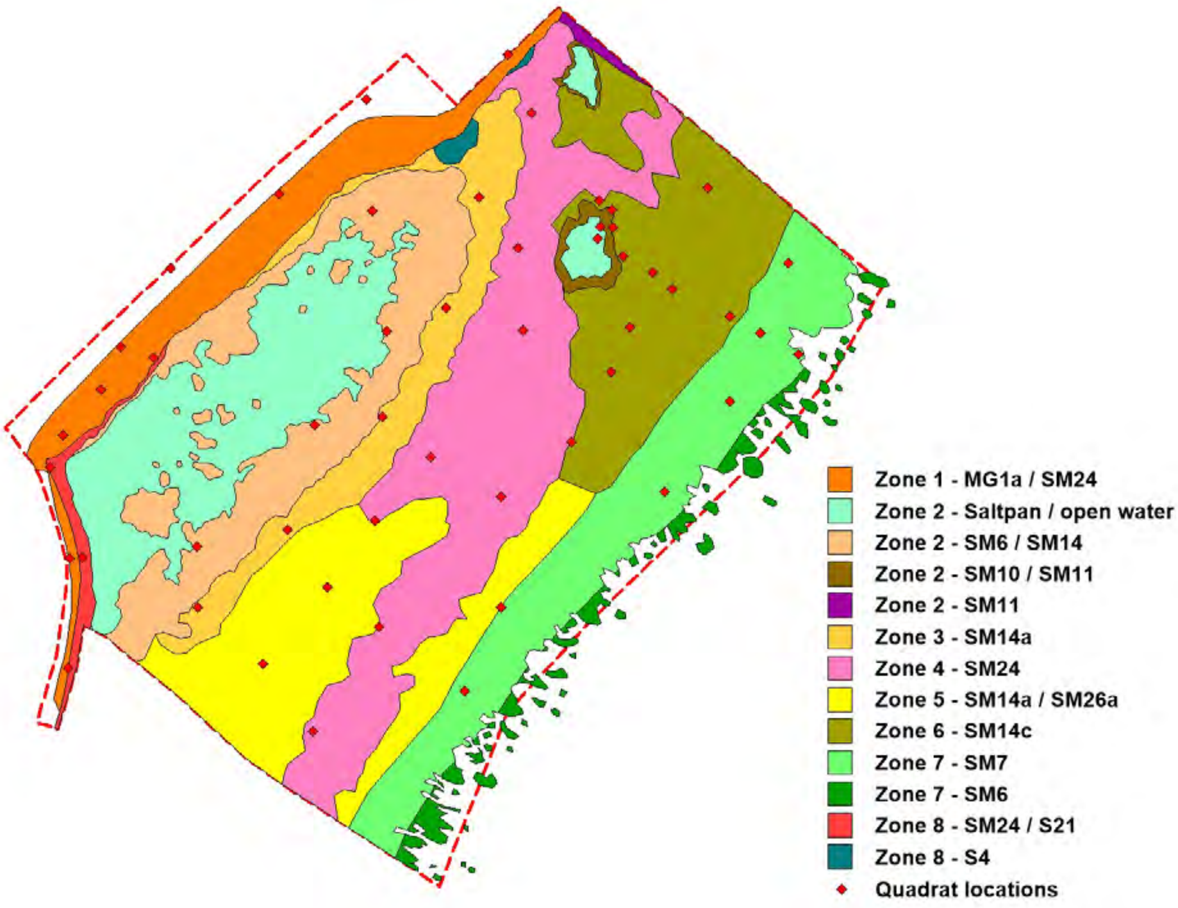
Extremely hot and dry weather early in the year led to plants growing in drier parts of the site (particularly ground at the landward fringes of the saltmarsh) to dry up and die-off. However, many of the annual species re-flowered during the final survey visits. Overall, timing was not considered to pose a constraint to assessment of the site.

4. Results

4.1. Overview

Site visits in 2018 suggested the saltmarsh zonation provided in 2011 was simplified making visual comparison difficult with the updated survey results. In order to remedy this, internet sourced aerial imagery in conjunction with field data were used to create an updated pre-construction map.

Figure 2: Pre-construction NVC communities (2011)



NVC communities: MG1a *Arrhenatherum elatius* grassland (*Festuca rubra* sub-community); SM24 *Elytrigia atherica* saltmarsh; SM6 Spartina anglica saltmarsh; SM14 *Atriplex portulacoides* saltmarsh (SM14a *Atriplex portulacoides* dominant / SM14c *Puccinellia maritima* sub-community); SM10 Transitional low-marsh with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*; SM11 *Aster tripolium var. discoideus* saltmarsh; SM26a *Inula crithmoides* on salt marshes with *Puccinellia maritima, Salicornia* agg and *Limonium vulgare*; SM7 *Sarcocornia perennis* stands; S21 *Bolboschoenus maritimus* swamp; and S4 *Phragmites australis* swamp.

4.2. Analysis of quadrat results

A full account of the quadrat data for each month is presented in Appendix 1.

Quadrats were analysed using MAVIS version 1.03 (CEH, 2014). A combined species list was generated for each quadrat using the October 2018 results complimented by any additional species noted during the preceding months (June to September surveys). The additional species were noted as *present* for the purpose of analysis. The combined list for each quadrat was analysed by MAVIS and the five highest statistical NVC community fits are listed in Table 3 below:

Table 3: Analysis of zone 1 quadrat data

Zone	Quadrat	NVC	% fit	Description
1	1.1	S26a	31.75%	*Phragmites australis-Urtica dioica* fen
		S26b	30.73%	*Phragmites australis-Urtica dioica* fen
		S26	29.33%	*Phragmites australis-Urtica dioica* fen
		S4	**28.30%**	***Phragmites australis* swamp**
		S26d	27.36%	*Phragmites australis-Urtica dioica* fen
	1.2	**OV19c**	**47.43%**	***Poa annua-Tripleurospermum inodorum* community**
		OV19	39.97%	*Poa annua-Tripleurospermum inodorum* community
		OV19b	37.41%	*Poa annua-Tripleurospermum inodorum* community
		OV19d	36.14%	*Poa annua-Tripleurospermum inodorum* community
		OV10c	36.01%	*Poa annua-Senecio vulgaris* community
	1.3	**OV19c**	**21.78%**	***Poa annua-Tripleurospermum inodorum* community**
		SM28	18.7%	*Elymus repens* saltmarsh
		OV9	18.65%	*Tripleurospermum inodorum -Stellaria media* community
		OV9d	17.84%	*Tripleurospermum inodorum -Stellaria media* community
		OV19	17.8%	*Poa annua- Tripleurospermum inodorum* community
	1.4	**MG1a**	**24.48%**	***Arrhenatherum elatius* grassland**
		OV23d	24.11%	*Lolium perenne-Dactylis glomerata* community
		SD9a	22.57%	*Ammophila arenaria-Arrhenatherum elatius* dune grassland
		MG1	21.6%	*Arrhenatherum elatius* grassland
		MG1e	21.47%	*Arrhenatherum elatius* grassland
	1.5	SD7e	16.72%	*Ammophila arenaria-Festuca rubra* semi-fixed dune grassland
		MC11a	15.95%	*Festuca rubra-Daucus carota* maritime grassland
		OV23	15.65%	*Lolium perenne-Dactylis glomerata* community
		MC4a	15.59%	*Brassica oleracea* maritime cliff-ledge community
		OV23d	14.62%	*Lolium perenne-Dactylis glomerata* community
	All quadrat locations with the exception of 1.1 & 1.4 were located on disturbed ground associated with the construction corridor. None of the disturbed ground communities fit			

	particularly well with the NVC. This is not unexpected given the location of quadrats 1.2, 1.3 & 1.5 at a transitional point between saltmarsh and disturbed terrestrial habitat. Quadrat 1.1 is located between a sea couch dominated bank (SM24) and stand of common reed (S4) at the edge of the saltmarsh. Quadrat 1.2 is a transitional habitat on disturbed ground. Quadrat 1.3 is a transitional habitat with a substrate probably mixed with saline intertidal muds given that halophytes including *Atriplex littoralis* and *Salicornia ramosissima* were recorded from it. Quadrat 1.4 is a roadside verge probably best described as MG1 grassland with maritime influence. Quadrat 1.5 is a transitional disturbed ground habitat.

Table 4: Analysis of zone 2 quadrat data (2.1-2.5)

Zone	Quadrat	NVC	% fit	Description
2	2.1	**SM14a**	**47.97%**	***Atriplex portulacoides* dominated saltmarsh**
		S7	47.69%	*Sarcocornia perennis* saltmarsh
		S14	46.95%	*Atriplex portulacoides* saltmarsh
		SM11	46.51%	*Aster tripolium* saltmarsh
		SM10	43.41%	Transitional low-marsh with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*
	2.2	**SM2**		***Ruppia maritima saltmarsh community***
		A21	15.09%	*Ranunculus baudotii* community
		S21a	12.42%	*Bolboschoenus maritimus* swamp
		A12	12.42%	*Potamogeton pectinatus* community
		S20a	11.98%	*Schoenoplectus tabernaemontani* swamp
		S20	10.36%	*Schoenoplectus tabernaemontani* swamp
	2.3	**SM2**		***Ruppia maritima* saltmarsh**
		A21	21.78%	*Ranunculus baudotii* community
		S21a	18.7%	*Bolboschoenus maritimus* swamp
		A12	18.65%	*Potamogeton pectinatus* community
		S20a	17.84%	*Schoenoplectus tabernaemontani* swamp
		S20	17.8%	*Schoenoplectus tabernaemontani* swamp
	2.4	**SM2**		***Ruppia maritima* saltmarsh**
		A21	24.48%	*Ranunculus baudotii* community
		S21a	24.11%	*Bolboschoenus maritimus* swamp
		A12	22.57%	*Potamogeton pectinatus* community
		S20a	21.6%	*Schoenoplectus tabernaemontani* swamp
		S20	21.47%	*Schoenoplectus tabernaemontani* swamp
	2.5	**SM2**		***Ruppia maritima* saltmarsh**
		A21	16.72%	*Ranunculus baudotii* community
		S21a	15.95%	*Bolboschoenus maritimus* swamp
		A12	15.65%	*Potamogeton pectinatus* community
		S20a	15.59%	*Schoenoplectus tabernaemontani* swamp
		S20	14.62%	*Schoenoplectus tabernaemontani* swamp
	In 2011 the vegetation of Zone 2 was associated with the saltpan / saline lagoon fringe and attributed to the SM6 *Spartina anglica* community interspersed by patches of SM14 *Atriplex portulacoides* saltmarsh. Quadrat 2.1 is still located at the edge of the saline lagoon whilst quadrats 2.2 to 2.5 now sit within a flooded part of the saline lagoon. The only vegetation associated with the lagoon apart from algae was beaked tasselweed (*Ruppia maritima*). This habitat appears to have the			

	closest affinity to the *SM2 Ruppia maritima* saltmarsh although MAVIS failed to classify it as such.

Table 5: Analysis of zone 2 quadrat data (2.6-2.9)

Zone	Quadrat	NVC	% fit	Description
2	2.6	**SM10**	**41.15%**	**Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda***
		SM14a	36.55%	*Atriplex portulacoides* dominated saltmarsh
		S14	33.97%	*Atriplex portulacoides* saltmarsh
		S11	32.32%	*Aster tripolium* saltmarsh
		SM7	31.97%	*Sarcocornia perennis* saltmarsh
	2.7	**SM10**	**48.51%**	**Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda***
		SM11	47.71%	*Aster tripolium* saltmarsh
		SM13f	39.69%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM7	39.15%	*Sarcocornia perennis* saltmarsh
		SM9	36.66%	*Suaeda maritima* saltmarsh
	2.8	**SM14a**	**50.82%**	***Atriplex portulacoides* dominated saltmarsh**
		SM7	49.86%	*Sarcocornia perennis* saltmarsh
		SM11	48.93%	*Aster tripolium* saltmarsh
		SM14	46.95%	*Atriplex portulacoides* saltmarsh
		SM10	45.87%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
	2.9	**SM14**	**24.48%**	***Atriplex portulacoides* saltmarsh**
		SM14c	24.11%	*Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
		SM14a	22.57%	*Atriplex portulacoides* dominated saltmarsh
		SM13f	21.6%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM7	21.47%	*Sarcocornia perennis* saltmarsh
	In 2011 the vegetation of Zone 2 (in the vicinity of quadrats 2.6-2.9) was associated with a minor saltpan and attributed to the SM6 *Spartina anglica* community interspersed by patches of SM14 *Atriplex portulacoides* saltmarsh. The quadrats are now associated with the construction corridor or edge of it. Quadrats 2.6 is in the early stages of colonisation and appears closest to SM8 annual Salicornia salt-marsh but statistically fits the transitional low-marsh community SM10 *Puccinellia maritima*, *Salicornia* & *Suaeda maritima.* This anomaly is probably the result of the mechanical disturbance during construction (creating minor topographical differences and seed bank mixing ultimately boosting the number of species present). The community is located in proximity to established saltmarsh best described as SM14c *Atriplex portulacoides* saltmarsh (*Puccinellia maritima* sub-community).			

Table 6: Analysis of zone 3 quadrat data

Zone	Quadrat	NVC	% fit	Description
3	3.1	**SM14a**	**35.09%**	***Atriplex portulacoides* dominated saltmarsh**
		SM11	31.46%	*Aster tripolium* saltmarsh
		SM7	31.19%	*Sarcocornia perennis* saltmarsh
		SM14	27.91%	*Atriplex portulacoides* saltmarsh
		SM14c	27.61%	*Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
	3.2	**SM14a**	**45.92%**	***Atriplex portulacoides* dominated saltmarsh**
		SM7	42.63%	*Sarcocornia perennis* saltmarsh

		SM9 SM11 SM14	40.82% 40.40% 37.50%	*Suaeda maritima* saltmarsh *Aster tripolium* saltmarsh *Atriplex portulacoides* saltmarsh
	3.3	**SM14a** SM11 SM7 SM14 SM14c	**51.02%** 48.48% 46.18% 45.83% 43.09%	***Atriplex portulacoides* dominated saltmarsh** *Aster tripolium* saltmarsh *Sarcocornia perennis* saltmarsh *Atriplex portulacoides* saltmarsh *Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
	3.4	**SM14a** SM7 SM11 SM14 SM10	**58.82%** 55.46% 55.05% 52.83% 51.38%	***Atriplex portulacoides* dominated saltmarsh** *Sarcocornia perennis* saltmarsh *Aster tripolium* saltmarsh *Atriplex portulacoides* saltmarsh Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
	3.5	**SM11** SM7 SM13f SM10 SM14c	**57.14%** 48.27% 48.23% 47.06% 45.66%	***Aster tripolium* saltmarsh** *Sarcocornia perennis* saltmarsh *Puccinellia maritima* saltmarsh (*Spartina* sub-community) Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda* *Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
	In 2011, Zone 3 was described as *Aster tripolium* and *Atriplex portulacoides* dominated vegetation attributable to SM12a *Aster tripolium* saltmarsh merging towards SM14 *Halimione portulacoides* saltmarsh. Survey in 2018 found that quadrats 3.1 to 3.5 were located within a zone dominated by *Atriplex portulacoides* (SM14a) with patches of transitional vegetation often supporting *Aster tripolium*. However, although the rayed variety was found to be present, the rayless form of sea aster (*Aster tripolium var discoideus*) was considered to be dominant in 3.5 (SM11).			

Table 7: Analysis of zone 4 quadrat data

Zone	Quadrat	NVC	% fit	Description
4	4.1	**SM24** SM26b SM11 SM25a SM25	**43.01%** 33.20% 28.99% 25.97% 23.19%	*Elytrigia atherica* saltmarsh *Inula crithmoides* salt marsh with *Elytrigia atherica* *Aster tripolium* saltmarsh *Suaeda vera* driftline community (*E.atherica* sub-community) *Suaeda vera* driftline community
	4.2	SM26b **SM24** SM25 SM25a SM14a	66.39% **59.63%** 52.17% 51.95% 42.92%	*Inula crithmoides* salt marsh with *Elytrigia atherica* *Elytrigia atherica* saltmarsh *Suaeda vera* driftline community *Suaeda vera* driftline community (*E.atherica* sub-community) *Atriplex portulacoides* dominated saltmarsh
	4.3	SM26b **SM24** SM25a SM25 SM14a	54.98% **54.71%** 45.98% 45.57% 41.10%	*Inula crithmoides* salt marsh with *Elytrigia atherica* *Elytrigia atherica* saltmarsh *Suaeda vera* driftline community (*E.atherica* sub-community) *Suaeda vera* driftline community *Atriplex portulacoides* dominated saltmarsh
	4.4	**SM24** SM26b SM11 SM25a	**43.01%** 33.20% 28.99% 25.97%	*Elytrigia atherica* saltmarsh *Inula crithmoides* salt marsh with *Elytrigia atherica* *Aster tripolium* saltmarsh *Suaeda vera* driftline community (*E.atherica* sub-community)

		SM25	23.19%	*Suaeda vera* driftline community
	4.5	**SM24**	**43.01%**	*Elytrigia atherica* saltmarsh
		SM26b	33.20%	*Inula crithmoides* salt marsh with *Elytrigia atherica*
		SM11	28.99%	*Aster tripolium* saltmarsh
		SM25a	25.97%	*Suaeda vera* driftline community (*E.atherica* sub-community)
		SM25	23.19%	*Suaeda vera* driftline community
	4.6	**SM11**	**55.05%**	*Aster tripolium* saltmarsh
		SM10	48.51%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM13f	42.75%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM8	38.96%	Annual *Salicornia* saltmarsh
		SM12	35.95%	*Aster tripolium (rayed)* saltmarsh
	In 2011, Zone 4 was described as a species-poor SM24 *Elytrigia atherica* saltmarsh community (with richer patches of SM26 *Inula crithmoides*). Survey in 2018 found quadrats 4.1 to 4.5 located in species-poor SM24. Quadrat 4.6 was located in the construction corridor and supported vegetation dominated by Salicornia species. Quadrat 4.6 appeared to have the closest affinity to SM8 Annual *Salicornia* saltmarsh but statistically (probably due to its origins as a mechanically disturbed marsh) was considered closest to SM11 *Aster tripolium* saltmarsh.			

Table 8: Analysis of zone 5 quadrat data

Zone	Quadrat	NVC	% fit	Description
5	5.1	SM26b	54.98%	*Inula crithmoides* salt marsh with *Elytrigia atherica*
		SM24	**54.71%**	***Elytrigia atherica* saltmarsh**
		SM25a	45.98%	*Suaeda vera* driftline community (*E.atherica* sub-community)
		SM25	45.57%	*Suaeda vera* driftline community
		SM14a	41.10%	*Atriplex portulacoides* dominated saltmarsh
	5.2	SM26b	66.39%	*Inula crithmoides* salt marsh with *Elytrigia atherica*
		SM24	**59.26%**	***Elytrigia atherica* saltmarsh**
		SM25	52.17%	*Suaeda vera* driftline community
		SM25a	51.95%	*Suaeda vera* driftline community (*E.atherica* sub-community)
		SM14a	42.92%	*Atriplex portulacoides* dominated saltmarsh
	5.3	**SM26b**	**54.98%**	***Inula crithmoides* salt marsh with *Elytrigia atherica***
		SM24	54.71%	*Elytrigia atherica* saltmarsh
		SM25a	45.98%	*Suaeda vera* driftline community (*E.atherica* sub-community)
		SM25	45.57%	*Suaeda vera* driftline community
		SM14a	41.10%	*Atriplex portulacoides* dominated saltmarsh
	5.4	**SM14a**	**52.63%**	***Atriplex portulacoides* dominated saltmarsh**
		SM7	46.78%	*Sarcocornia perennis* saltmarsh
		SM9	46.04%	*Suaeda maritima* saltmarsh
		SM11	44.94%	*Aster tripolium* saltmarsh
		SM14	41.86%	*Atriplex portulacoides* saltmarsh
	5.5	**SM26b**	**54.98%**	***Inula crithmoides* salt marsh with *Elytrigia atherica***
		SM24	54.71%	*Elytrigia atherica* saltmarsh
		SM25a	45.98%	*Suaeda vera* driftline community (*E.atherica* sub-community)
		SM25	45.57%	*Suaeda vera* driftline community
		SM14a	41.10%	*Atriplex portulacoides* dominated saltmarsh
	In 2011, Zone 5 was described a sea purslane dominated community attributed to SM14a			

	Atriplex portulacoides saltmarsh interspersed by patches of SM26b *Inula crithmoides* saltmarsh (*Elytrigia atherica* sub-community). Survey in 2018 found zone 5 to be a mosaic of *Elytrigia atherica* and *Atriplex portulacoides* with occasional *Inula crithmoides*. Quadrats 5.1 and 5.2 were located in relatively species-poor vegetation dominated by *Elytrigia atherica* and *Atriplex portulacoides* most closely resembling SM24. Quadrat 5.3 and 5.5 were located in an SM14a / SM26b mosaic and quadrat 5.4 in a small saltpan visually closest to SM10.

Table 9: Analysis of zone 6 quadrat data

Zone	Quadrat	NVC	% fit	Description
6	6.1	**SM11**	**64.22%**	***Aster tripolium* saltmarsh**
		SM10	63.35%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM13f	62.83%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM14c	61.45%	*Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
		SM14	59.47%	*Atriplex portulacoides* saltmarsh
	6.2	**SM10**	**45.87%**	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM8	45.33%	Annual *Salicornia* saltmarsh
		SM11	44.94%	*Aster tripolium* saltmarsh
		SM13f	36.04%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM14	33.25%	*Atriplex portulacoides* saltmarsh
	6.3	SM11	69.54%	***Aster tripolium* saltmarsh**
		SM10	**66.23%**	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM7	62.50%	*Sarcocornia perennis* saltmarsh
		SM13f	61.62%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM14a	58.82%	*Atriplex portulacoides* dominated saltmarsh
	6.4	**SM14a**	**51.02%**	***Atriplex portulacoides* dominated saltmarsh**
		SM11	48.48%	*Aster tripolium* saltmarsh
		SM7	46.18%	*Sarcocornia perennis* saltmarsh
		SM14	45.83%	*Atriplex portulacoides* saltmarsh
		SM14c	43.09%	*Atriplex portulacoides* saltmarsh (*Puccinellia* sub-community)
	6.5	**SM14a**	**50.82%**	***Atriplex portulacoides* dominated saltmarsh**
		SM7	49.86%	*Sarcocornia perennis* saltmarsh
		SM14	49.38%	*Atriplex portulacoides* saltmarsh
		SM11	48.93%	*Aster tripolium* saltmarsh
		SM10	45.87%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
	6.6	**SM14a**	**28.27%**	***Atriplex portulacoides* dominated saltmarsh**
		SM14	26.95%	*Atriplex portulacoides* saltmarsh
		SM10	25.91%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM11	25.32%	*Aster tripolium* saltmarsh
		SM13	23.09%	*Puccinellia maritima* saltmarsh
	6.7	**SM10**	**41.15%**	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM11	40.40%	*Aster tripolium* saltmarsh
		SM8	39.70%	Annual *Salicornia* saltmarsh
		SM13f	33.06%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM26a	30.63%	*Inula crithmoides* on salt marshes with *Puccinellia maritima*
	In 2011, Zone 6 was described as SM13a *Puccinellia maritima* saltmarsh with patches of SM14c *Atriplex portulacoides* (*Puccinellia maritima* sub-community).			

	Survey in 2018 found that quadrats 6.1, 6.3, 6.4 and 6.5 were located within an *Atriplex portulacoides* zone probably best described as SM14c although statistically they appear closer to SM14a. Quadrats 6.2, 6.6 and 6.7 fall within the construction corridor and are probably best assigned to SM8 (in transition to SM10 / SM11).

Table 10: Analysis of zone 7 quadrat data

Zone	Quadrat	NVC	% fit	Description
7	7.1	**SM7**	**45.02%**	***Sarcocornia perennis* saltmarsh**
		SM11	42.63%	*Aster tripolium* saltmarsh
		SM13f	36.14%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM12	35.95%	*Aster tripolium* (rayed*)* saltmarsh
		SM10	33.03%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
	7.2	**SM7**	**38.99%**	***Sarcocornia perennis* saltmarsh**
		SM14a	29.24%	*Atriplex portulacoides* dominated saltmarsh
		SM14	27.91%	*Atriplex portulacoides* saltmarsh
		SM11	26.43%	*Aster tripolium* saltmarsh
		SM13f	25.23%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
	7.3	**SM7**	**21.60%**	***Sarcocornia perennis* saltmarsh**
		SM26	7.94%	*Inula crithmoides* on salt marshes
		SM13f	7.92%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM26a	7.23%	*Inula crithmoides* on salt marshes with *Puccinellia maritima*
		SM25b	6.87%	*Suaeda vera* driftline (*A.portulacoides* sub-community)
	7.4	**SM7**	**61.09%**	***Sarcocornia perennis* saltmarsh**
		SM14a	52.17%	*Atriplex portulacoides* dominated saltmarsh
		SM11	49.73%	*Aster tripolium* saltmarsh
		SM14	47.45%	*Atriplex portulacoides* saltmarsh
		SM13f	45.18%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
	7.5	**SM7**	**24.21%**	***Sarcocornia perennis* saltmarsh**
		SM26	8.81%	*Inula crithmoides* on salt marshes
		SM13f	8.79%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM14a	8.26%	*Atriplex portulacoides* dominated saltmarsh
		SM26a	7.95%	*Inula crithmoides* on salt marshes with *Puccinellia maritima*
	7.6	**SM8**	**39.53%**	**Annual *Salicornia* saltmarsh**
		SM10	29.76%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM11	28.99%	*Aster tripolium* saltmarsh
		SM9	27.49%	*Suaeda maritima* saltmarsh
		SM6	22.30%	*Spartina anglica* saltmarsh
	7.7	**SM10**	**45.87%**	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
		SM8	45.33%	Annual *Salicornia* saltmarsh
		SM11	44.94%	*Aster tripolium* saltmarsh
		SM13f	36.04%	*Puccinellia maritima* saltmarsh (*Spartina* sub-community)
		SM14	33.25%	*Atriplex portulacoides* saltmarsh
	7.8	**SM6**	**-**	*Spartina anglica* saltmarsh
	In 2011, Zone 7 was described as the seaward edge of the saltmarsh area with a fringe of common cord-grass, glasswort (*Salicornia* spp) and intertidal mud. The vegetation was attributed to a mosaic of SM6 *Spartina anglica* and SM8 *Annual Salicornia* saltmarsh.			

	Survey in 2018 found a zone with ridges largely dominated by perennial glasswort (*Sarcocornia perennis*) and troughs dominated by *Spartina anglica*. This indicates the baseline data was incorrect and the zone should be described as SM7 *Sarcocornia perennis* saltmarsh with SM6 *Spartina anglica* saltmarsh (particularly at the extreme seaward edge). Quadrats 7.1 to 7.5 sample the SM7 community whilst quadrats 7.6 to 7.8 fall with the construction corridor. The most seaward quadrat (7.8) comprised bare mud with a few shoots of *Spartina anglica* (SM6), quadrat 7.6 and 7.7 were dominated by annual *Salicornia* species (SM8 in transition to SM10 / SM11).

Table 11: Analysis of zone 8 quadrat data

Zone	Quadrat	NVC	% fit	Description
8	8.1	**S21a**	**51.85%**	***Bolboschoenus maritimus* dominated swamp**
		S21	40.35%	*Bolboschoenus maritimus* swamp
		S21b	39.77%	*Bolboschoenus maritimus* (*Atriplex prostrata* sub-community)
		SM24	36.47%	*Elytrigia atherica* saltmarsh
		SM21c	29.85%	*Bolboschoenus maritimus* (*Agrostis stolonifera* sub-comm.)
	8.2	SD7e	23.32%	*Ammophila arenaria-Festuca rubra* semi-fixed dune
		MG1a	20.36%	*Arrhenatherum elatius* grassland
		MG9b	20.16%	*Holcus lanatus-Deschampsia flexuosa* grassland
		SD7	19.47%	*Ammophila arenaria-Festuca rubra* semi-fixed dune
		SD7a	19.41%	*Ammophila arenaria-Festuca rubra* semi-fixed dune
	8.3	MC6	**28.99%**	*Atriplex prostrata-Beta vulgaris* cliff community
		S21b	28.54%	*Bolboschoenus maritimus* (*Atriplex prostrata* sub-community)
		S21c	27.24%	*Bolboschoenus maritimus* (*Agrostis stolonifera* sub.)
		SM24	27.03%	*Elytrigia atherica* saltmarsh
		S21	26.23%	*Bolboschoenus maritimus* swamp
	8.4	**OV23c**	**28.53%**	***Lolium perenne-Dactylis glomerata* (*P.major/T.repens* sub.)**
		OV23	27.76%	*Lolium perenne-Dactylis glomerata* community
		MC11a	27.66%	*Festuca rubra-Daucus carota* (*Bromus hordeaceus* sub.)
		MC11b	25.41%	*Festuca rubra-Daucus carota* (*Ononis repens* sub.)
		MC11	25.09%	*Festuca rubra-Daucus carota* maritime grassland
	8.5	**OV23c**	**22.23%**	***Lolium perenne-Dactylis glomerata* (*P.major/T.repens* sub.)**
		OV23	22.01%	*Lolium perenne-Dactylis glomerata* community
		OV23d	21.52%	*Lolium perenne-Dactylis glomerata* (*A.elatius/M.lupulina* sub)
		OV19	19.79%	*Poa annua-Tripleurospermum inodorum* community
		OV10d	19.01%	*Poa annua-Senecio vulgaris* (*D.glomerata/A.capillaris* sub.)
	8.6	**S21/**	-	***B.maritimus swamp /***
		SM24	-	***E.atherica saltmarsh***
		SM14a	47.97%	*Atriplex portulacoides* dominated saltmarsh
		SM7	47.69%	*Sarcocornia perennis* saltmarsh
		SM14	46.95%	*Atriplex portulacoides* saltmarsh
		SM11	46.51%	*Aster tripolium* saltmarsh
		SM10	43.41%	Transitional marsh with *P.maritima*, *Salicornia* & *Suaeda*
	In 2011, Zone 8 was described as a narrow strip of vegetation bordering the north-western fringe of the saltpan. The quadrats sampled included S21 *Bolboscoenus maritimus* swamp (8.1 & 8.2), a patch of SM16b *Festuca rubra-Juncus gerardii* saltmarsh (*Juncus gerardii* sub-community) (8.3) as well as SM24 *Elymus pycnanthus* saltmarsh (8.4 & 8.5).			

	Survey in 2018 found quadrat 8.1 in a band of *Bolboschoenus maritimus* (S21). Quadrat 8.2 was located on a bank reinforced with concrete and did not easily fit into an NVC community. Given that this quadrat was previously described as S21 an additional quadrat was taken at the base of the slope bordering the saline lagoon. The quadrat was found to be split between a band of SM24 *Elytrigia atherica* and S21 *Bolboschoenus maritimus.* Plants of *Spartina anglica, Atriplex portulacoides* and *Puccinellia maritima* at the edge of the lagoon further confused statistical analysis of the quadrat. Quadrat 8.3 encompassed a band of S21, then *Juncus gerardii* dominated vegetation before bare ground associated with the construction corridor (probably best described by S21 then SM16b before an area of disturbed ground). Quadrats 8.4 and 8.5 currently support a transitional habitat associated with bare ground.

Figure 2: Post-construction NVC communities (2018)

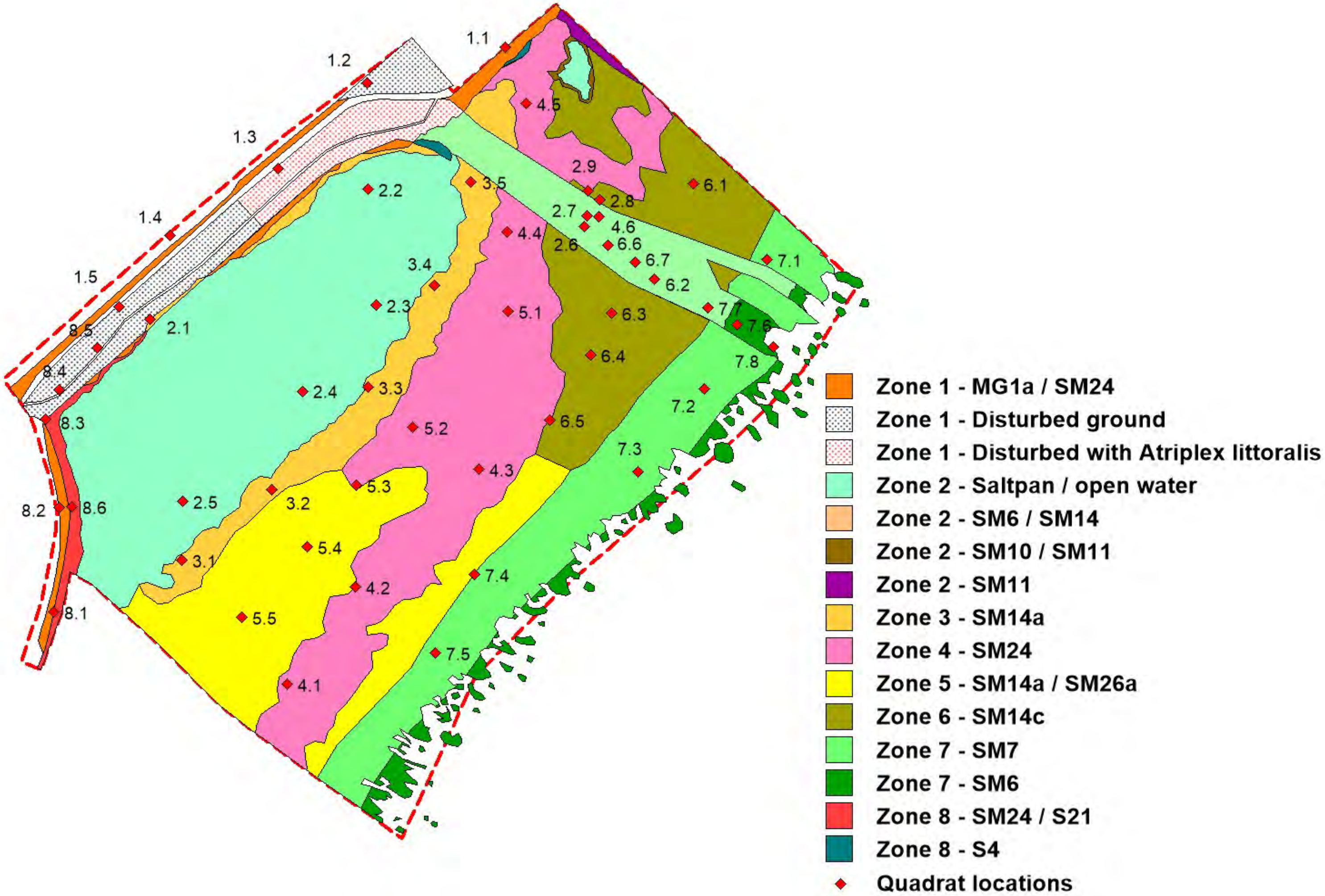
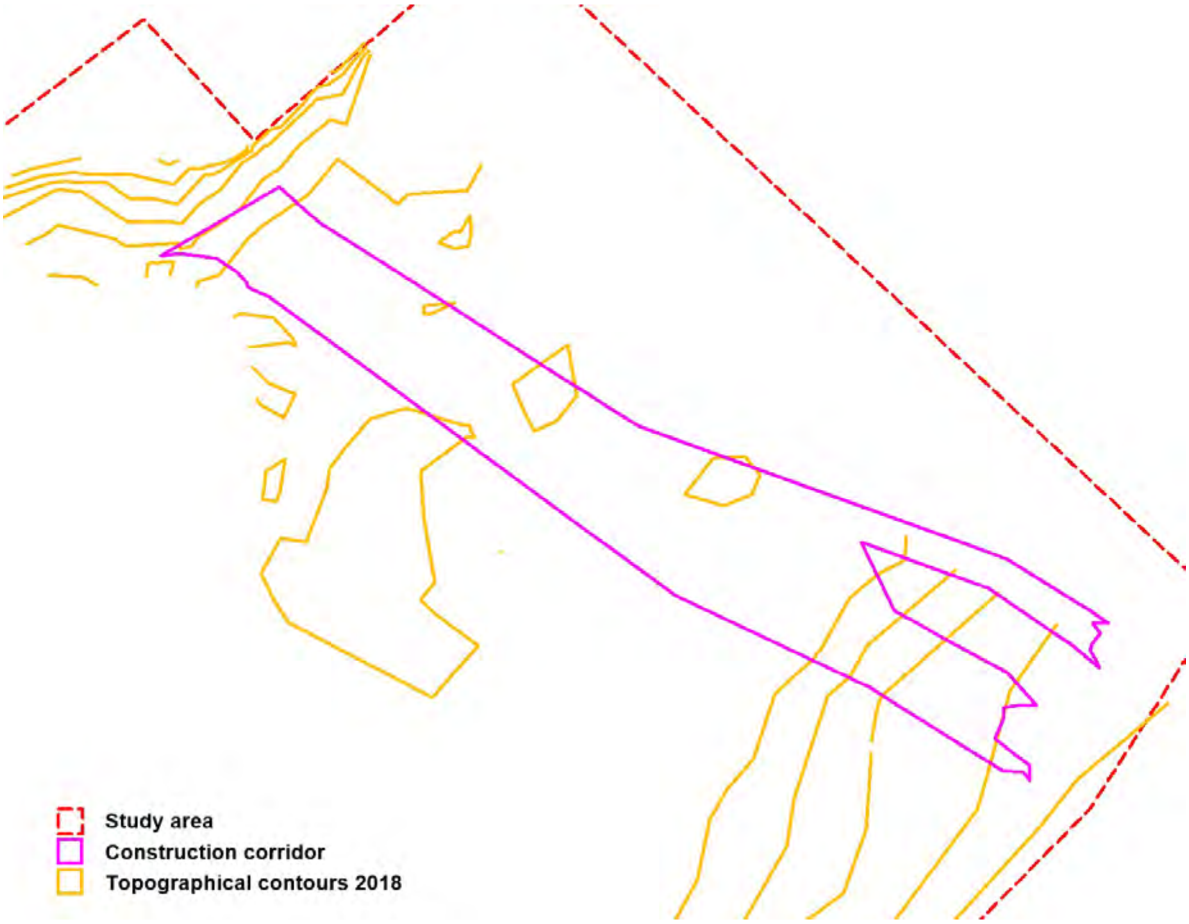


Figure 3: Post-construction topographical survey (2018)



5. Assessment

5.1. Habitats

Obvious construction related changes have occurred since the 2011 baseline survey. The most direct change is the presence of a diverse annual plant community now associated with the construction corridor. The corridor created large areas of bare intertidal mud which proved suitable for annual *Salicornia* species, particularly purple glasswort (*Salicornia ramosissima*). In addition to species of *Salicornia*, annual seablight (*Suaeda maritima*) was found to be frequent during surveys as well as occasional plants of sea aster (*Aster tripolium*), common saltmarsh-grass (*Puccinellia maritima*), greater sea-spurrey (*Spergularia media*) and common cord-grass (*Spartina anglica*). The community is probably best described in terms of *SM8 annual Salicornia saltmarsh* of the NVC. However, it is probably already in transition towards *SM10 transitional low-marsh with Puccinellia maritima, Salicornia agg and Suaeda maritima / SM11 Aster tripolium saltmarsh*.

	
Photo 1: Annual Salicornia species in corridor	Photo 2: *Sarcocornia perennis* dominated ridges

The seaward edge of the construction corridor is currently open to the sea although very occasional spikes of *Spartina anglica* suggest *SM6 Spartina anglica* saltmarsh may be starting to gain a hold. The presence of perennial glasswort (*Sarcocornia perennis*) was not identified during the 2011 although it forms a prominent community in its own right at the seaward edge either side of the construction corridor. Perennial glasswort was found to dominate ridges of the low marsh with *Spartina anglica* interspersed in each trough between ridges. The perennial glasswort community is described by SM7 of the NVC.

In 2011, the fringes of the saline lagoon, which forms a prominent feature towards the upper end of the marsh, was sampled by quadrats 2.1 to 2.5 and assigned to *SM6 Spartina anglica saltmarsh* of the NVC. The 2018 survey found that these quadrats to be almost permanently flooded and the community to be largely missing. The edge of the lagoon appears to have expanded and quadrats 3.1 to 3.5 now form its fringes. The vegetation associated with quadrats 3.1 to 3.5 also appeared to be suffering from inundation with plants of *Spartina anglica* and *Atriplex portulacoides* visibly stressed and dying. Conversely, the lagoon was found to support a healthy population of beaked tasselweed (*Ruppia maritima)* prior to it drying out in July. Given the presence of this species the lagoon can be assigned to the *SM2 Ruppia maritima saltmarsh community* of the NVC.

Zone 1 originally comprised a stable and relatively species-poor upper marsh community which graded into partly disturbed terrestrial habitat beside a footpath and main road. Construction disturbance has temporarily changed this habitat to an area dominated by open ground and colonising plants. Subsequently, plant species diversity has increased significantly. Of the opportunistic species that have capitalised on the open ground, two Kent rare plant register species (Kitchener, 2018) were encountered. These were bur medick (*Medicago minima*) and toothed medick (*Medicago polymorpha*). Although both of these species have a restricted UK distribution, neither are considered particularly scarce in Kent.

5.2. Invertebrate interest

Habitat associated with Pegwell Bay, including the saltmarsh and ruderal communities, would be expected to support a range of invertebrate species. Construction activity has not changed this potential and it is likely that the flush of opportunistic plant species that have colonised areas of disturbed ground (such as zone 1) may have introduced additional opportunities.

For instance, small melilot (*Melilotus indicus*) has become established on disturbed ground associated with the terrestrial part of the construction corridor. Locally, a similar species, white melilot (*Melilotus albus*) has been found to support a tent miner (invertebrate) new to Britain (*Phyllonorycter medicaginella*). When small melilot plants within the construction corridor were inspected, 'tents' of *P. medicaginella* were discovered.

One of the most obvious of the coastal species noted during surveys was the sea aster mining bee (*Colletes halophilus*) visiting flowers of sea aster. However, a number of other observations of invertebrates were made during surveys including: *Agapanthia villosoviridescens* (golden-bloomed grey longhorn beetle); *Argiope bruennichi* (wasp spider); *Autographa gamma* (silver Y); *Conocephalus discolour* (long-winged conehead); *Conocephalus dorsalis* (short-winged conehead); *Eupithecia centaureata* (lime-speck pug); *Metrioptera roeselii* (Roesel's bush cricket); *Nabis lineatus* (reed damsel-bug); *Scrobipalpa nitentella* (common sea groundling); *Thymelicus lineola* (Essex skipper); *Vanessa atalanta* (red admiral).

5.3. Evaluation of changes since 2011

The direct physical change to saltmarsh habitat within the construction corridor has brought about a predictable response in a flush of annual saltmarsh plant species within the newly available bare intertidal muds. Saltmarshes are dynamic habitats and the colonisation of this available habitat is considered likely to continue. The only factor likely to inhibit successful colonisation would be erosion of unconsolidated substrate. However, no evidence of erosion was found within the construction corridor during the 2018 site visits. Conversely, the leading edge of the existing marsh in the vicinity of quadrat 7.5 appeared to be suffering from erosion with cockle shells possibly enhancing the scouring effect during storm events (unrelated to construction activity).

	
Photo 3: Erosion landward of Q7.5	Photo 4: Water flowing into the north-eastern end of the lagoon from construction corridor at high tide (10.10.2018).

Prior to cable installation, the saltmarsh included a contiguous band of sea couch (zone 4) which has now been divided by the construction zone. Sea couch tends to grow on slightly raised ground where it is less susceptible to regular tidal inundation. The presence of sea couch therefore suggests a barrier may have existed that inhibited flooding of the saline lagoon except during particularly high tides. The disappearance of SM6 habitat from the fringes of the lagoon (quadrats 2.1-2.5) and apparent expansion of the waterbody suggests inundation has somehow become easier or more frequent. This assumption was given more weight by observations during the October 2018 site visit when sea water was observed flowing into the lagoon from the construction corridor. Topographical survey information also indicates the absence of any barriers to water movement other than a gradual incline towards the land. Notwithstanding this and probably due to the width of the corridor, erosion does not appear to be a problem. In addition, any remedial activity (such as creation of a slightly raised bund) to resolve this issue is likely to promote the establishment of species-poor SM24 habitat at the expense of more valuable saltmarsh habitat. Given that the effect has already been expressed as a change in the vegetation surrounding the lagoon, it is recommended that no action is undertaken and the saltmarsh is allowed to naturally reach its own equilibrium.

5.4. Summary

The site visits during 2018 found a number of changes attributable to construction of the cable route. These included the obvious physical impacts to saltmarsh within the construction corridor. Not surprisingly, disturbance has led to a flush of annual species exploiting the availability of open ground. This has led to the development of an interesting and diverse assemblage of pioneer and early colonising species within the saltmarsh and nearby terrestrial habitat.

An unexpected consequence of the work appears to be more frequent flooding of the saline lagoon which has led to changes in the composition of its marginal vegetation. This is likely to reach an equilibrium as the vegetation melds to the new dynamics. The change to the vegetation is not considered to be particular negative as the lagoon in itself provides a valuable biodiversity resource for birds as well as aquatic plants such as *Ruppia maritima*.

6. References

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The Sizewell C Project

9.65/ 10.23 Outline Vessel Management Plan - Clean Version

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PINS Reference Number: EN010012

October 2021

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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EDF CGN

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EXECUTIVE SUMMARY

Level 1 control documents will either be certified under the DCO at grant or annexed to the DoO. All are secured and legally enforceable. Some Level 1 documents are compliance documents and must be complied with when certain activities are carried out. Other Level 1 documents are strategies or draft plans which set the boundaries for a subsequent Level 2 document which is required to be approved by a body or governance group. The obligations in the DCO and DoO set out the status of each Level 1 document.

This Outline Vessel Management Plan (OVMP) is a Level 1 document which concerns the construction and operational phases of the Sizewell C Project. Condition 31A of the Deemed Marine Licence in Schedule 20 of the d**DCO** (Doc. Ref. 3.1(I)) requires a vessel management plan in general accordance with this OVMP to be approved by the MMO in the event that SZC Co. requires vessels to traverse the Outer Thames Estuary Special Protection Area (SPA) during the winter months. “Winter months” is means the period between 1 November and 31 March inclusive.

Where further documents or details require approval, this document states which body or governance group is responsible for the approval and/or must be consulted. Any approvals by East Suffolk Council, Suffolk County Council or the MMO will be carried out in accordance with the procedure in Schedule 23 of the DCO. The DoO establishes the governance groups and sets out how these governance groups will run and, where appropriate, how decisions (including approvals) should be made. Any updates to these further documents or details must be approved by the same body or governance group and through the same consultation and procedure as the original document or details.

Where separate Level 1 or Level 2 control documents include measures that are relevant to the measures within this document, those measures have not been duplicated in this document, but cross-references have been included for context. Where separate legislation, consents, permits and licences are described in this document they are set out in the **Schedule of Other Consents, Licences and Agreements** (Doc Ref. 5.11(B))

For the purposes of this document the term ‘SZC Co.’ refers to NNB Nuclear Generation (SZC) Limited (or any other undertaker as defined by the DCO), its appointed representatives and the appointed construction contractors.

1 INTRODUCTION

1.1 General

1.1.1 This Outline Vessel Management Plan (OVMP) provides details of the proposed approach to managing deliveries to the Marine Bulk import Facility (MBIF) and Permanent Beach Landing Facility (BLF) at the main development site via the marine route over the period of construction and deliveries to the permanent BLF during operation if these deliveries are required during the winter months.

1.1.2 For the purposes of this OVMP and the final Vessel Management Plan, “winter” means the period between 1 November and 31 March inclusive, “summer” means the period between 1 April and 31 October inclusive.

1.1.3 This OVMP outlines the proposed restrictions to vessel movements and routes and provides the strategy to protect the Outer Thames Estuary Special Protection Area (SPA) from vessel movements during the winter months. As set out in Section 3, there must be no vessel movements through the SPA during the winter months unless a Winter Vessel Management Plan has been submitted to and approved by the MMO, pursuant to DML Condition 31a.

1.1.4 The Winter Vessel Management Plan must include details of:

- The proposed vessel movement schedule, route and any measures that may be necessary to avoid impacts on red throated divers, along with the monitoring of vessel movements to ensure the minimum disturbance to wintering red-throated divers.

- Tug movements and marine works for outfall/intake tunnels: these movements will be concentrated around the SZC site area and are not expected to impinge signifcantly on the wider SPA area compared to the import of AIL’s and of bulk aggregate import.

- Delivery of rock armour for Hard Coastal Defence Feature: these movements will follow the same route selection hierarchy, protocols and routings as those presented in the OVMP, depending on the origin of the rock armour. An estimate of these movements is, however, included in Table 3.1.

- Shingle import/ recharge for Soft Coastal Defence Feature: these movements will follow the same route selection hierarchy, protocols and routings as those presented in the OVMP. Initial shingle import will ideally be completed during the fair weather periods which are more prevalent in summer months. Shingle recharge is expected to be infrequent (typically 10-year intervals) during the operational and decommissioning phases of SZC. An estimate of these movements is, however, included in Table 3.1.

1.1.5 The vessel count presented in this OVMP includes both the inbound and outbound legs of the journey, i.e. each vessel will have an inbound and outbound leg.

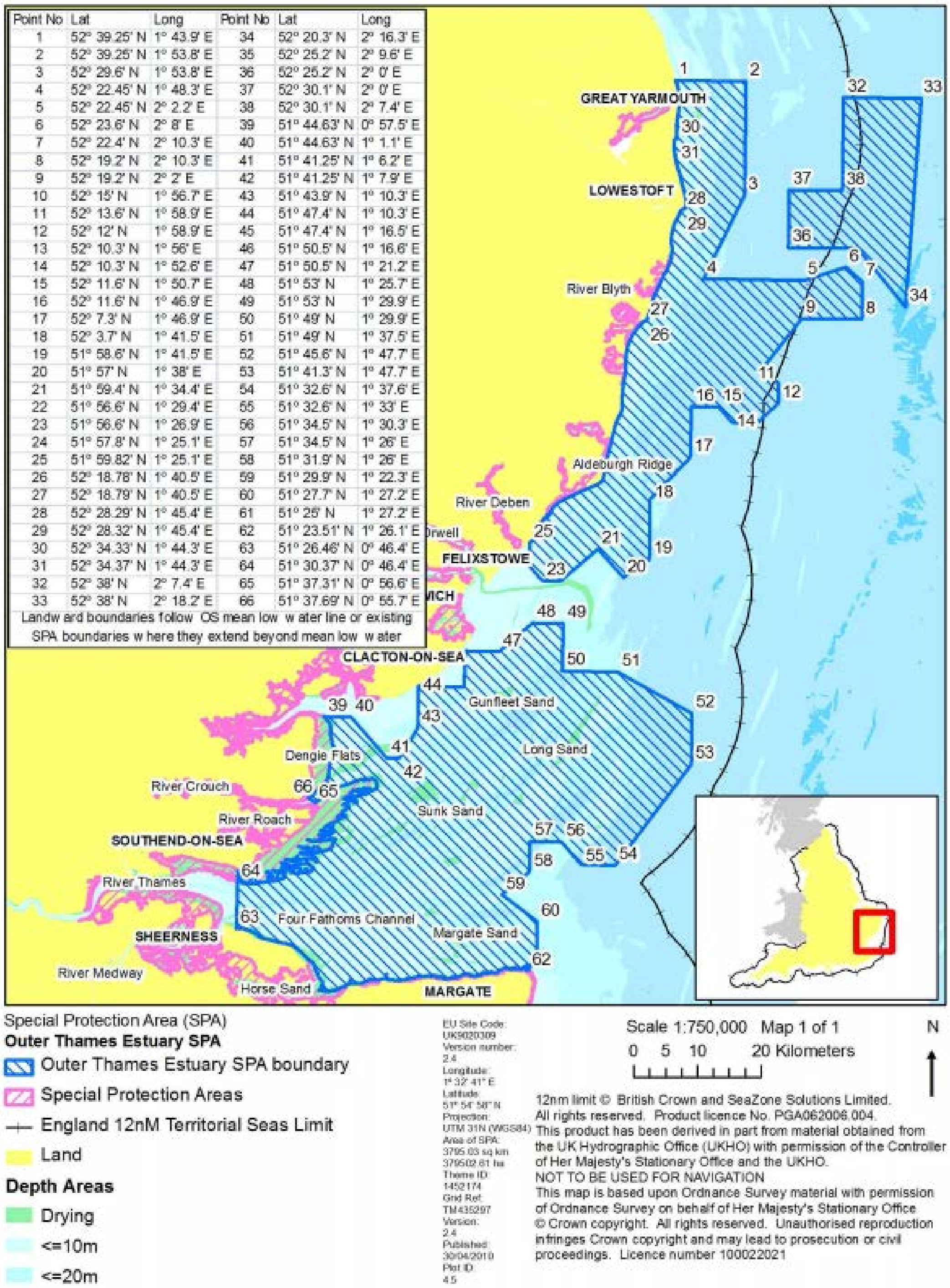
1.2 Spatial Extents of Plan

1.2.1 This OVMP outlines the proposed restrictions to vessel movements associated with the Sizewell C Project during the winter months and those movements that would otherwise go through the Outer Thames Estuary SPA. The extent of the SPA is shown on **Plate 1.1**.

1.2.2 This OVMP therefore relates to the following vessel movements during the winter months:

- any vessel leaving London ports and traversing the southern sector of the SPA and traversing the northern sector to Sizewell C;
- any vessel departing the ports of Harwich or Felixstowe and entering the northern sector of the SPA at its southern extent offshore of the Deben Estuary;
- any vessel departing Lowestoft for the entirety of the journey, in the northern sector of the SPA, to Sizewell C; and
- any international movements which enter the SPA. These are likely to enter the northern sector(s) of the SPA from the east and traverse the sector in a westerly direction to Sizewell C.

Plate 1.1: Extent of SPA



Point No	Lat	Long	Point No	Lat	Long
1	52° 39.25' N	1° 43.9' E	34	52° 20.3' N	2° 16.3' E
2	52° 39.25' N	1° 53.8' E	35	52° 25.2' N	2° 9.6' E
3	52° 29.6' N	1° 53.8' E	36	52° 25.2' N	2° 0' E
4	52° 22.45' N	1° 48.3' E	37	52° 30.1' N	2° 0' E
5	52° 22.45' N	2° 2.2' E	38	52° 30.1' N	2° 7.4' E
6	52° 23.6' N	2° 8' E	39	51° 44.63' N	0° 57.5' E
7	52° 22.4' N	2° 10.3' E	40	51° 44.63' N	1° 1.1' E
8	52° 19.2' N	2° 10.3' E	41	51° 41.25' N	1° 6.2' E
9	52° 19.2' N	2° 2' E	42	51° 41.25' N	1° 7.9' E
10	52° 15' N	1° 56.7' E	43	51° 43.9' N	1° 10.3' E
11	52° 13.6' N	1° 58.9' E	44	51° 47.4' N	1° 10.3' E
12	52° 12' N	1° 58.9' E	45	51° 47.4' N	1° 16.5' E
13	52° 10.3' N	1° 56' E	46	51° 50.5' N	1° 16.6' E
14	52° 10.3' N	1° 52.6' E	47	51° 50.5' N	1° 21.2' E
15	52° 11.6' N	1° 50.7' E	48	51° 53' N	1° 25.7' E
16	52° 11.6' N	1° 46.9' E	49	51° 53' N	1° 29.9' E
17	52° 7.3' N	1° 46.9' E	50	51° 49' N	1° 29.9' E
18	52° 3.7' N	1° 41.5' E	51	51° 49' N	1° 37.5' E
19	51° 58.6' N	1° 41.5' E	52	51° 45.6' N	1° 47.7' E
20	51° 57' N	1° 38' E	53	51° 41.3' N	1° 47.7' E
21	51° 59.4' N	1° 34.4' E	54	51° 32.6' N	1° 37.6' E
22	51° 56.6' N	1° 29.4' E	55	51° 32.6' N	1° 33' E
23	51° 56.6' N	1° 26.9' E	56	51° 34.5' N	1° 30.3' E
24	51° 57.8' N	1° 25.1' E	57	51° 34.5' N	1° 26' E
25	51° 59.82' N	1° 25.1' E	58	51° 31.9' N	1° 26' E
26	52° 18.78' N	1° 40.5' E	59	51° 29.9' N	1° 22.3' E
27	52° 18.79' N	1° 40.5' E	60	51° 27.7' N	1° 27.2' E
28	52° 28.29' N	1° 45.4' E	61	51° 25' N	1° 27.2' E
29	52° 28.32' N	1° 45.4' E	62	51° 23.51' N	1° 26.1' E
30	52° 34.33' N	1° 44.3' E	63	51° 26.46' N	0° 46.4' E
31	52° 34.37' N	1° 44.3' E	64	51° 30.37' N	0° 46.4' E
32	52° 38' N	2° 7.4' E	65	51° 37.31' N	0° 56.6' E
33	52° 38' N	2° 18.2' E	66	51° 37.69' N	0° 55.7' E

Landward boundaries follow OS mean low water line or existing SPA boundaries where they extend beyond mean low water

2 VESSEL MOVEMENT RESTRICTIONS

2.1.1 The BLF and MBIF will be operated during the summer period.

2.1.2 There must be no winter vessel movements unless or until a Winter Vessel Management Plan has been submitted to and approved by the MMO, pursuant to DML Condition 31a, following consultation with the ERG, Natural England and the RSPB.

2.1.3 The Winter Vessel Management Plan must set out the proposed vessel movement schedule, route and any measures that may be necessary to avoid impacts on red throated divers. The Winter Vessel Management Plan must be implemented as approved.

2.1.4 Appendix A sets out the types of vessel movements and requirements and Appendix B sets out a summary of the estimated vessel movements per season associated with the permanent BLF and the MBIF.

3 VESSEL ROUTING

3.1 Principles

3.1.1 A number of preferred and potential alternative routes that may be suitable for winter vessel movements have been identified to mitigate potential disturbance impacts on red throated divers within the Outer Thames Estuary SPA.

3.1.2 Route selection in any Winter Vessel Management Plan must be determined in accordance with the following a hierarchy of requirements (in descending order):

- Maritime safety considerations;
- Avoid traversing SPA, if not possible to avoid, then minimise the time vessels are travelling through the SPA to minimise exposure to red-throated divers; and
- Prioritise use of existing shipping lanes, where practicable.

3.1.3 For the avoidance of doubt, route selection will prioritise those routes that avoid and reduce the amount of time spent in the SPA as far as practicable, subject to any overriding marine safety considerations that would arise.

3.1.4 It should be noted that routes are indicative corridors and are not intended to be prescriptive for the purposes of navigation and will not be followed precisely by every vessel. All vessels must passage plan as per the International Regulations for the Safety of Life at Sea (SOLAS) (Ref. 2).

3.1.5 Vessels may deviate from these routes for a variety of health and safety reasons at the discretion of the vessel's Master, including:

- Compliance with COLREGS (Ref. 1) or SOLAS (Ref. 2);
- Traffic density;
- Prevailing weather, tidal or sea state conditions;
- Navigational hazards as indicated on charts or notified through Notices to Mariners or other such sources;
- Due to a vessel originating from or being bound for a destination not indicated by the transit routes, although for clarity, it is noted that whilst the preferred routes may not be appropriate for these movements,

vessels would be required to apply the route selection principles in 3.1.2; and

- Such other reasons as the Master of a vessel may deem relevant for the purposes of ensuring the safety of his vessel or another vessel.

3.2 Preferred & Alternative Routes

3.2.1 This section defines the preferred routes from the north (Lowestoft) and the south (Ipswich/ Harwich, Lowestoft, Isle of Grain) and proposed alternative routings.

3.2.2 **Plate 4-1** shows candidate locations for the sources and destinations of material supplies to the Sizewell C project. **Table 4.1** describes the materials and their likely source / destinations.

3.2.3 Routes for any winter vessel movements would be set out and approved in a Winter Vessel Management Plan, as set out in section 2.

Plate 3.1: Source – Destination Map

Table 3.1: Source-Destination Table

Description	Source		Destination	
	Ref	Location	Ref	Location
AILs	2	Lowestoft	SZC	Permanent BLF
Bulk Aggregates for blending	1	Ipswich/ Harwich/ Isle of Grain	SZC	Temporary BLF (MBIF)
	2	Lowestoft		

3.2.4 The delivery routes are indicative and have been defined taking into consideration a number of factors, including shallow waters, existing routing, navigational features and existing offshore developments or areas to be avoided.

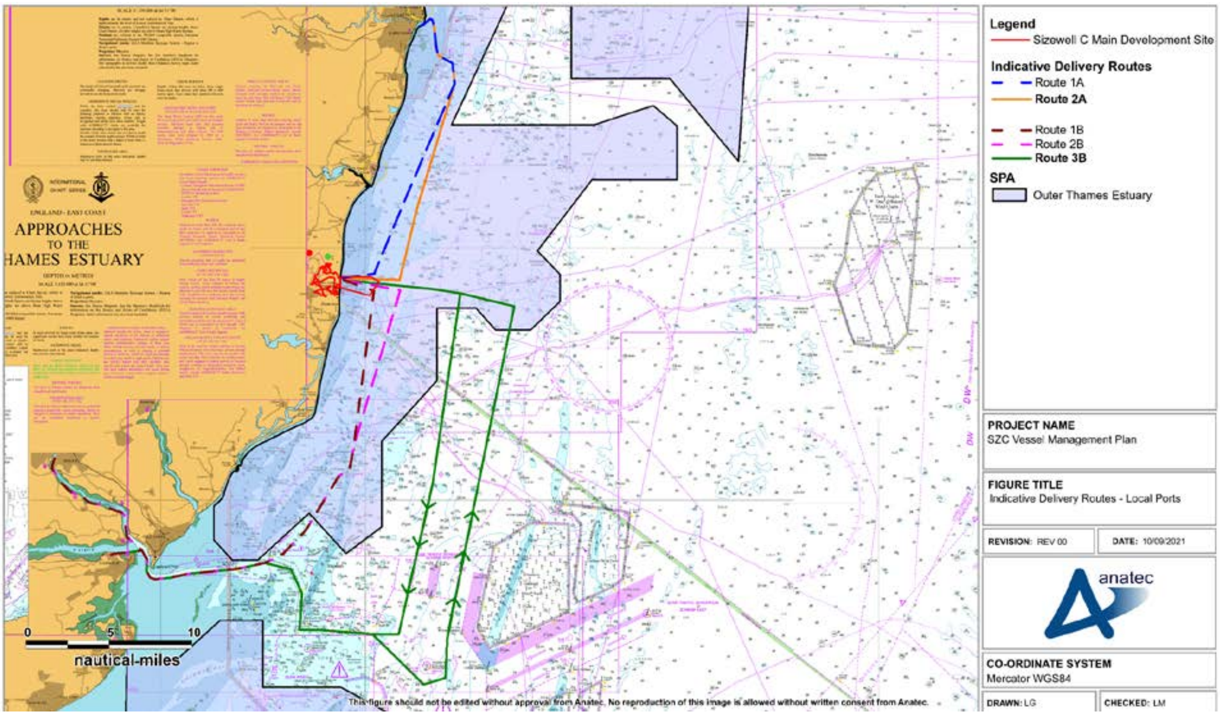
3.2.5 The focus is on routes taken by vessels delivering AILs to the permanent BLF and bulk aggregates for blending to the MBIF. The ports of Lowestoft, Ipswich, Harwich and the Isle of Grain have been identified as the most likely source of these materials.

3.2.6 For the local ports of Lowestoft, Ipswich and Harwich, indicative routes are presented in **Plate 4.2**. Routes designated with the suffix “A” approach the site from the north, and routes designated with the suffix “B” approach the site from the south. Routes in bold in the text, and shown as solid lines in **Plate 4.2** are the preferred routes which will minimise adverse impacts to the SPA:

- Route 1A/1B – direct route from local ports. There are no existing movements on these routes as Sizewell is not a marine destination. However, it is noted that the area around these routes is not devoid of commercial vessel activity, as commerical vessels are currently navigating alternative routes within this area.
- Route **2A**/2B – semi-direct route from local ports using an existing coastal route with approximately 172 existing vessel movements per year, and with vessels turning off the existing route to approach Sizewell C. Route 2A is Natural England’s preferred route for vessels from Lowestoft to minimise adverse impacts to the SPA.
- Route **3B** – alternative route from Ipswich/ Harwich is Natural England’s preferred route to minimise impacts on the the SPA, but may lead to potential increase in navigational safety associated with the additional time required to transit to and from the permanent BLF or MBIF in busier traffic. There are approximately 3285 existing vessel movements per year on this route.

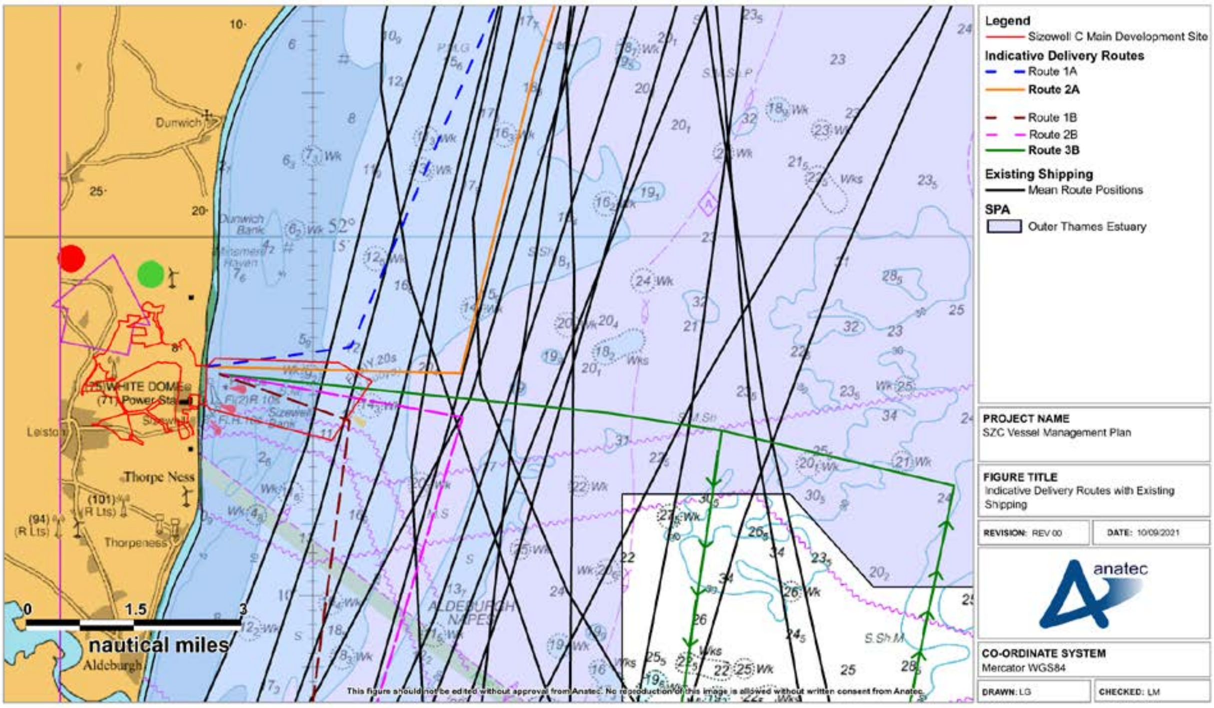
3.2.7 It is noted that there is no route 3A from Lowestoft as there is no reasonable route for vessels to take that will avoid the SPA without significantly increasing the safety risk to the vessels from increased journey time, increased interaction with other vessels and less favourable weather conditions experienced further offshore, particularly in the case of barges being towed. In addition, any such route 3A alternative would significantly increase the emissions associated with the deliveries.

Plate 3.2: Indicative Delivery Routes – Local Ports



3.2.8 In order to provide a comparison of these routes with existing vessel movements in proximity to the Sizewell red line boundary, **Plate 4-3** shows the mean route positions of all commercial vessels within approximately 5nm of the Sizewell site.

Plate 3.3: Indicative Delivery Routes – Local Ports



3.2.9 Based on the approximate number of vessels on the existing shipping routes 2 and 3, **Table 4.2** presents the maximum percentage increase in vessel movements for these routes, above the existing baseline levels, for the maximum capacity of cargo landings per season, as described in **Table 3.1** (i.e. 100 for the Permanent BLF in summer, 400 for the MBIF in summer and 200 for MBIF in winter, noting that each landing represents 2 movements).

3.2.10 Although the maximum availability of winter movements for the MBIF will be 200, the currently anticipated number of deliveries is 0. **Table 4.3** presents the percentage increase for the highest number of currently anticipated deliveries in any one season (i.e. 100 for the Permanent BLF in summer, 160 for the MBIF in summer and 0 for both the permanent BLF and the MBIF in winter).

3.2.11 For routes 1A and 1B, there are no vessels currently taking the exact routes through the area, and therefore a percentage increase in vessel movements cannot be calculated. However, it is noted that there are existing commercial vessels navigating alternative routes in the area, albeit on a slightly different bearing to routes 1A and 1B.

Table 3.2: Percentage Increased Vessel Movements (Maximum Capacity)

Route	Current Movements (summer)	Current Movements (winter)	BLF (summer)	MBIF (summer)	BLF (winter)	MBIF (winter)
1[1]	N/A	N/A	N/A	N/A	N/A	N/A
2	101	71	198%	793%	0%	562%
3	1926	1359	10%	42%	0%	29%

Table 3.3: Percentage Increased Vessel Movements (Anticipated Deliveries)

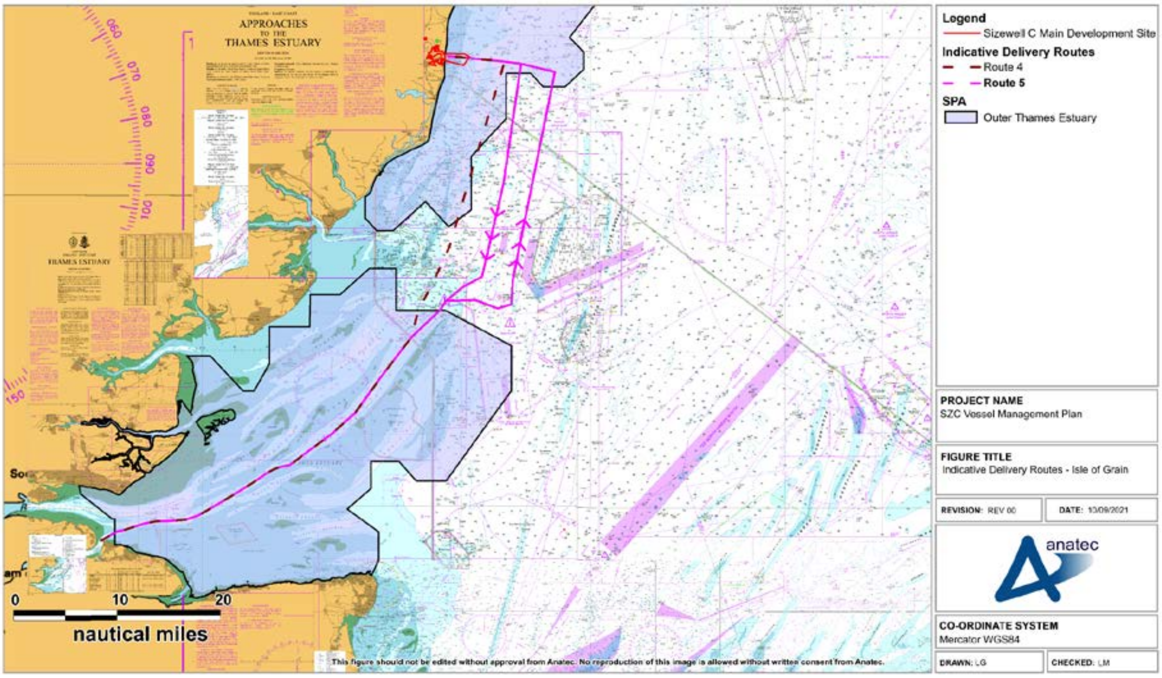
Route	Current Movements (summer)	Current movements (winter)	BLF (summer)	MBIF (summer)	BLF (winter)	MBIF (winter)
1[1]	N/A	N/A	N/A	N/A	N/A	N/A
2	101	71	198%	317%	0%	0%
3	1926	1359	10%	17%	0%	0%

3.2.12 Two indicative delivery routes from the Isle of Grain are presented in Plate 4.4:

- Route 4 – direct route using existing shipping routes
- **Route 5** – less direct route using charted routeing measures which minimises adverse impacts to the SPA

[1] Route 1 would be a new route directly to the BLF / MBIF from the local ports and therefore a percentage increase is not applicable

Plate 3.4: Indicative Delivery Routes – Isle of Grain

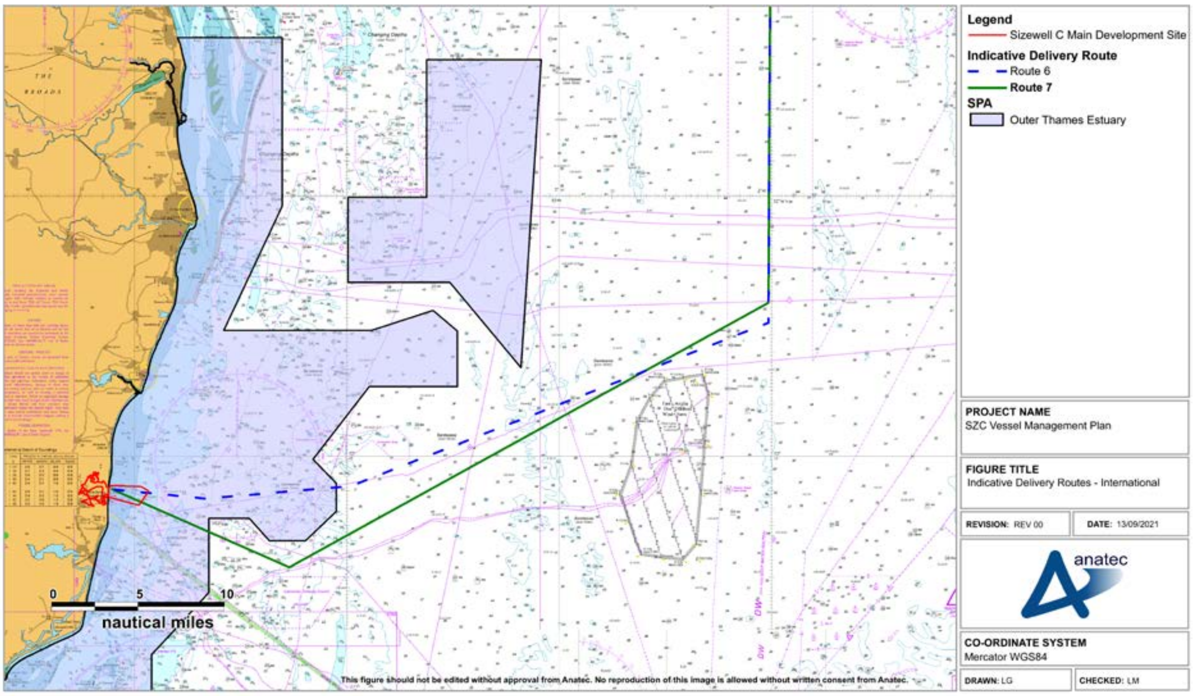


3.2.13 It is noted that vessels transiting to the permanent BLF and the MBIF from further south are expected to join the Sunk Traffic Separation Scheme (TSS)[2] from the south and then follow a similar route as Route 5 above.

3.2.14 Indicative routes for vessels travelling from international ports to the north and east are presented in **Plate 4.4.** Route 6 is a direct route using existing shipping lanes, while Route 7 is a less direct route which minimises adverse impacts to the SPA. It is noted that routing may be required to change depending on the approval and construction of offshore wind farms in the area. These routes are predominantly for vessels expected from international ports further afield to supply specific AILs and materials.

[2] Traffic Separation Schemes are areas in the sea where navigation of ships is highly regulated and designed to create *lanes* in the water with ships in a specific lane all travelling in (roughly) the same direction. The Sunk TSS is TSS for the approaches to the Thames Estuary.

Plate 3.5: Indicative Delivery Routes – International



4 MONITORING, MANAGEMENT AND MITIGATION

4.1 Background

4.1.1 Red-throated divers are only present in the Outer Thames Estuary SPA in the winter period. There are no currently planned vessel movements in the winter periods. There is significant available capacity in the summer months and currently planned vessel movements, and potential increases in vessel movements and compensation for poor weather conditions are unlikely to require movements in winter. ***There is therefore no expected interaction between the planned vessel movements and the presence of Red-throated divers in the Outer Thames Estuary SPA.***

4.1.2 Should exceptional vessel movements in the winter period become necessary during the course of the Sizewell C project then specific vessel routings and Vessel Management Plans must be prepared at that time and submitted to the MMO for approval. Those routings and associated monitoring/mitigations must be developed according to the hierarchy described in Section 1.1.1, and must be subject to approval by the MMO pursuant to DML Condition 31a, following consultation with the ERG, Natural England and the RSPB.

4.2 Vessel Disturbance Mitigation

4.2.1 The following measures to minimise vessel disturbance must be implemented:

- Vessel routing must be in accordance with the principles set out in section 3 of this Plan;
- Where it is necessary to go outside of established navigational routes, avoid rafting birds and where possible avoid disturbance to areas with consistently high diver density;
- Avoid over-revving of engines to minimise noise disturbance; and
- Brief the vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks).

5 REFERENCES

Ref. 1. IMO (1972), *COLREGS*, IMO, London.

Ref. 2. IMO (1974). *SOLAS*, IMO, London.

APPENDIX A: VESSEL MOVEMENTS AND REQUIREMENTS

A.1.1. Vessels will support the construction and operation of Sizewell C, but cross the SPA on their way to and from Sizewell C. The infrastructure and works required is explained in the **Construction Method Statement** (Doc Ref. 6.3 3D(D)) (secured pursuant to Requirement 8 of the **dDCO**). The four vessel requirements are:

- Permanent Beach Landing Facility (BLF): allows for the import and export of Abnormal Indivisible Loads (AILs) during construction and operation of the Sizewell C project. It is served by a North Sea Barge with tug.
- Temporary Marine Bulk Import Facility (MBIF): allows for import of bulk aggregate during teh Sizewell C construction phase. It is served by self-discharging coaster vessels. It may be possible to deliver other cargos to the temporary MBIF once bulk aggregate import is complete during the construction period.
- General site access is required for dredging and mooring
- Construction vessles will be required for the construction of the marine works.

A.2. Permanent BLF

A.2.1. The Permanent BLF is described in the CMS (Doc Ref. 6.3 3D(D)) (secured pursuant to Requirement 8 of the **dDCO**). The Permanent BLF design is optimised for a particular size of North Sea Barge (NSB) which, when ballasted correctly, provides a smooth graded transition to the land via the in-built roll-on / roll-off mechanism.

A.2.2. The NSB will be unpowered and will be towed and manoeuvred using a tug power unit. Due to low draft, specific shallow water vessels are expected to be necessary, at least for parts of the berthing/ offload/ departure process (e.g. Shoalbuster tugs). Details of typical vessels and a grounded landing operation are provided in **Plates 2.1 to 2.3** below:

Plate 2.1: North Sea Barge

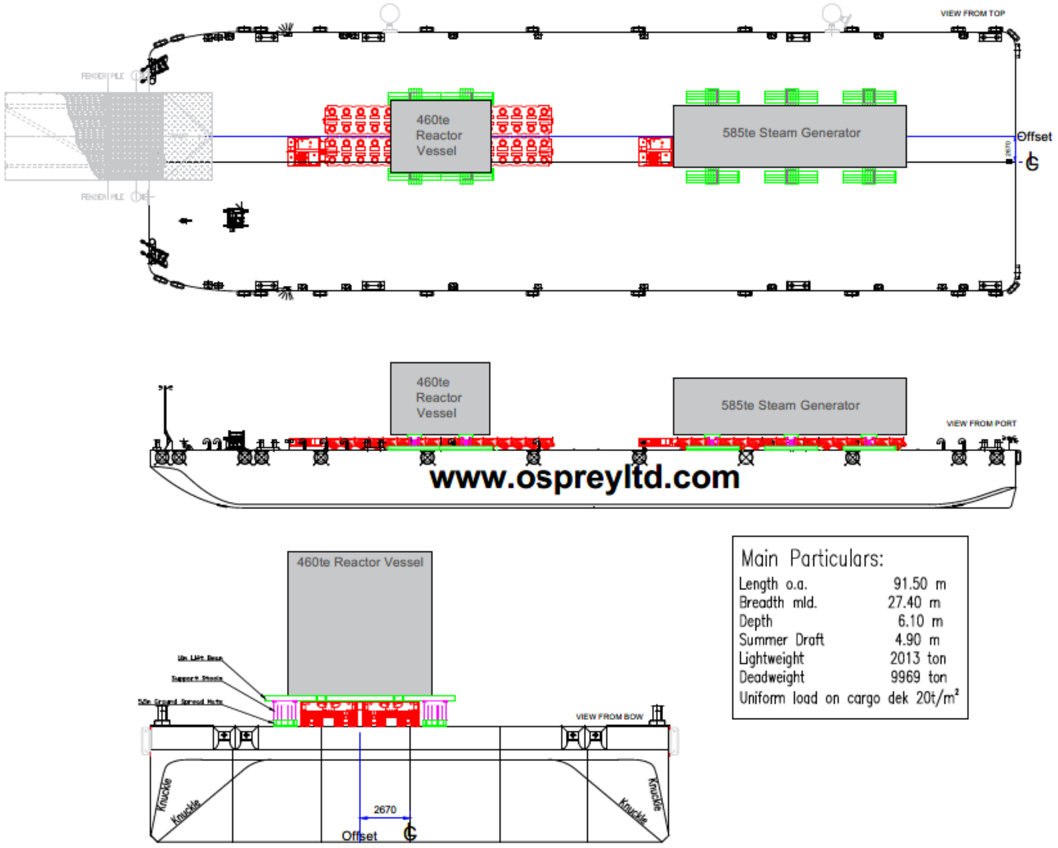


Plate 2.2: Shoalbuster Tug Power Unit

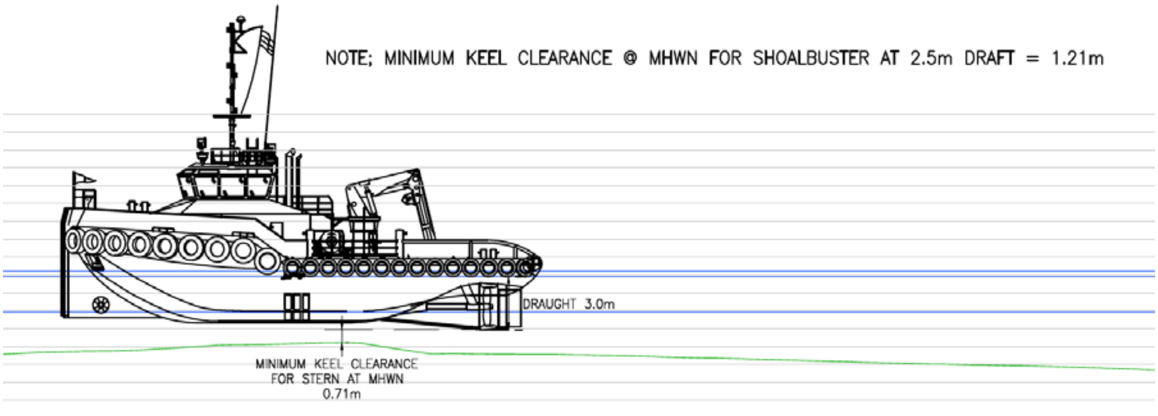


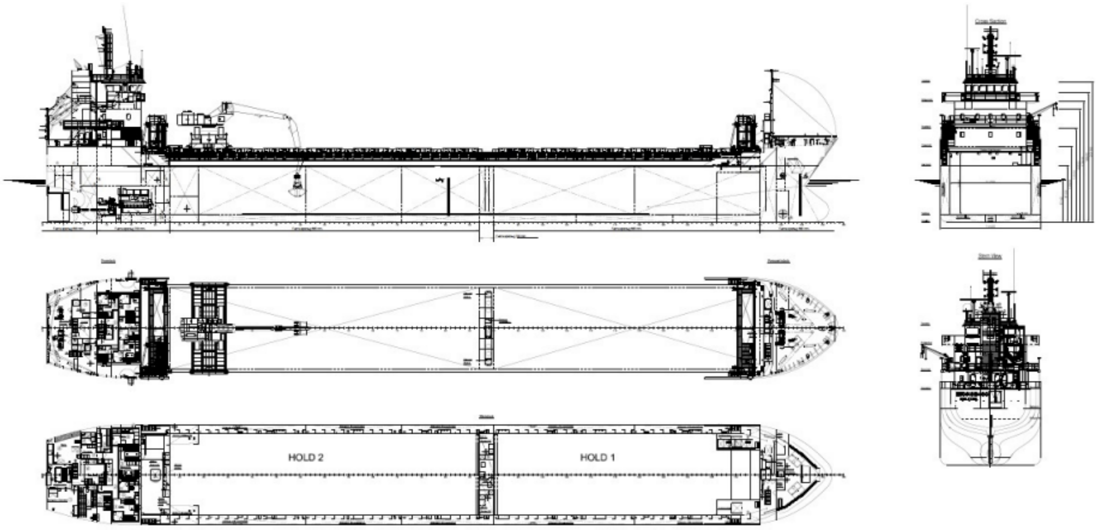
Plate 2.3: Typical NAABSA landing

A.3. Temporary BLF (MBIF)

A.3.1. The Temporary BLF, also referred to as the Marine Bulk Import facility (MBIF) is described in the CMS (Doc Ref. 6.3 3D(D)) (secured pursuant to Requirement 8 of the **dDCO**). The design of the facility is optimised for a typical coastal cruiser in the 6 – 7000 tonne class, nominally loaded to 4500 tonnes as permitted by the draft available at the landing position. All vessels will be self-powered and rigged for self-unloading into the receiving hopper.

A.3.2. Details of a typical vessel are provided below in **Plate 2.4**:

Plate 2.4: Indicative Bulk Carrier Vessel



APPENDIX B: ESTIMATED VESSEL MOVEMENTS

B.1.1. **Table 3.1** presents a summary of the estimated vessel movements per season associated with the permanent BLF and the MBIF.

B.1.2. The figures in the body of **Table 3.1** represent the estimate of the number of landings of each type in each year. These represent estimates only, and are expected to vary to reflect factors such as the achievable degree of consolidation of AILs on individual barges, compensation for weather-related delays, changes to quantities for import, etc.

B.1.3. Each “landing” comprises two journeys: one inbound and one return journey.

B.1.4. The “Inshore Support Vessels per Landing” column in **Table 3.1** indicates the number of ancillary vessels required in attendance at each landing. These insure support vessels will be the harbourmaster’s craft and/or a shallow-draft tug. For a single Permanent BLF landing, the seagoing journey will be attended by two local support vessels: a shallow-draft tug and the harbourmaster’s craft. For a MBIF delivery, the seagoing journey will be attended by one local support vessel: the harbourmaster’s craft. The inshore support vessels may remain on station pending subsequent deliveries or may return to a local base for fuelling, maintenance, crew change, etc. Mooring facilities for inshore support vessels remaining on station are incorporated into the design of the permanent BLF and MBIF.

Table 3.1: Seasonal capacity and anticipated deliveries

Cargo deliveries SZC Marine Facilities											
Summer Season											
Facility			**Season**								
			2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2042-2142 (10 yearly)**
	Maximum availability of Cargo deliveries	Inshore support vessels per landing	Current assessment								
BLF (AIL, Sea Defence)	100	2	0	0	7	28	28	20	1	100	30
MBIF	400	1*	160	160	0	0	0	0	0	40	0
Total	**500**		160	160	7	28	28	20	1	140	30
Winter Season											
Facility			**Season**								
			2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2042-2142 (10 yearly)**
	Maximum availability of Cargo Landings	Inshore support vessels per landing	Current assessment								
BLF	0	2	0	0	Facility unavailable						
MBIF	200	1*	0	0	Retained for resilience						Decomissioned
Total	**200**		0	0	0	0	0	0	0	0	0

B.1.5. Support vessels at or near the shore will be required to attend each cargo delivery as follows:

- Permanent BLF: the towed barge and tug power unit operating as a joined pair are counted as a single vessel combination.
- For Permanent BLF, each cargo will be attended by an additional shallow water tug on standby at the dock for additional control during mooring.
- For MBIF operations, a tug will not normally required to be in attendance. A vessel which is unable to manoeuvre from the berth will continue to discharge and then ride out the low tide on station.It will then be repaired and depart under its own power or will be towed and moored offshore using the Marine Works tug and wait for a larger tug from a local port to take it back to a port for repair. Where no Marine Works tug is available, a bespoke tug will be provided.
- A vessel which is unable to discharge will self-manoeuvre off station under its own power. Should tug towage be required (in case of a concurrent discharge and propulsion failure on a fully laden vessel), the Marine Works tug will be called off station from the marine heads location to manoeuvre a crippled vessel into deeper water. Where no Marine Works tug is available, a bespoke tug will be provided.
- For all manoeuvres at the marine facilities the Harbour Master's vessel may be in attendance
- Winter availability of the MBIF is not currently expected but the potential for availability is retained for resilience and, therefore, included in this OVMP.

Create Habitat

Turtle Doves spend two thirds of their time outside the UK where they face a range of threats along their migratory route, which takes them from their wintering grounds in West Africa to their breeding grounds in the UK. However, research shows that the loss of habitat in England is the biggest factor driving their declines here.

For this reason, it is essential that we establish good Turtle Dove feeding and nesting habitat over the turtle dove's core UK breeding range in East Anglia and South-East England.

And this is where you can help Turtle Doves – by providing them with places to feed, nest and drink.

Download Helping your local Turtle Doves PDF for a handy guide that outlines how you can provide Turtle Doves with the habitats they need in the UK.

How can I help turtle doves on my land?

Providing habitat is a vital component of Turtle Dove conservation. If you farm or manage land, there are a number of ways in which you can help support the species and benefit your rural business while doing so. Find out more

How can I help turtle doves in my garden or local community green space?

Provide habitat for Turtle Doves and other wildlife in your garden and local communities. Find out more

Version 1.3 (last updated May 2024). This advice sheet is regularly reviewed and updated. To ensure you are using the latest advice, please download the most recent advice sheet from this QR code.

Helping your local Turtle Doves

Conservation Advice from Operation Turtle Dove

This advice is principally aimed at farmers and those managing agricultural land but can be used by other land managers.

The Turtle Dove is a migratory bird wintering in West Africa and returning to Europe in spring to breed. Numbers have declined dramatically in the UK and across Europe, but there is real hope for recovery. With the issue of unsustainable hunting on the Turtle Dove's migratory flyway in western Europe being addressed, providing good quality habitat for UK breeding Turtle Doves is now a priority. As a farmer or land manager, you can help by following this guidance to ensure you are 'Turtle Dove Ready'.

What do Turtle Doves need?

Turtle Doves require three key breeding season resources:

1. **Food:** Turtle Doves feed on the ground, almost entirely on seeds of low growing wild plants or spilt crop seeds. They need sparse vegetation and or patches of open ground to be able to find the seeds. The past decline of Turtle Doves has been so serious that in addition to growing seed-bearing plants we recommend supplementary feeding, particularly early in the breeding season, when naturally occurring seeds are scarce. This can be done with a specially-designed seed mix to provide an additional food source,
2. **Nesting habitat:** dense woody vegetation, particularly tall, dense thorny broadleaved scrub or tall, wide hedgerows.
3. **Accessible water:** such as a well-managed pond, ditches, puddles and shallow troughs with suitable access for Turtle Doves.

How can I help?

Turtle Doves are now mainly restricted to eastern and south-eastern England. If you're based in one of these regions, you can help.

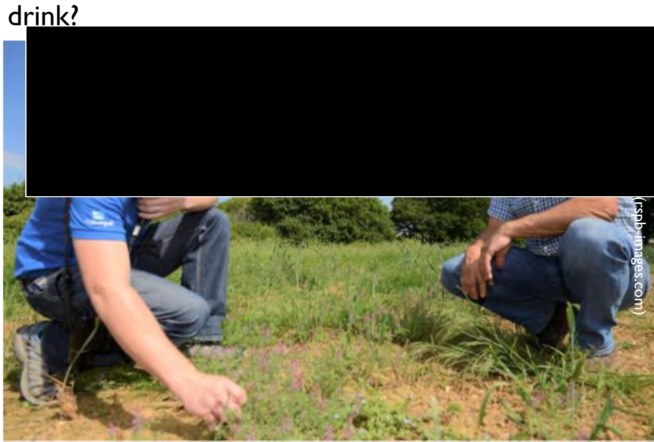
Protecting and creating places for Turtle Doves to feed, nest and drink is vital. Evidence clearly shows that restoring these lost resources in our countryside is the number one priority action for Turtle Doves in the UK.

Dense hedges and broadleaved thorny scrub provide suitable nesting habitat for Turtle Doves.

Collaborating with others

Your area might have one or more of the key resources that Turtle Doves need already. Consider what is missing and look to see where gaps can be filled. Can you work with others within your local area to give Turtle Doves places to feed, nest and drink?

[redacted]



Advisors can help provide locally-tailored guidance

With your help, we can make sure that when Turtle Doves return to the UK in spring they are met with the breeding sites, food and water that they need. The following guidance provides information on how key features can be created or maintained.

The Operation Turtle Dove partnership, your local Natural England or RSPB advisor can help to provide locally relevant guidance for all of these measures.

Help Turtle Doves – help wildlife

Providing any of the features listed in this note will benefit other wildlife, including plants, butterflies, bees, mammals and other birds.

RSPB · Fair to Nature · Pensthorpe Conservation Trust · Natural England

Providing nesting habitat

In the UK, Turtle Doves usually nest in tall, wide mature scrub or hedgerows, especially if they contain standard trees, thorny shrubs and climbers. Dense thorny vegetation provides the birds with a safe place to build their nest, which is often just a small collection of twigs. Dense thorny scrub benefits lots of wildlife – from birds like Nightingales and Bullfinches to butterflies and other invertebrates.

Protect what's there already

If you already have scrubby areas and hedgerows in your local landscape then you hold a vital resource for Turtle Doves.

Good Turtle Dove nesting habitat can take a long time to develop from scratch, so it is essential to protect what's there already. Think about how you can help your neighbours to protect hedgerows and scrubby areas in your local landscape.

Management

To provide the dense scrubby structure that's ideal nesting habitat for Turtle Doves, we recommend the following:

Areas of scrub or dense hedgerow should be, as a minimum, 3m tall and 4m wide. Allow room for hedges to expand if necessary.

Encourage and keep thorny species such as Bramble, Hawthorn or Blackthorn.

Encourage and keep native climbing plants such as Dog Rose, Honeysuckle, Clematis (Old Man's Beard) or Ivy.

In the long-term, scrub will eventually turn into woodland and hedges may turn into mature treelines. To maintain the dense, scrubby structure that Turtle Doves prefer, areas may need to be coppiced in sections on a long-term rotational basis (15 years+).

Avoid management and cutting between March and September (inclusive) as Turtle Doves can still be nesting in August.

Turtle Doves will also nest in other habitats. This includes Gorse on heathland, orchards, and thicket stage conifers in forestry areas.

A patch of scrub used by Turtle Doves

Providing water

Like many seed-eating animals, Turtle Doves need regular access to drinking water, for instance from ponds, artificially-lined pools, semi-permanent puddles and water courses. Accessible water within 300m of suitable nesting habitat will provide Turtle Doves with a place to drink and bathe.

Water bodies should be accessible. An exposed, gently sloping side is vital. If not, a partially submerged dead branch is a good substitute. Restoring historic ponds should follow best practice set out in the Guide to the Restoration, Creation and Management of Ponds to ensure that their historic profile is not lost.

If the local soil structure is not suitable for pond creation, then it is possible to provide other water sources, such as a shallow livestock drinking trough. Care must be taken to ensure this is safe for all wildlife, at a height to prevent access by badgers (in areas with cattle) and the water in the trough is changed periodically to prevent the build up of parasites.

Pond suitable for Turtle Doves

Providing feeding habitat

Turtle Doves feed almost entirely on the ground on the seeds of low-growing annual or perennial plants. They need open ground without tall vegetation to find these seeds. Turtle Doves will find and feed in a wide range of locations that fit these criteria, including roadsides and trackways, coastal dune grasslands, short flower-rich calcareous grassland. But in many places suitable feeding habitat is lacking, therefore we advocate creating more seed-rich habitat. Measures to provide more seed food for Turtle Doves should be located near to suitable nesting habitat (see **Providing nesting habitat** section).

1. Allow plants to regenerate naturally

This is the preferred method of creating feeding habitat

Cultivate an area of land and allow plants to naturally grow. The plants that grow up may provide seeds for Turtle Doves to feed on. This measure may also benefit rare arable plants that might be present in the seed bank and may establish once the soil is cultivated.

This is particularly useful on lighter soils and is most beneficial for Turtle Doves if cultivated in the autumn as this then allows for plants to regenerate and set seed early the following summer. However if there is space, providing autumn and spring-cultivated plots will provide a variety of seed across the season.

Turtle Doves need a variety of plants that provide the small seeds they feed on, for example Fumitory shown here.

On heavy soils, where vegetation can become too dense for Turtle Doves to access the seed, a two-stage cultivation programme can be used to create suitable vegetation structure. An autumn cultivation followed by weed management (if necessary) with a second early spring cultivation, is more likely to deliver suitable habitat will minimise pernicious weed problems.

Evidence shows that on heavy soils, being patient and retaining your plot in the same location will produce optimum Turtle Dove habitat by gradually reducing nutrient levels. This may take a few years. Cutting and removing vegetation at the end of the season can help achieve this.

Turtle Doves need open ground without tall vegetation in order to find seeds.

Annual management (2-stage cultivation method)

The dates given here are a guide, please discuss with your local advisor regarding what is appropriate for your site.

Cultivate the allocated area between 1 August and 1st November each year in order to produce a flush of autumn growth.

Carry out weed management if necessary by 15 February.

Carry out a final cultivation to achieve a fine tilth by 15 March. This should produce spring germinating plants such as Knotgrass, Black Bindweed, Chickweed and Fumitory.

Do not disturb fallow areas until 31 August.

An example of Turtle Dove foraging habitat with patches of bare ground.

2) Plant a bespoke seed mix

In some circumstances, particularly on heavy soils, natural regeneration may be difficult due to excessive plant growth. In these cases, we recommend first speaking to your local Natural England or RSPB advisor to explore how you can make the natural regeneration option work. However, if this is not possible, a sown seed mix can sometimes be considered as an alternative.

Sow a specially designed seed mix that will provide Turtle Doves with the right food plants. This will provide a source of food throughout the breeding season. Work with your local advisor to identify the right mix.

If you are on a site with rare arable plant interest, then this option won't be suitable.

When and where to sow

Wildflowers grow better on less fertile soil where it is also easier to maintain 30-60% bare ground.

For autumn establishment create blocks or 6 m-wide (minimum) strips between 1 August and 15 October. Plots should be sown at no more than 6 kg per hectare, and in most cases a much lower rate of 2-3 kg/ha can provide optimal foraging conditions for Turtle Doves. This recommended seed rate is based on recent studies.

Rates may vary with soil type – speak to your local advisor. It should be broadcast, not drilled. Once sown, the area should be rolled.

Where feasible, establishing multiple plots in autumn and spring will likely increase the range and timing of plants available.

Maintenance

During the first year, you can top the plots to control the growth of problem weeds during establishment. In following summers, between 15 June and 7 July, half of the plot should be lightly cultivated or as a second choice alternative, cut to 5cm, on a rotational basis, i.e. do not manage the same area in successive years. In all cases check timings of any spring and summer management with your local advisor to protect other wildlife interest.

Cutting and removal or light cultivation between 1 and 31 September may be required to prevent build up of vegetation.

With successful establishment and good management and patience these plots can last many years. However, in some cases mixes may need to be re-sown every two to three years. If in doubt, contact your local advisor.

Supplementary feeding

Supplementary feeding is an important stop-gap measure to support the longer-term aim of providing forage areas of native wild plants. Research has shown that native plant seeds provide best nutritional value for growing Turtle Dove chicks, but supplementary feeding will provide an additional energy boost, particularly for adult birds. This helps them quickly get into breeding condition on return from migration encourage multiple nesting attempts during the summer. We recommend reading our detailed research-based guide before starting feeding. Click on or scan the QR code to the right.

Key points

When

Supplementary feeding should be carried out from at least the first week of May to the end of July. Starting earlier and continuing later can also be beneficial and is recommended wherever possible.

Use a recommended mix of suitable small seed ~~types~~ varieties, not just a single variety, to provide better nutritional variety.

Where

Supplementary food should be located within 300m of known Turtle Dove nest sites, or good nesting habitat.

Feeding sites must be a bare surface free of vegetation or have vegetation that is short and patchy. Avoid areas of existing botanical interest.

How

Seed should be put out each week and spread thinly and evenly across the whole feeding site, to avoid creating piles or trails of seed.

If there is a visible build-up of unused food, stop feeding for at least one week to reduce disease risk. If seed build-up continues, consider using an alternative site.

Supplementary feeding.

For further information about providing supplementary food or for any other conservation measure outlined in this document, please contact your local Turtle Dove advisor. Contact details are available on the Operation Turtle Dove website.

Ornis Hungarica 2021. 29(1): 139–148.
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The possible occurrence of cranial asymmetry in three harrier (Accipitridae: *Circus*) species

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Abstract The harriers (Accipitridae: *Circus*) represent a unique group of raptorial birds due to their hunting behaviour and their facial ruff and prominent facial disc. During previous studies it was suggested that harrier species may have other convergent features shared with owls like asymmetric or enlarged ear openings related to sensitive hearing capabilities. In this study, cranial asymmetry was done using SAGE (Symmetry and Asymmetry of Geometric Data) software. 32 skulls of 3 species (Western Marsh Harrier *(Circus aeruginosus*) n=8, Montagu's Harrier *(Circus pygargus)* n=10, Hen Harrier *(Circus cyaneus)* n=14) were photographed, digitized and assigned with 2D landmarks with TpsDig software. The variables were analysed based on Generalized Procrustes analysis. The morphometric data showed cranial asymmetry of harriers. This asymmetry should rather be explained by foraging strategies as the results are corresponding to the exceptionally good hearing of these species among diurnal raptors.

Keywords: cranial morphology, morphometrics, anatomy, skull, shape, convergent evolution, harrier, auditory system

Összefoglalás A rétihéják (Accipitridae: *Circus*) egyedi képviselői a ragadozó madaraknak, köszönhetően sajátos vadászati technikájuknak és megjelenésüknek, a tollak által alkotott gallérral és arcfátyollal. A korábbi kutatások során felvetődött, hogy utóbbiakon kívül más konvergens tulajdonságokon is osztozhatnak a baglyokkal, mint amilyen az aszimmetrikus vagy megnagyobbodott fülnyílás, amely érzékeny hallásukra utal. Jelen tanulmányban a koponya aszimmetria vizsgálatát a SAGE (Symmetry and Asymmetry of Geometric Data) szoftver segítségével végeztük. Összesen 3 faj 32 koponyájának (barna rétihéja – *Circus aeruginosus*, n=8, hamvas rétihéja – *Circus pygargus*, n=10, kékes rétihéja – *Circus cyaneus*, n=14) fényképét digitalizálva, kétdimenziós landmarkokkal láttuk el azokat a TpsDig programban. A változókat Prokrusztész analízis segítségével vizsgáltuk, ahol a morfometriai adatok aszimmetriát mutattak a rétihéja koponyákon. Ez az aszimmetria a táplálkozásmóddal és viselkedéssel köthető össze és megerősíti azt a megállapítást, miszerint nappali ragadozókhoz mérten ezek a madarak kifinomult hallással rendelkeznek.

Kulcsszavak: koponyasajátosságok, morfometria, anatómia, koponya, alak, konvergens evolúció, rétihéja, táplálékpreferencia, auditív érzékelés

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Introduction

The harriers (Accipitridae: *Circus*) represent a unique group of raptorial birds due to their particular hunting behaviour (Redpath 1992), low, quartering flight, exceptionally light wing loading, their mating pattern of polygyny. In their external appearance, harriers are one of the most easily recognisable Accipitrinae raptors due to their external features such as facial ruff and prominent facial disc (Simmons 2000). Harriers have traditionally been placed within the subfamily Circinae (Peters 1931), but recent molecular studies have revealed that harriers are more closely related to *Accipiter* (Nagy & Tökölyi 2014, Oatley *et al.* 2015). The feeding strategies are highly diverse and the morphological adaptations for feeding are a notable feature of avian evolution (Zusi 1993, Zweers *et al.* 1994). As in many other avian groups, food supply is one of the main factors influencing the ecology of raptors. Population densities of raptors are often limited by food supply (Newton 1980, Franklin *et al.* 2000), which also influences the number of specialist hunters being more likely to fluctuate annually when dependent on a fluctuating food source (Hamerstrom 1969, Korpimäki & Norrdahl 1991, Butet & Leroux 1993).

Previously, the adaptive significance of the anatomical and behavioural convergence between the harriers and some owl species was examined (Clark *et al.* 2020). Anatomically, both groups evolved a sound collecting facial ruff, a curved structure of skin and feathers surrounding the ears, and forage very close to the ground, harriers are very vocal birds while gliding over the hunting area (Rice 1980). The harriers circle an area several times listening and looking for prey, as they have exceptionally good hearing among diurnal raptors. It suggests that these species have a highly developed auditory system. The ears are covered by the feathers of the facial disc (Rice 1982). Some owl species also have a pronounced facial disc, guiding sounds into the ear openings. In owls, the beak is pointed downward, increasing the surface area over which the soundwaves are collected by the facial disc (Nishikawa 2002). Many owl species are remarkable for the bilateral asymmetry of the ears which attributes support a highly developed sense of directional hearing (Coles & Guppy 1988, Pecsics *et al.* 2018). However, the differences are represented by different tissues of the head (feathers, earflaps, ear holes, etc.), ear asymmetry basically caused by cranial structures only, due to the different positions and orientations of the *squamoso-occipital* wings. Ear morphology is different in structure and geometry between species (Norberg 1978). The symmetrical ears are representing a most basal form and cranial structure (Nishikawa 2002).

Bilateral symmetry is a subject of widespread interest, and structures with such symmetry are particularly considered when these consist of two mirror copies on opposite sides of the body (Klingenberg *et al.* 2002). Bilateral symmetry analysis focuses on identifying and measuring the location and extent of symmetry departures in structures, like in the context of matching symmetry, where the two mirror images are considered separated parts of the structure (Torcida *et al.* 2016).

Ear adaptations are a well-known feature of owl evolution. Also there are some documented size and shape asymmetries in birds (Norbeg 1978, Aparicio & Bonal 2002, Güntürkün *et al.* 2000, Parés-Casanova & Salas-Bosch 2020). It was suggested that harrier species may have asymmetric or enlarged ear openings for accurately pinpointing sound (Van Grouw 2012), but our knowledge is still limited regarding the degree and the direction of these skeletal asymmetries.

In this preliminary study, we investigated the cranial diversity among three harrier species. Our objective was to increase our knowledge in the relationship between skull shape and the possible asymmetric skeletal features. For this reason, we investigated shape asymmetries related to hearing capabilities.

Materials and Methods

Specimens

This study is based on 32 skulls of 3 species: Western Marsh Harrier *(Circus aeruginosus*) n=8, Montagu's Harrier *(Circus pygargus)* n=10, Hen Harrier *(Circus cyaneus)* n=14. All skulls are from adult specimens belonging to the collection of Eötvös Loránd University (Budapest, Hungary), the collection of the Hungarian Natural History Museum (Budapest, Hungary), Mátra Museum (Gyöngyös, Hungary) and the digital archives of Natural Sciences Museum of Barcelona (Barcelona, Spain). No bird has been killed to obtain its skull; all birds died either of natural causes, whether accidental death or whether death in captivity.

Landmarks and procedures

The variation of cranial morphology was analysed using landmark-based geometric morphometry. In this study, we tried to find landmarks for this analysis to cover the geometric form of the *regio oticalis*. Ideal landmarks are discrete and noticeable anatomical features that do not alter their topological positions, providing adequate coverage of the morphology (Zelditch *et al*. 2004). The landmarks were taken from high resolution (1200×1600 pixels) photos. We took 3 photographs from each specimen

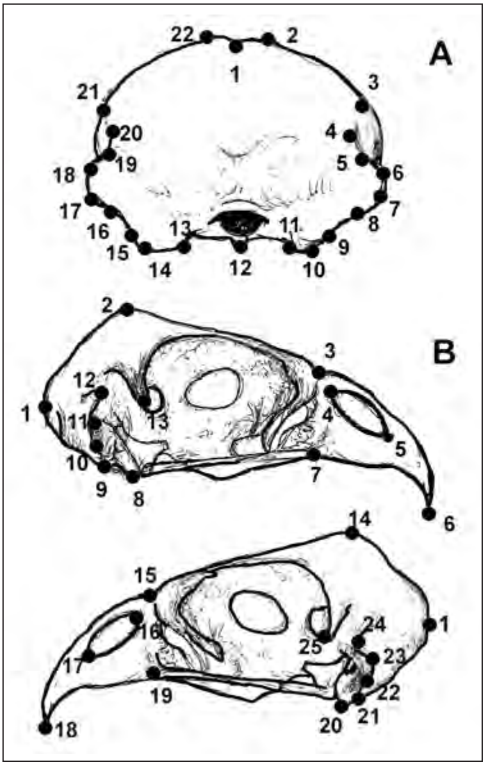

Figure 1. Position and number of landmarks. A: fixed landmarks in caudal view, B: fixed landmarks in lateral (left-right) view (numbers correspond to *Table 1*)

1. ábra A vizsgálatban használt landmarkok száma és pozíciója. A: fix landmarkok hátulnézetből, B: fix landmarkok oldalnézetből (bal-jobb) (a számok megnevezését lásd a *1. táblázatban*) (caudal, lateral – right and left). Images were standardised for the *foramen magnum occipitale* and the tip of the mandible. Testing for fluctuating asymmetry, three measurements were taken (replicates) per individual. For each specimen, 22 fixed landmarks were recorded in caudal view and 25 fixed landmarks in lateral view (right and left) *(Figure 1) (Table 1)*. The coordinates of the landmarks were digitised using TpsDig 2.16 software (Rohlf 2010) and were transformed using the Procrustes superimposition method. We used Mann-Whitney U two-tailed test for comparing the sides. To detect the components of variances

Table 1. Number and description of landmarks in caudal (A) and lateral (B) view (terminology according to Baumel 1993, Sun *et al.* 2018)

1. táblázat Az egyes landmarkok száma és leírása, hátulnézetben (A) és oldalnézetben (B) (terminológia Baumel 1993 és Sun *et al.* 2018 alapján)

A) Number of landmark	Description of landmark
1	mid section of the *neurocranium*
2 , 22	highest point of the *neurocranium*
3 , 21	top of curvature at the *superior* end of the *M. add. mandibular externus* scar
4 , 20	top of curvature at the *caudal* end of the *M. add. mandibular externus* scar
5 , 19	top of curvature at the *inferior* end of the *M. add. mandibular externus* scar
6 , 18	highest edge of the temporal wing
7 , 17	top of curvature at the *superior* end of the temporal wing
8 , 16	top of curvature at the *caudal* end of the temporal wing
9 , 15	top of curvature at *inferior* end of the temporal wing
10 , 14	lowest edge of the temporal wing
11 , 13	most inner edge of the temporal wing at the inferior end
12	lowest point of *condylus occipitalis*

B) Number of landmark	Description of landmark
1	*prominentia cerebellaris*
2 , 14	highest point of the *neurocranium*
3 , 15	mid-point of the *cranio-facial* hinge
4 , 16	top of curvature at the *caudal* end of the external nares
5 , 17	top of curvature at the *rostral* end of the external nares
6 , 18	tip of the beak
7 , 19	articulation point of jugal bar and *maxilla*
8 , 20	the *processus* of the *opisthotic*
9 , 21	lowest edge of the temporal wing
10 , 22	top of curvature at the *inferior* end of the temporal wing
11 , 23	top of curvature at the *superior* end of the temporal wing
12 , 24	highest edge of the temporal wing
13 , 25	*processus postorbitalis*

and deviations, Procrustes ANOVA was used (Klingenberg *et al.* 1998, Marquez 2006). Consensus configurations and relative warps were conducted. Variability in shape was assessed using the scores obtained for each individual on the first two relative warps. Cranial asymmetry was estimated using SAGE (Symmetry and Asymmetry of Geometric Data) software (Marquez 2006). We conducted principal component analyses (PCA) on these morphological variables in caudal view. The relative warps are corresponding to the principal components (PCs) and define the shape space in which individuals are replaced. We used PAST v.1.7 software (Hammer *et al.* 2001) for principal component analysis and to extract deformation grids. We only considered those PCs which are explaining >10% of the variance.

Results

Mann-Whitney U two-tailed test showed significant differences between the two sides of the skull regarding the temporal region ($U=838.5$; $z=-8.22$, $P<0.001$ at the significance level 0.01).

Procrustes ANOVAs revealed that directional asymmetry was greater than fluctuating asymmetry *(Table 2)* reflecting the coordinates in caudal and lateral view.

During the second analysis, we used 22 fixed landmarks recorded in caudal view. The first two PCs explained 38%, and 22% of the variance in shape. The first PC described the variation in shape, the second the relative orientation of the temporal wing which showed that *Circus* species differ considerably in their degree of asymmetry *(Figure 2)*. The Western Marsh Harrier showed less cranial asymmetry than the other two species, Montagu's Harrier was in intermediate position in the analysis and Hen Harrier showed the most asymmetric scores *(Figure 3)*.

Table 2. Results of ANOVA for the registered coordinates in caudal (above) and lateral view (bottom), with the effect of "side" (directional asymmetry) and "side*individual" effect (fluctuating asymmetry)

2. táblázat Az ANOVA eredményei a regisztrált koordináták tekintetében hátulnézetben (fent) és oldalnézetben (alul), az "oldal" (direkcionális aszimmetria) és az "oldal*egyed" (fluktuáló aszimmetria) hatásával

effect / hatás	SS	MS	df	F	p
individual / egyed	0.0566	0.0004	160	4.6948	0.001
side / oldal	0.0045	0.0002	20	2.9694	0.001
side*individual / oldal*egyed	0.0121	0.0001	160	16.7492	0.001
error / hiba	0.0032	0.0002	720		

effect / hatás	SS	MS	df	F	p
individual / egyed	0.0646	0.0004	184	4.7844	0.0001
side / oldal	0.0073	0.0003	23	4.346	0.0001
side*individual / oldal*egyed	0.0135	0.0001	184	93.4848	0.001
error / hiba	0.0006	0.0001	828		

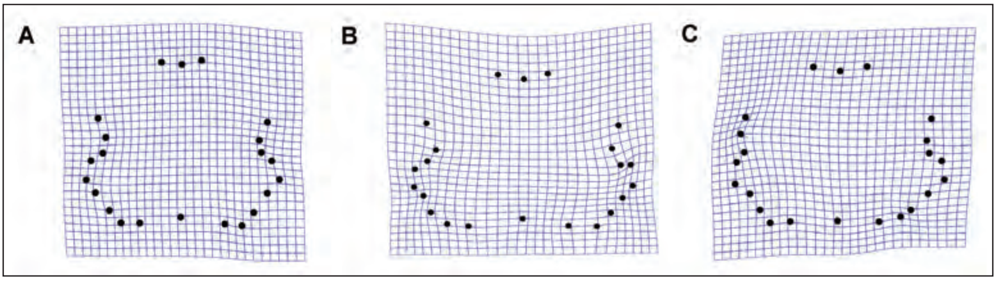

Figure 2. Various harrier species differ considerably in their degree of asymmetry (in caudal view). A: Western Marsh Harrier *(Circus aeruginosus)*, B: Montagu's Harrier *(Circus pygargus)*, C: Hen Harrier *(Circus cyaneus)*

2. ábra Az egyes rétihéja fajok különböznek az aszimmetria mértékében (hátulnézetben. A: barna rétihéja *(Circus aeruginosus)*, B: hamvas rétihéja *(Circus pygargus)*, C: kékes rétihéja *(Circus cyaneus)*

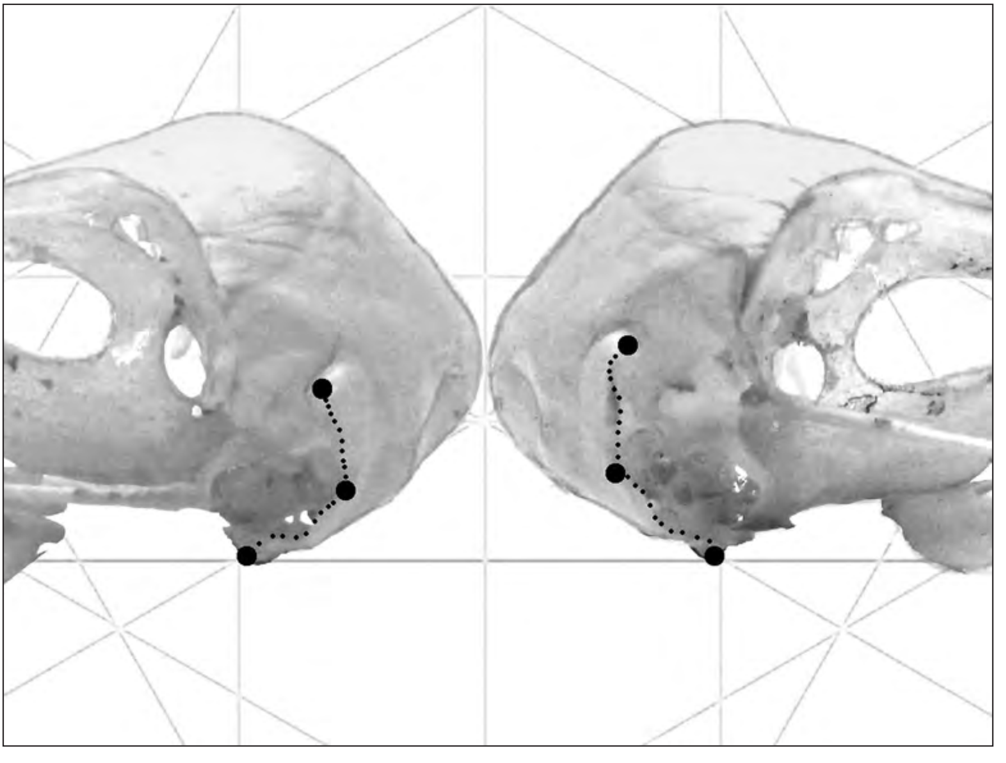

Figure 3. Differences in position and shape of left and right tympanic wings on the skull of a Hen Harrier *(Circus cyaneus)* specimen

3. ábra A kékes rétihéja *(Circus cyaneus)* egy példányának koponyáján lévő különbségek a bal és jobb oldali halántékcsont *tympanicus* nyúlványainak helyzetében és alakjában

Discussion

We found that the influence of directional asymmetry was greater than fluctuating asymmetry which suggests that these asymmetrical features probably evolved to support directional hearing and sound localization. In lateral and caudal view, there are differences in the size and orientation of the temporal wing between the species. However, the anatomical similarities between harriers can be explained by their slightly different foraging methods and hunting behaviour.

Comparisons between sympatric raptor species with similar ecological needs and preferences but different body size and social behaviour are helpful in assessing the influence of energy needs or dominance on foraging strategies and food partitioning (Fedriani *et al.* 2000, Buij *et al.* 2011). The Montagu's Harrier and the Hen Harrier are breeding and foraging sympatrically in many areas. The diet of these species is very similar (Millon *et al.* 2002). The species differ in size, Hen Harrier being larger and also there are differences in their breeding system (Cramp 1980). Food partitioning by size between species that differ in food requirements is expected and has been observed in other species too (Gerstell & Bednarz 1999). Accordingly, within the large spectrum of prey types indicated that Hen Harriers preyed more frequently on larger prey and Montagu's Harriers on smaller prey (including more insects). This kind of segregation was observed in the main prey (small lagomorphs and rodents), and in the sizes of the most important alternative prey (Garcia & Arroyo 2002, Arroyo & Garcia 2006, Arroyo 2008).

The competition between Western Marsh and Hen Harriers for hunting space in the same area was also observed, i.e. Western Marsh Harriers hunted mainly over the marsh (Buij 2012, Tornberg & Haapala 2013) resulting in niche separation between the two species. Western Marsh Harrier has proportionately shorter wings and tail, its flight is slower and less manoeuvrable compared to Hen Harrier. Western Marsh Harrier has longer tarsi which should be an adaptation to reach deep into tall marsh vegetation preferred to hunt, maybe because this gave it more opportunity for surprise during hunting (Clarke *et al.* 1993, Cardador *et al.* 2012).

Differences in foraging efficiency between generalist and specialist species could be explained by neural limitations. This means that generalists need learning to be able to narrow their resource choices (Bernays *et al.* 2004). Specialization may be also associated with morphological or behavioural adaptations to handle certain resources. Harriers are diurnal raptors but evolved a parabolic collar of feathers surrounding the eyes, suggesting that hearing is enhanced to locate small mammal prey hiding in dense vegetation (Rice 1982, Redpath 1992, Simmons 2000). The facial disc is more pronounced in those harrier species which are feeding on mainly small rodent prey like the Pallid Harrier *(Circus macrourus)* (Buij 2012). The facial disc encircling the ears and meeting below the beak, in contrast, the facial disc of the Montagu's Harrier is confined to an arc just behind the ear openings, suggesting its hearing capacities might be less well developed than that of the rodent specialist species (Clarke *et al.* 2008, Terraube *et al.* 2011). This is also in accordance with our results. The Western Marsh Harrier is a great opportunist with lack of specialization (which means very wide range of prey, varying with local availability) showed less asymmetrical features. The Montagu's Harrier is feeding on small ground birds, small mammals, reptiles and large insects (Thiollay 1994) but the Hen Harrier (which preys on mostly small rodents, like voles, mice, cotton rats, ground squirrels) (Garcia & Arroyo 2004) showed greater asymmetries in temporal region than the other two species. It suggests that feeding mainly on small rodents requires more sensitive auditory capabilities to detect the movement of the prey item. It is also possible that the relative size of the facial disc is in relationship with asymmetrical cranial structures, which also connected with hearing and auditory capabilities in owls (Norberg 2002). In the case of Hen Harrier some kind of nocturnal behaviour (Russell 1991) may have also effect on this feature.

Our results show relationships between cranial asymmetry and hunting behaviour but also highlight the morphological complexity and diversity of raptor skulls. Future studies should rather examine the possible interspecific and intersexual differences that may have effect on the cranial morphology and asymmetry of these birds. With a larger sample size (including more harrier species) and using parameters of soft tissues of the ear and temporal region will create a more complex vision regarding the evolution of asymmetrical features which are supporting directional hearing. New investigations reflecting on cranial asymmetries may increase our knowledge to understand how these special features are functioning in living specimens.

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Observations of roosting Water Pipits and comments on the species' British status

January 2025

Abstract

The Water Pipit *Anthus spinoletta* is an uncommon winter visitor and passage migrant in Britain. The shy and retiring behaviour of the species in its favoured wetland habitats can make it difficult to observe and record accurately. This paper reviews the species' historical status in Britain and describes observations at a communal winter roost in Suffolk, where counts regularly exceed the numbers observed foraging on adjacent marshes during daylight. Observers are encouraged to seek out further roosts, which could support the evidence from this site that the current estimate of the British wintering population may be too low.

Observations of roosting Water Pipits and comments on the species' British status
2025 Vol.118: Pages 20–26

National Grid Electricity Transmission
By email only

18th December 2023

Dear Sir/Madam

Re: Sea Link project public consultation

Thank you for informing us of your public consultation regarding the Sea Link Preliminary Environmental Information. Please find below our comments on the consultation materials.

Overarching comments

The RSPB believes that climate change poses the greatest threat to wildlife and people that we face today. Decarbonising the UK's energy sector will be vital in the fight against dangerous climate change and switching to renewable sources of energy is essential to achieving this goal. The RSPB is therefore supportive of renewable energy projects (and associated works required to the network) providing adverse impacts on wildlife and habitats can be avoided through careful siting and design. Currently, however, protected wildlife sites are threatened by damage from a range of energy projects in Suffolk, including Sizewell C and several National Grid infrastructure projects. We need Government, National Grid and OFGEM to work together to develop a more strategic approach to the planning of energy projects to enable a response to the energy and climate crisis that helps us to achieve a 'nature friendly net zero'.

The RSPB remains seriously concerned that the Sea Link proposals are a considerable threat to RSPB North Warren and the Leiston-Aldeburgh Site of Special Scientific Interest (SSSI) in Suffolk and Thanet Coast and Sandwich Bay Ramsar, Thanet Coast and Sandwich Bay Special Protection Area (SPA), Sandwich Bay Special Area of Conservation (SAC) and Sandwich Bay to Hacklinge Marshes SSSI in Kent. We are extremely disappointed that infrastructure development has been proposed within important wildlife sites. National Grid should consider how impacts on important wildlife sites can be avoided and mitigated as far as possible, in line with the mitigation hierarchy.

RSPB England Headquarters
First Floor
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This should include consideration of alternative options to avoid sensitive areas. We do not agree that this approach has been adequately demonstrated thus far and therefore we object to the proposals in their current form.

Notwithstanding the above point, we are also disappointed with the standard of environmental evidence provided for the Sea Link proposals through this consultation on the Preliminary Environmental Information. In our view, National Grid will need to refine and amend these proposals, including further consideration of alternatives, if the project is to be brought forward without significant damage to the nationally and internationally important wildlife and habitats of the Suffolk and Kent Coasts. Based on the information provided in this public consultation, we are not reassured that impacts will not be significant due to the lack of detail about the current proposals, evidence regarding potential impact significance and design and efficacy of mitigation measures. Therefore, we are unable to agree that there will be no adverse effects on the integrity of the following internationally designated sites:

- Thanet Coast and Sandwich Bay SPA, Thanet Coast and Sandwich Bay Ramsar, and Sandwich Bay SAC, Kent
- The Sandlings SPA, Suffolk
- The Outer Thames SPA

We are also unable to agree that significant damage will not occur to the following nationally designated sites:

- The Leiston-Aldeburgh SSSI, Suffolk
- Sandwich Bay to Hacklinge Marshes SSSI (Kent)

We are also concerned about the potential for impacts on the following designated sites arising from the Sea Link project cumulatively with other projects:

- Minsmere-Walberswick SPA and Ramsar site
- Alde-Ore Estuary SPA and Ramsar site
- Sandlings SPA
- Thanet Coast and Sandwich Bay SPA
- The Outer Thames SPA

Whilst we object overall to the proposals in their current form, we acknowledge that the project may proceed to application and be consented despite these concerns. Therefore, we also will seek to engage with National Grid to secure mitigation to avoid and reduce impacts on nature conservation as far as possible should the development go ahead. Our detailed comments thus include both further detail of our objection due to the inadequate approach to avoidance of designated sites as well as discussion of the potential impacts and mitigation relating to the proposals in their current form.

Comments on the Suffolk Onshore Scheme

Evolution of the Suffolk Onshore Scheme

Whilst PEIR, Part 2, Ch. 1 Evolution of the Suffolk Onshore Scheme does mention opportunities to avoid and mitigate impacts on designated sites for some parts of the process, there are still some areas where we feel the approach is not clear, particularly around the refinement from the initial routing and siting study area (from Hollesley to Dunwich) towards the identification of the landfall areas of search.

We are also disappointed to see a number of references to the use of trenchless techniques at the Leiston-Aldeburgh SSSI and RSPB North Warren being described as avoidance (for example, PEIR, Part 2, Ch. 1 Evolution of the Suffolk Onshore Scheme paragraph 2.1.2.48). Whilst the proposal of such techniques is welcomed (subject to the caveats discussed below), this does not constitute avoidance of the designated site, but is rather mitigation to reduce impacts. Geographic avoidance would require an alternative route to be proposed. This is an important distinction as even with the use of trenchless techniques, there are still risks to the SSSI associated with disturbance during construction and technical failures during construction or operation. There are also several instances where the documents refer to the Suffolk Onshore Scheme being adjacent to the Leiston-Aldeburgh SSSI and RSPB North Warren (e.g. Paragraphs 2.3.8.2-3 of PEIR Vol. 1, Part 2, Chapter 3, Ecology and Biodiversity). Again, the use of trenchless techniques to install cables beneath the surface of the site does not mean that the project lies outside the SSSI boundaries. We therefore do not agree that the information presented at this stage demonstrates that adequate weight has been given to the need to avoid impacts on designated sites. It is necessary to collate and expand on the information about the approach to avoidance and mitigation so that the narrative with regard avoidance of designated sites is clear from the beginning to the end of the process.

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In our view the exploration of alternatives has been too narrow as a result of the above limitations in the process. This is illustrated by the recent inclusion of an additional potential route option by the LionLink project which could avoid designated sites (although we acknowledge that other issues may remain). Given that it has been possible for that project to identify alternatives, we query why it has not been possible so far for the Sea Link project.

We note that the documents do give great weight to the capacity of landfall sites and cable corridors to support project co-location. We consider that this must be weighed carefully against the potentially greater impacts of co-location – i.e., consideration should be given to the total impacts of the three projects using more than one cable route where they can avoid designated sites as compared to the impacts of co-location within a designated site, as is currently proposed. We also note that whilst Sea Link is geographically constrained in its overall area of search through the needs arising from various generation sources in the local area, the justification for a limited geographic area of consideration for the subsequent projects (multi-purpose interconnectors rather than network reinforcements) is not as strong and therefore the needs of these subsequent projects should not be an overriding consideration in the location of the Sea Link project.

Given our concerns above, we object to landfall S2 remaining as the preferred location and, whilst supportive of co-location in principle <u>where significant impacts on designated sites can be avoided</u>, we also object to co-location at this site.

<u>Ecological Impacts of the Suffolk Onshore Scheme</u>
We have the following high-level concerns about the potential ecological impacts of the project on RSPB North Warren, the Leiston-Aldeburgh SSSI and Sandlings SPA:

1. Disturbance: There is potential for construction-related disturbance to birds which use the marshes identified within the route corridor. Wintering White-fronted Geese prefer the area north of the footpath which crosses RSPB North Warren roughly east, whilst breeding waders are found either side of the footpath and wildfowl are likely to be present across the whole marsh. The presence of a construction compound just to the west of the

site has potential to result in significant noise and visual disturbance to SSSI features.
2. Damage to habitats: The potential for damage to SSSI habitats should any technical failures occur (particularly in relation to the use of trenchless techniques) during or after the construction process is unclear at present. Any open trenching and associated vehicle movements could cause long-term damage to coastal and wetland habitats (including ditches) which support features of SSSI interest. It would also have the potential to restrict the ability to move cattle, machinery and vehicles necessary for site management around the site.
3. Future management: The presence of a buried cable could compromise the RSPB's ability to manage the site in future, particularly should it be necessary/ecologically desirable to adapt the site due to climate change and sea level rise through e.g. the creation of new scrapes or footdrains or larger scale remodelling. This could compromise the ability of the site to achieve its ecological objectives in future.
4. Potential impacts on Sandlings SPA: The proposed route west of North Warren passes through habitat that supports Woodlark (and therefore may have a functional linkage with the Sandlings SPA) and also supports breeding Turtle Dove and Nightingale.

These issues are explored in further detail in relation to specific topics below.

Co-location

The documents explain that co-ordination of the Sea Link project with LionLink and Nautilus is being explored. Whilst the RSPB is supportive of the principle of trying to reduce impacts through project co-ordination, we are extremely concerned that co-location in this instance could have significant additional impacts on the proposed landfall area within the Leiston-Aldeburgh SSSI and RSPB North Warren. As explained above, we do not agree that it has been adequately demonstrated that there are no alternative options which would avoid impacts on designated sites, due to weaknesses in the site selection and routing process.

Our main concerns around co-location arise from concerns around increased duration of the works, the additional infrastructure required for construction, impacts of the increased width of the cable corridor through the site and the

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increased level of risk associated with any failure/faults which would require open trenching to resolve.

With regard duration of the works, we are concerned that no commitments are made to ensure that works are temporally co-ordinated as far as possible. Extending the duration of the works required at the landfall would increase the significance of noise and visual disturbance impacts as well as any direct effects on habitats at the landfall within Leiston-Aldeburgh SSSI and RSPB North Warren. Table 1.4.12 in PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project indicates that the duration of HDD drilling would increase from 125 days for one project to 250 days for three projects (assuming one drilling rig is used). Whilst this gives an indication of the additional duration of the work involved with co-location, this is only one aspect. We are also concerned about the sequencing of work and the potential for work to cross into several bird breeding/wintering seasons due to gaps between the installation of ducts for one project and cable pulling for subsequent projects. Repeated periods of disturbance (and any repeated impacts on habitats) would exacerbate the effects of the proposals on designated sites significantly, with a longer duration of impacts potentially more likely to result in longer term changes to breeding and/or wintering bird populations.

Paragraph 1.4.2.4 of the PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project appears to state that there is no benefit (and it may not be possible) to share all the infrastructure required for the projects. The types of infrastructure which could not be shared are not explained, and it is unclear what the implications of this would be for the Leiston-Aldeburgh SSSI at the landfall. More information is required to understand any potential direct effects on the SSSI as well as any impacts of additional infrastructure adjacent to the SSSI.

The PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project explains that co-location of the three projects would require an increase in the number of cables laid within the Leiston-Aldeburgh SSSI and RSPB North Warren from 4 to 10. We have not been able to find mention of the exact width of the area affected for either scenario (assuming trenchless techniques are used), although we note that minimum offset distances between cables are set out in Table 1.4.10. This is also illustrated on Figure 1.4.8 Suffolk Landfall Indicative Location with Co-location. This Figure appears to show that under the co-location scenario, a significant portion of the central area of the RSPB North

Warren (Leiston-Aldeburgh SSSI) wetlands would be affected by the presence of cables. Depending on the depth at which these cables are buried (again this is unclear), these could constrain potential future management of the site through restrictions to landshaping activities in the area above the cables, a particularly important constraint on a site potentially subject to coastal change such as this. We also note that the description referenced above conflicts with Design Drawing S42_M/TDD/SS/1041. This drawing shows 11 ducts installed under the co-location scenario, rather than 10 as described above. This also requires clarification to enable proper assessment of impacts. We are also concerned about the potential for any technical failures, during duct or cable installation or subsequent operation, which could result in open trenching and potential damage to habitats.

Commitment to use trenchless techniques at landfall
PEIR, Vol. 2, Part 1, Appendix 1.4.F Outline Schedule of Environmental Commitments and Mitigation Measures states that:

> "*The preferred installation method for the Suffolk Landfall is a trenchless technique to minimise the loss of habitat within the Site of Special Scientific Interest (SSSI): Leiston – Aldeburgh and North Warren RSPB Reserve.*"

Whilst we welcome this intention, this should be made a firm commitment as soon as geotechnical trials confirm that trenchless techniques are a suitable option. In the event that this cannot be confirmed, an alternative route should be proposed. This is because the works to install a cable via open trenching, along with the associated haul route and vehicle movements could cause long-term damage to coastal and wetland habitats (including ditches) which support features of SSSI interest.

Risks associated with trenchless techniques
Paragraph 1.4.5.70 - 72 of the PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project describe the risk of HDD drilling fluid frac-out and the mitigation that can be applied. Due to the potential for benthic smothering from releases of bentonite (or similar) in the aquatic environment, these risks require particular attention in the assessment of potential impacts on watercourses within the Leiston-Aldeburgh SSSI and RSPB North Warren.

We note that, whilst paragraph 1.4.2.54 of the PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project commits to the installation of a spare duct for the Sea Link project to reduce the need for further digging/drilling in the event of any duct failure, the likelihood of such an occurrence (or multiple occurrences) is not discussed and no assessment of the likely impacts of additional duct installation or the impacts of remedial action in the absence of a spare duct is given. This information should be provided in order to understand the full risks and implications of the project.

Installation of a spare duct

We welcome the commitment in paragraph 1.4.2.54 of the PEIR Vol. 1, Part 1, Ch. 4 Description of the Proposed Project to install a spare duct for the Sea Link project at the landfall to allow for any necessary replacement of a cable without further drilling/digging works (as discussed above). Whilst we seek assurance that such a spare duct is likely to remain functional and available for this purpose, we also raise the concern that it appears that no additional spare ducts are proposed for Nautilus and LionLink in the event of co-location. The likelihood of more than one cable/duct failure in the event of the co-location scenario and the impacts of any further drilling/digging works required should be assessed.

Construction compound

Design Drawings S42_M/TDD/SS/1044 and S42_M/TDD/SS/1038 show the layout of the HDD construction compound adjacent to the Leiston-Aldeburgh SSSI and RSPB North Warren under the Sea Link only and co-location scenarios respectively. We query why the layout appears to differ to that of the construction compound shown in General Arrangement Plans S42_S/IGA/PS/0006 and S42_S/IGA/PS/0007. Clarity regarding the location of the compound and the activities that are proposed within it is essential for the purposes of assessing impact on the SSSI and RSPB reserve. At this stage, we cannot have confidence in any conclusions around such impacts as there does not appear to be certainty regarding the designs assessed.

Noise disturbance – construction and operation

We welcome the consideration given to reduction of noise impacts on sensitive breeding bird species of the Sandlings SPA in the PEIR, Vol. 2, Part 1, Appendix 1.4.F Outline Schedule of Environmental Commitments and Mitigation Measures through the inclusion of the following measure:

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> “*Where feasible and necessary, the most potentially disturbing elements of trenchless installation will take place between September and February, to minimise disturbance of breeding nightjar and woodlark in the adjacent Sandlings SPA*”

Whilst we acknowledge that full noise modelling and assessment is not yet available, we recommend that the wording is strengthened to indicate that such mitigation would be deployed should the noise modelling indicate that noise levels within any areas of the SPA would be likely to cause disturbance. We also acknowledge the proposal to install noise barriers around the construction compound to reduce impacts on both the Sandlings SPA and Leiston-Aldeburgh SSSI and RSPB North Warren, but it will be necessary to consider the outputs of the noise modelling with such a structure in place to determine whether there is also a need for timing restrictions to further reduce impacts on the breeding and wintering bird interest of the SSSI and nature reserve.

Table 2.3.18 in the PEIR Vol. 1, Part 2, Chapter 3, Ecology and Biodiversity acknowledges that, despite the measures above, some bird species will be displaced during construction. Given the potential duration of the construction period, we are concerned that noise disturbance impacts on both the Sandlings SPA and Leiston-Aldeburgh SSSI could be significant. This will require more detailed assessment based on the outputs of the noise modelling, which should be mapped and include consideration of both average and peak noise levels. The impact of any displacement of birds will also require consideration cumulatively with other projects affecting the wider area; for example, the construction of Sizewell C may also have impacts on some wetland bird populations which use Leiston-Aldeburgh SSSI and RSPB North Warren, such as the White-fronted Goose (as acknowledged in Tables 2.14.3 and 2.14.31 of the PEIR Part 2, Ch. 14, Suffolk Onshore Scheme Inter-Project Cumulative Effects). At this stage, we do not have confidence that the noise disturbance impacts of this project alone, under the co-location scenario or cumulatively with other projects will be avoided or adequately mitigated.

We welcome the proposal below to address impacts of maintenance activities during operation and which recognises the importance of both the breeding and wintering interest of the Leiston-Aldeburgh SSSI and RSPB North Warren, although given the inclusion of the wording “*where practicable*”, we recommend that the requirement to only “*Consider*” should be removed:

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"Consider undertaking potentially disturbing (noisy) maintenance activities during August and September, where practicable, reducing risk of disturbance of breeding or non-breeding birds using RSPB North Warren Reserve or breeding nightjar and woodlark using Sandlings SPA."

Watercourse crossings
Table 1.4.D.1 PEIR Vol. 2, Part 1, Appendix 1.4.D Crossings Schedule includes four watercourse crossings within the Leiston-Aldeburgh SSSI and RSPB North Warren (crossings S/WA/0004 – S/WA/0007). The table indicates that these crossings are for a haul road as well as installation of the HVDC cables. Given a commitment is made to utilise trenchless cable installation techniques across the designated site and RSPB reserve, we query why a haul road is needed in this area? The construction of a haul road across SSSI wetland habitats, along with the disturbance arising from its use, is likely to have an unacceptably significant impact on the SSSI interest of the site.

Hydrological impacts
We note that Table 2.3.22 of the PEIR Vol. 1, Part 2, Chapter 3, Ecology and Biodiversity states that launch pit dewatering and the use of trenchless techniques could result in changes to water levels within the Leiston-Aldeburgh SSSI and RSPB North Warren. As a wetland site, maintenance of appropriate water levels is critical to enable it to continue to support specialist wetland plants and invertebrates, as well as provide suitable breeding and foraging habitat for birds. Whilst we welcome the commitment in the PEIR, Vol. 2, Part 1, Appendix 1.4.F Outline Schedule of Environmental Commitments and Mitigation Measures to "*Implement measures to ensure no significant hydrological impact on water levels in North Warren RSPB Reserve*", further detail of the potential impact pathways, mitigation measures under consideration and the evidence regarding their effectiveness is required to provide confidence that hydrological impacts can be avoided.

Breeding bird surveys
Paragraph 2.3.5.28 of PEIR Vol. 1, Part 2, Chapter 3, Ecology and Biodiversity states that no dedicated breeding surveys of Marsh Harrier were carried out at RSPB North Warren as the site will be crossed using trenchless techniques. This seems inconsistent with the approach taken for other breeding birds at the site which have been surveyed. With the potential for impacts from construction

disturbance from works adjacent to the site as well as the possibility of technical failures during the trenchless crossing requiring further work, impacts on Marsh Harrier cannot be ruled out at this stage. As a Schedule 1 breeding bird and a species mentioned in the Leiston-Aldeburgh SSSI citation, we consider that this omission is an oversight which should be rectified.

Cable corridor impacts

As explained in Table 2.3.15 of PEIR Vol. 1, Part 2, Chapter 3, Ecology and Biodiversity, the proposed cable corridor to the west of RSPB North Warren passes through areas of importance for Woodlark and Nightjar. These species are both features of the Sandlings SPA and Woodlark is listed under Schedule 1 of The Wildlife and Countryside Act. Given the number of breeding records of Woodlark in close proximity to the onshore works, we are concerned by the statement in the Table that "*there will be temporary loss of up to approximately 116 ha of potentially suitable foraging habitat within 2 km of the SPA*" and that this is not considered significant. Further information is required to show how this potential impact will be minimised, with mitigation proposed if needed.

We agree with the need for further consideration of potential loss of functionally-linked habitat associated with Alde-Ore Estuary SPA/Ramsar and Minsmere-Walberswick SPA for wetland birds once further survey information is available.

The cable corridor also passes through areas which may support Turtle Doves. This species is on the Birds of Conservation Concern (BoCC) Red List due to its dramatic decline and the RSPB has been working with partners and land managers through Operation Turtle Dove to try to halt this decline through improvements to breeding and foraging habitats. Due to the fragile state of the breeding population, it is important that impacts on key habitats for these species (including scrub and mature hedgerows) are avoided and minimised as far as possible, as reinstatement through replanting of young trees after up to 5 years is likely to mean that the habitat would not be sufficiently mature to support breeding Turtle Doves for some time beyond this. Reduction and/or mitigation of this impact is also likely to be beneficial for breeding Nightingale.

We also note that the sandy, acidic soils in parts of this section of the cable corridor make the area potentially suitable for Stone-curlew. Stone-curlew are amber listed on BoCC and listed under Schedule 1 of the Wildlife and

Countryside Act. Presence of this species should be considered in any areas of suitable acidic grassland or arable farmland, with particular consideration given to the potential for colonisation of any areas of bare ground created during the construction of the cable route. Surveys and mitigation may be required in order to avoid impacts on this species.

Cumulative/in-combination effects with other projects
We acknowledge that PEIR Part 2, Chapter 14, Suffolk Onshore Scheme Inter-Project Cumulative Effects has identified several projects, including the other National Grid projects, Sizewell C and East Anglia ONE North and TWO, which together with Sea Link may result in cumulative impacts on the following sites:

- Minsmere-Walberswick SPA
- Alde-Ore Estuary SPA
- Sandlings SPA

Given the potential for impacts on birds, it should be noted that the Ramsar sites at Minsmere-Walberswick and the Alde Ore Estuary are also likely to be at risk and should therefore be included in the assessment. Detailed consideration of impact pathways, timelines and construction methods will be required to inform the assessment and further mitigation of impacts may be required.

Biodiversity Net Gain (Suffolk Area)
We welcome the commitment in the PEIR, Vol. 2, Part 1, Appendix 1.4.F Outline Schedule of Environmental Commitments and Mitigation Measures to deliver net gain by at least 10% or greater on this project. Given the significance of the proposals, we request that consideration is given to a more ambitious net gain target of 20%.

This project has potential to contribute to the conservation of important farmland bird species, including Turtle Dove. We recommend that habitat enhancements consider planting targeted at providing nesting, foraging and watering habitat for farmland birds, where appropriate. Further details of the types of measures that could be employed can be found on the Operation Turtle Dove website[1].

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[1] https://operationturtledove.org/get-involved/habitat/

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The project also passes through areas that are of importance for breeding waders and therefore this suite of species could be a relevant target for environmental enhancements. It is, however, important that any enhancements targeted at breeding waders are clearly additional to any works required as mitigation for impacts on these species. The Suffolk Wader Strategy is led by a partnership of organisations working together to improve habitat management and increase populations of breeding waders in Suffolk, both on nature reserves and in the wider landscape. The project could consider supporting such work as part of its aspirations for environmental enhancements. Further details are available on the SWS website[2].

We would be pleased to advise further should BNG proposals targeted at farmland birds or breeding waders be developed.

Conclusions regarding the Suffolk Onshore Scheme

In summary our main concerns relate to the likely impacts of the landfall (S2) on the Leiston-Aldeburgh SSSI and RSPB North Warren, along with potential impacts on the Sandlings SPA from the associated cable route. We therefore object to landfall S2 being taken forward for Sea Link and to co-location with other projects at this site. The reasons for our objection are:

- Insufficient consideration given to avoidance of designated sites during the route selection process.
- Exploration of ecologically less-damaging alternatives too geographically constrained.
- Weak justification for co-location of Sea Link with additional multi-purpose interconnector projects at this landfall given significantly greater ecological impacts of co-location.
- Ecological impacts of the proposed landfall including disturbance, damage to habitats and constraints on future management of the SSSI and RSPB reserve.

[2] https://www.suffolkwaders.org/

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Comments on the Kent Onshore Scheme

Problems with the proposed Kent route

The RSPB repeats the same overarching comments given for Suffolk but for the Kent route options, in the sense that avoidance must be the first option for designated sites, with compensation an absolute last resort, following the National Planning Policy Framework (NPPF) mitigation hierarchy. We are disappointed that our concerns raised in the response to the pre-consultation have not been addressed and a less environmentally sensitive route chosen, such as the Broadstairs option, and many of the comments we submit here regarding the Kent route and landfall remain the same. Less damaging route options appear to have been too easily discarded at the expense of designated wildlife sites. Green infrastructure should not be at odds with biodiversity conservation. At this stage the plans are still uncertain in terms of impact assessments, including a lack of guarantee that trenchless techniques would be used, and any corresponding proposed mitigation. Therefore, we are not assured that harm to ecology at the designated sites in the region are minimal, and we cannot support the proposals. We also repeat that the Wildlife and Countryside Act 1981 places a general duty on statutory undertakers and public bodies to further the conservation and enhancement of the wildlife in the areas affected. Note that the following points are not exhaustive and additional concerns may arise as further details of the proposals are made available.

Regarding the Kent area, we have similar concerns as with the Suffolk proposals about lack of detail in the consultation to help assuage ecological concerns. Biodiverse and, particularly, heavily designated wildlife sites should not be chosen for impacts when there is the option of crossing alternative land that can more easily be replicated or reinstated. The Option Selection and Design Evolution Report Ch. 4, Paragraph 4.4.33 states that:

> *"There are several scheduled monuments located within each of these three corridors, however the blue corridor was considered the most constrained, with a combination of scheduled monuments and a proposed planning allocation in the south of Birchington, creating a pinch point that reduced the ability to route away from and around these sites."*

The preferred route option crosses Thanet Coast and Sandwich Bay Ramsar, Thanet Coast and Sandwich Bay SPA, Sandwich Bay SAC and Sandwich Bay to

Hacklinge Marshes SSSI. Such a heavily designated landscape should not be chosen for development or infrastructure projects. There are also areas away from the designated sites but functionally linked to those because some species, such as waders and wildfowl, habitually move between sites. For example, one of the designated features of the SPA, Golden Plover, uses land at Minster Marshes in significant numbers (Paragraph 3.3.8.19 of the PEIR Vol. 1, Part 3 Kent Onshore Scheme, Ch. 3 Ecology and Biodiversity) in the area threatened by development of the converter station building and associated works.

We remain unconvinced that '*a proposed planning allocation in the south of Birchington'* (Option Selection and Design Evolution Report Ch. 4, Paragraph 4.4.33) is a sufficient constraint to justify choosing to impact an SPA/Ramsar/SSSI over other, less environmentally damaging, route options such as Broadstairs. This appears to disregard NPPF guidelines for avoiding impacts on designated sites. It appears the choice has been made that nature is not a top priority, with minimal efforts to avoid harm to the biodiversity of designated sites. This is disappointing considering the ecological emergency we are facing, and the dire state of our biodiversity as evidenced[3].

The designated areas under threat and key species

National Grid's preferred route for landfall and connection to substation further inland crosses Thanet Coast and Sandwich Bay Ramsar, Thanet Coast and Sandwich Bay SPA, Sandwich Bay SAC and Sandwich Bay to Hacklinge Marshes SSSI. It would be preferable if these important areas could be avoided. If not, there needs to be clear evidence provided of how the impacts of works will avoid serious damage to these sites at landfall and onshore. For example, the site is a Ramsar for its wetland invertebrates (key wetlands must be avoided by the cable route) and its wintering Turnstones *Arenaria interpres*[4] – Turnstone winter roost and feeding areas must not be disturbed beyond an absolute minimum and coastal habitat must be protected. Thanet Coast and Sandwich Bay SPA[5] is designated such for breeding Little Tern *Sterna albifrons*, wintering Turnstone and Golden Plover *Pluvialis apricaria*. Little Tern colonies, if present, must not be disturbed or damaged in the breeding season, while the Ramsar notes for wintering Turnstone apply again. According to the SPA designation site details:

[3] State of Nature 2023 - report on the UK's current biodiversity
[4] untitled (jncc.gov.uk)
[5] Designated Sites View (naturalengland.org.uk)

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"Terrestrial habitats within the SPA, close to Sandwich Bay consist of improved and unimproved grassland, with some arable land all important habitat for golden plover to roost and feed.

The intertidal reef, together with the mudflats and sandflats which characterise the remainder of the coastline in North East Kent, provide valuable feeding grounds and roosting areas at low water for wintering waders including turnstone. In summer, shingle provides an important breeding habitat for little terns."

The SSSI designation[6] includes various habitats, scarce invertebrates and botanical interest. Looking at ornithological interest, the SSSI citation mentions:

"...the large numbers of waders and wildfowl which use the area in winter and during the Spring and Autumn migrations. Dunlin Calidris alpina is usually the most common wader present, found particularly on the mudflats where the rich invertebrate fauna also attracts a wide range of other common species such as oystercatcher Haematopus ostralegus, curlew Numenius arquata, and redshank Tringa totanus. Grey plover Plurialis squatarola and sanderling Calidris alba both overwinter in nationally important numbers, whilst ringed plover Charadrius hiaticula also occurs in nationally important numbers during migration.

Many of the birds use more than one habitat, some for example feed on the mudflats at low tide and then move up to roost on the saltmarsh or grazing marsh.

Breeding birds include ringed plover, oystercatcher and little tern Sterna albifrons, a species specially protected by law and listed on Schedule 1 of the Wildlife and Countryside Act 1981. Inland areas are also of interest supporting two nationally rare species of breeding birds."

All these habitats and others would need to be safeguarded and the wintering areas protected from significant and prolonged disturbance. Care will need to be

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6 https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1001128.pdf

taken for wintering Golden Plover, which roam and use different fields each winter as functionally linked land, and so their presence may be less predictable.

<u>Trenchless techniques are not guaranteed - there is a precedent of broken promises from a very similar scheme</u>

National Grid notes that Horizontal Direct Drilling (HDD) may be used to minimise harm to terrestrial habitats. While HDD could reduce impacts, our concerns are that this is not guaranteed, and what the options would be should HDD fail or be discounted for whatever reason (such as soil type). Ecology consultants Biocensus found there was apparently permanent damage to protected saltmarsh and mudflat habitats in the SPA/SAC/Ramsar/SSSI at Pegwell Bay due to the Nemo Link infrastructure project using trenching techniques, after it had promised to use trenchless techniques[7]. This included physical impacts to saltmarsh within the construction corridor and flooding of the saline lagoon with corresponding changes to the marginal vegetation there. Natural England are aware of this damage. This is something that must not be allowed to happen again at these designated sites. Given this uncertainty, the risk of serious damage to the SPA and the other designated habitats cannot be ruled out at this stage. There must be guarantees that methods of cabling must not result in serious harm to designated wildlife sites. We would also need to see a commitment to use HDD to avoid direct damage or serious disturbance to non-designated but functionally linked land (FLL) that is important for wildlife. The 40m to 100m width for the HVDC and HVAC terrestrial cable works respectively need to avoid key habitats and wildlife areas.

While we would expect avoidance of trenching in intertidal and saltmarsh habitats important for wading birds, this area is protected by a number of national and international designations and harm should be avoided in the first instance. As paragraph 3.3.8.17 of the PEIR Vol. 1, Part 3 Kent Onshore Scheme, Ch. 3 Ecology and Biodiversity notes, the intertidal zone is of considerable importance for wading birds and other shoreline species:

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[7] Post-construction Saltmarsh Monitoring – NEMO Link Ltd – Pegwell Bay, Kent – November 2018, Version 1.0

"The intertidal zone was of considerable significance. Dunlin (Calidris alpina), cormorant (Phalacrocorax carbo), oystercatcher (Haematopus ostralegus) and sanderling were recorded in large numbers and peak counts approaching or exceeding the 1% Great Britain national thresholds. Golden plover and sanderling were recorded in large numbers (peaks of 307 and 413) within the survey area, comprising a large proportion of the most recent SPA/Ramsar Wetland Bird Survey (WeBS) 5 year mean peak of 433. Sanderling was also recorded in significant numbers. Ringed plover, turnstone and red-throated diver (Gavia stellata) were recorded in much smaller numbers than the original SPA/Ramsar counts but comparable to the latest Pegwell Bay WeBS data."

Trenchless techniques are proposed to minimise harm – as below – but the problem is that it is an assumption and not yet a guarantee:

> "*Assuming trenchless techniques will be used to traverse sensitive intertidal habitats, notable habitats had no significant combined effect from the Proposed Project* (Paragraph 8.2.4 of the PEIR Non-technical Summary Version A, Ch. 8 Project-wide Preliminary Environmental Assessment)."

Regarding landfall for K1 at the Pegwell Bay green corridor, we agree that if a trenchless route is not possible here, this route should be avoided as a trenchless technique would be essential to avoid harm - as has already happened in the area, despite the promises, at the Nemo Link site.

<u>Functionally linked land – Golden Plover and other species</u>

The 26-metre-high planned converter station and new substation site covers much of Minster Marshes, and this is likely to impact wintering Golden Plover as a designated feature of the SPA, and Curlew, as FLL though habitat loss and disturbance. This is evidenced by over 1% of the SPA population observed within the proposed development zone during winter surveys in 2022-2023, as reported in table 3.3.15 preliminary assessment in the PEIR Vol. 1, Part 3 Kent Onshore Scheme, Ch. 3 Ecology and Biodiversity:

"The first season (2022-2023) of wintering bird surveys has identified that fields northeast of the River Stour through which the proposed Kent Onshore Scheme will pass supported significant numbers (more than 1% of both the SPA population and the latest WeBS counts) of golden plover,

albeit only on a single visit in December, when a flock of more than 700 individuals was recorded. This record appears correlated with localised standing water within these fields. These fields overlap with the location of the proposed Minster Converter Station and Minster Substation."

Furthermore, loss of this functionally linked land will be permanent and significant in terms of SPA impacts (paragraph 3.3.10.5 of the PEIR Vol. 1, Part 3 Kent Onshore Scheme, Ch. 3 Ecology and Biodiversity):

"Although the entire fields will not be occupied by the Proposed Project, they will effectively cease to support significant non-breeding bird assemblages."

Should the development proceed, the possibility of mitigation is raised to:

"...deliver long-term improved habitat (for example, in the form of seasonally flooded grassland and new riverside scrapes) to offset the permanent loss of fields currently used by non-breeding golden plover, and to enhance the Stour corridor." (PEIR 3.3.10.3 and 3.3.10.5).

We would need to see details of what area - in terms of location and size - could be secured, what quality this would be, and when. Such habitat mitigation should be done before the functionally linked land is damaged or destroyed in order that the designated SPA feature population, Golden Plover, does not suffer a loss of key habitat before Sea Link is completed. Should that not prove possible, then this must be explained and factored into the size of the land eventually secured for habitat creation and/or improvement, to ensure the long-term benefit of the SPA feature. Any such land must be protected in perpetuity from future upheaval by this or other projects.

We are also concerned about the impact of new pylons across the Stour on flying birds moving between designated sites and functionally linked land. This concern is recognised by National Grid:

"At this stage of the Proposed Project, the potential for operational period collision risk cannot be dismissed, associated with the new section of overhead powerline and species travelling to Stodmarsh SPA/Ramsar"

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(Paragraph 3.3.8.17 of the PEIR Vol. 1, Part 3 Kent Onshore Scheme, Ch. 3 Ecology and Biodiversity).

We seek further detail and clarity about how impacts would be avoided or minimised in the Stour and Minster Marshes area, as well impacts of light pollution on wildlife there. There are substantial areas of farmland, including habitat managed for wildlife, in this area that are important for Red-listed birds and others, including land around the proposed converter station site. These farms are managed sympathetically for declining wildlife and have produced impressive results: some examples include a thriving Grey Partridge *Perdix perdix* population, breeding Nightingales *Luscinia megarhynchos* and Long-eared Owls *Asio otus*, as well as wintering Curlews and Lapwings. Some land is part of Operation Turtle Dove[8] - with Turtle Dove *Streptopelia turtur* successfully breeding in recent years. There are also ongoing habitat enhancement efforts such as creating scrapes for Lapwings *Vanellus vanellus.* The work local farmers are undertaking for wildlife there is increasingly valuable given the widespread declines of British farmland and woodland birds, and it is important that Sea Link does not impede these efforts. Survey work undertaken by Sea Link must be sure to capture the extent of the bird fauna in this area and to incorporate data from the long-running bird studies, such as bird ringing, the landowners have overseen.

The route and associated works should avoid the mouth of the Stour and the biodiverse areas south of this. We ask that options for siting landfall further into previously industrialised areas and building construction on existing developed and low-biodiversity land be chosen. The SSSI designation makes clear that birds use a mix of habitats, and habitats in and around the designated areas should be considered connected and the impacts assessed and minimised accordingly, with FLL of the SPA avoided.

<u>Disturbance impacts and risks of further problems in the future</u>

Disturbance during construction is likely to have serious impacts, for example on Golden Plover, and National Grid needs to show how this would be avoided or kept to an absolute minimum. Techniques to minimise disturbance such as low-

[8] Home - Operation Turtle Dove

noise machinery and acoustic barriers should be used, as well as reacting in real time to bird assemblages at the site. This impact needs to be avoided not only during the breeding season but also during the winter where important wintering bird assemblages are present. Reliable local ornithological expertise and local records centre data should be sought in addition to any new survey findings to ensure areas in use by breeding birds or important winter bird assemblages at the time of the development phase are avoided. Wintering birds such as Curlew and Golden Plover habitually range over wide areas and have different preferences of location each year according to weather, food abundance, disturbance and other factors – these variations need to be responded to carefully and appropriately in real time and decisions based on a combination of evidence, and not taken solely based on past surveys or assumptions.

We also have concerns about the cumulative impacts of infrastructure developments in Kent and whether future works will take place to co-locate with the current proposals and previous developments, and to prolong disturbance impacts on the birds of the designated areas. We would like to see effective coordination and long-term planning of such impacts to be able to adequately assess the suitability of individual projects such as Sea Link.

<u>Impacts on future management</u>

Any cabling or other infrastructure and associated works to take place around the designated areas and FLL must be done in such a way that will not hinder management or future habitat enhancement opportunities in the area – for example by ensuring cables do not interfere with water supply and are sited deep enough to prevent interference with machinery and habitat work. For example, if open-trenched cables are to be buried at only around 1.5m deep, this may damage the designated sites by precluding future habitat management, habitat creation or adaptation to rising sea levels. Damage caused by the Nemo Link trenching to saltmarsh and other habitats has caused lasting damage to the SPA/SAC/Ramsar/SSSI. We seek more details about how further such impacts will be minimised with Sea Link.

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2016 Review of Special Protection Areas

In respect of land with potential functional links to nearby SPAs we draw your attention to the 2016 UK review of Special Protection Areas[9]. The need to extend the UK's protection for scarce birds was set out in the third review of the UK's terrestrial Special Protection Area network, published by JNCC in 2016. This SPA Review examined whether existing SPAs sufficiently met the ecological needs of Annex 1 and regularly occurring migratory species.

The review outlined that the current suite of SPAs is considered insufficient for many species. As a result, any potential impacts on the SPA and its associated species should be avoided, including on FLL. The SPA Review also looked at the boundaries of existing sites to assess whether they meet the needs of the species they are designated to protect. This included consideration of habitats outside the current SPA boundaries that species are reliant on. The RSPB strongly advises that the findings of the SPA Review are fully taken into account for any surveys or decisions associated with the potential cable route. This will ensure that recognised important sites for nature can be properly considered alongside the existing SPA citations in survey and monitoring, impact assessment and decision-making, as clearly intended by the SPA Reviews.

Conclusion (Kent route)

In conclusion, we are unconvinced as to why other alternative routes in less sensitive locations are not chosen. Less damaging route options appear to have been too easily discarded, at the expense of designated wildlife sites. There are insufficient reassurances or details of how damage to the designated sites in the Pegwell Bay area and functionally linked land would be avoided or fully mitigated if the route currently preferred by National Grid is chosen. We consider some of the damage could be avoided by siting cabling or buildings on already developed land. We have concerns over impacts on designated features of the SPA due to impacts on intertidal habitat in the SPA and loss of functionally linked land around Minster Marshes, as well as impacts on declining farmland

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[9] Stroud, D.A., Bainbridge, I.P., Maddock, A., Anthony, S., Baker, H., Buxton, N., Chambers, D., Enlander, I., Hearn, R.D., Jennings, K.R, Mavor, R., Whitehead, S. & Wilson, J.D. – on behalf of the UK SPA & Ramsar Scientific Working Group (eds). 2016. The status of UK SPAs in the 2000s: the Third Network Review. JNCC, Peterborough.

and woodland birds in the area. We need to see detailed mitigation measures so that their suitability can be examined in good time. There need to be guarantees about using trenchless techniques, given the harm already caused to the designated areas from a similar infrastructure project that promised trenchless techniques but used damaging trenching methods after all. There are also concerns about other future infrastructure projects choosing to use the same area and prolonging damage and disturbance to this important site. We may be able to reassess our position in the future should more detail or other information be presented subsequently.

Comments on the Marine Scheme

The RSPB is particularly concerned about the disturbance and displacement impacts of construction, installation, maintenance and decommissioning of the subsea high voltage cable (HVDC) on red-throated diver in the Outer Thames Estuary SPA.

Our concern is reinforced by the Secretary of State's recognition in the East Anglia ONE North (EA1N) and East Anglia TWO (EA2) Decision Letters of a likely "*adverse effect on integrity … in relation to alone and in-combination impacts on red-throated diver from displacement/disturbance, a qualifying feature of the Outer Thames Estuary SPA*[10]".

As PINS also noted in the Sea Link Scoping Report (para. 5.3.3), the Outer Thames Estuary SPA "*qualifying features include species such as red-throated diver which are known to be vulnerable to disturbance and which could be affected by construction and maintenance activities*".

We consider that the preliminary assessment (at 4.6.9.6/Table 4.6.14, PEIR Volume: 1 Part 4 Offshore Scheme Chapter 6 Ornithology (PEIR 1/4/6)) that red-throated diver has only "*a medium sensitivity to disturbance from anthropogenic activities such as shipping and offshore wind farms during construction, maintenance and decommissioning*" may underestimate the level of sensitivity of the species to those impacts.

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[10] see 17.18 – 17.57, EA1N Decision Letter

Furthermore, notwithstanding what are described as the "*temporary, short-term nature of the construction, maintenance and decommissioning works*", the preliminary assessment that the "*temporary*" displacement of red-throated diver during construction is "*not significant*" is also likely to be an underestimate of the actual impacts.

This flaw in the preliminary assessment follows through into the assessment of intra-project cumulative effects because by categorising the displacement of red-throated diver during construction as "*not significant*", stage 2 of the intra-project cumulative effects assessment (Table 4.11.6, PEIR Volume: 1 Part 4 Offshore Scheme Chapter 11 Offshore Scheme Intra-Project Cumulative Effects) is avoided.

In relation to inter-project cumulative effects (Table 4.12.18 Marine Ornithology CEA, PEIR Volume: 1 Part 4 Offshore Scheme Chapter 12 Offshore Scheme Inter-Project Cumulative Effects) we are not convinced that the cumulative "*likely significant effects*" on red-throated diver from Sea Link along with EA1N, EA2 and others will be reduced to "*not significant*" by the embedded measures proposed. There are a number of factors that need further consideration and in respect of which more detailed embedded measures should be proposed.

There is good evidence that the overwintering period for red-throated diver in the Outer Thames Estuary SPA runs from September through to April (not just from January to March) so within the SPA it is essential that this longer overwintering period is observed and that no construction, installation, maintenance or decommissioning activities, or any project-related vessel movements, take place within that period.

If there is any possibility that such activities and vessel movements may occasionally need to take place in the SPA between September and April, a vessel management plan should set out detailed measures to include exactly what route or routes are to be used, how vessel operators will be made aware of the importance and sensitivity of the birds to disturbance, how vessel operators will recognise and steer clear of rafting birds and areas with high densities of birds, and how all such measures are to be monitored and enforced.

Conclusion regarding the Marine Scheme

The 'adverse effect on integrity' from displacement and disturbance impacts on red-throated diver as a qualifying feature of the Outer Thames Estuary SPA, is well known and formally acknowledged in the context of other infrastructure projects. Due also to the known high sensitivity of this species to vessel movements, project-related vessel movements and cable installation, maintenance or decommissioning activities during the red-throated diver overwintering period, from September to April, should be avoided. If there is any, even occasional, need for project-related vessel movements within that period, they should be subject to clearly detailed and practical bird avoidance measures to be set out in a detailed vessel management plan.

We would welcome discussion of the issues addressed in this letter and look forward to further updates in due course.

Yours sincerely

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Effects of ship traffic on seabirds in offshore waters: Implications for marine conservation and spatial planning

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Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning

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Abstract. Most anthropogenic influences on marine ecosystems, except for river- or terrestrial-borne pollution, involve some sort of vessel activity. Increasing anthropogenic activities mean that many countries are being forced to develop spatial planning schemes, while at the same time implementing conservation sites for sensitive species at sea. The effects of ship traffic on seabirds sensitive to human disturbance are currently too poorly understood to allow for the development of proper planning and conservation guidelines. We therefore used aerial surveys and experimental disturbance to elucidate the effects of passing ships on the distribution patterns, habitat loss, and species-specific flight reactions of birds, as well as the potential for habituation. Loons (*Gavia* spp.) showed clear avoidance of areas with high shipping intensity. Flush distances of four sea duck species differed significantly, with the longest distances recorded for Common Scoters (*Melanitta nigra*) and the shortest for Common Eiders (*Somateria mollissima*). Flush distance was positively related to flock size. Among all the sea duck species studied, the duration of temporary habitat loss was longest for Common Scoters. We found indications of habituation in sea ducks within areas of channeled traffic. However, it is questionable if habituation to free-ranging ships is likely to occur, because of their unpredictable nature. We therefore recommend that spatial planning should aim to channel ship traffic wherever possible to avoid further habitat fragmentation and to allow for habituation, at least in some species. Information on the effects of shipping on other seabird species and during different periods of the year is urgently needed, together with information on the effects of different types of boats, including recreational and fishing vessels.

Key words: Black-throated Loon; Common Eider; Common Scoter; distribution; disturbance; German North Sea and Baltic Sea; habitat loss; Long-tailed Duck; Marine Special Protection Area; Red-throated Loon; shipping; White-winged Scoter.

Introduction

Spatial planning of anthropogenic activities in the offshore zone is currently in progress in many countries worldwide. Most activities in marine ecosystems are in some way related to shipping. Disturbance by ships can be a major threat to birds, through affects on behavior, reproduction, and fitness of individuals in colonies (e.g., Burger 1998, see review in Carney and Sydeman 1999), as well as on foraging or resting habitats (e.g., Rodgers and Schwikert 2003, Stolen 2003, Kaiser et al. 2006). However, the effects of ship traffic on seabirds are still too poorly understood to allow for either proper spatial planning or conservation management actions.

The situation in the German offshore zone can be regarded as typical of that in many countries that are currently forced to combine anthropogenic activities (such as shipping) and conservation needs in their planning schemes. The German North Sea is one of the most intensely used marine systems worldwide (Halpern et al. 2008), and shipping is particularly intense in the German North Sea and Baltic Sea (Knust et al. 2003). These bodies of water are used as resting and foraging sites by high numbers of seabirds that are sensitive to human disturbance, many of which are listed in Annex I of the European Union (EU) Birds Directive (e.g., Garthe et al. 2003, 2007, Mendel et al. 2008). Special Protection Areas (SPAs) have recently been implemented in the Exclusive Economic Zones under the EU Birds Directive (Garthe 2006; hatched areas in Fig. 1b).

Numerous studies have examined the conflict between birds and ships in freshwater sites (e.g., Tuite et al. 1983, Rodgers and Schwikert 2003). In contrast, basic information on the impacts of ships on seabirds in offshore waters is generally scarce. The few studies involving marine habitats have focused on single species in connection with cargo shipping (Kube 1996, Camphuysen et al. 1999, Kaiser et al. 2006). Basic information on the effects of passing ships on individual flight reactions, distribution patterns, and habitat loss for a suite of sensitive species in a marine system has not yet been quantified. However, such basic knowledge is

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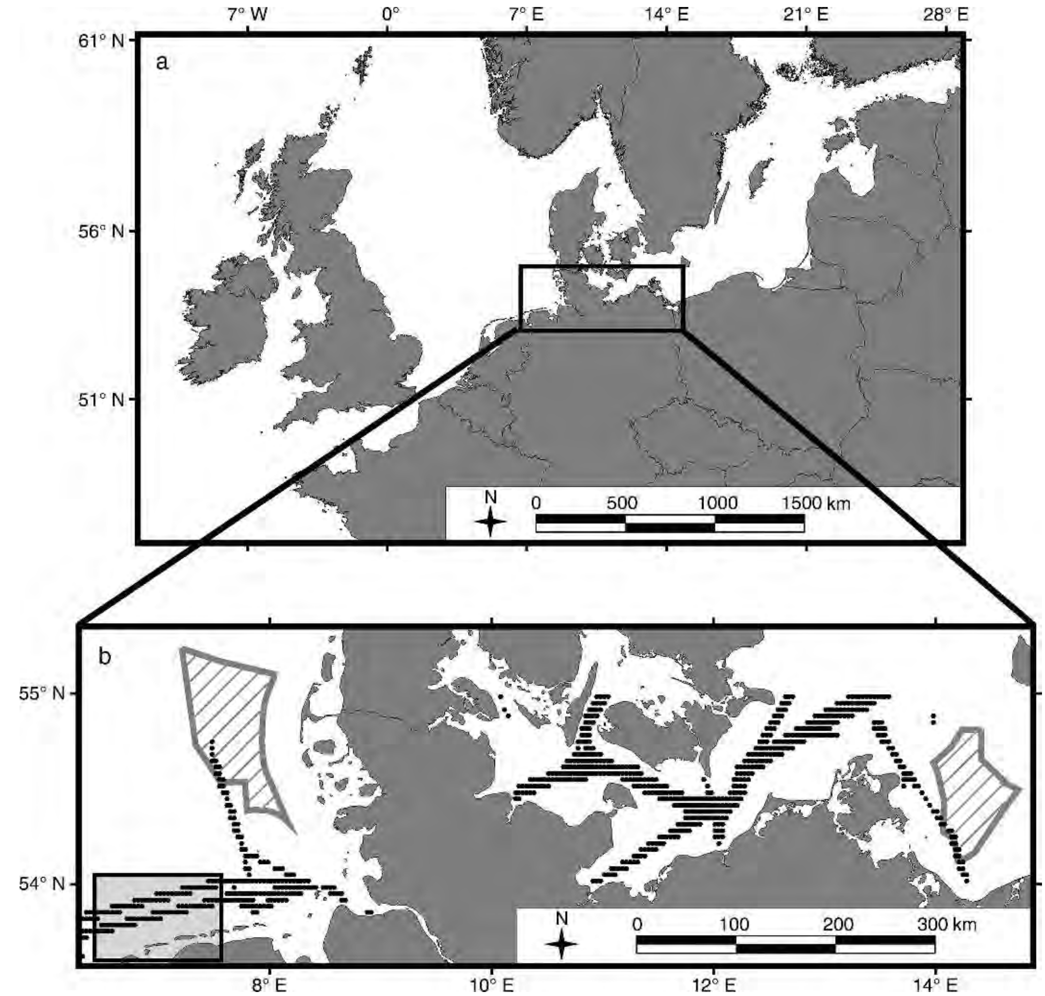

FIG. 1. Study area in the German parts of the North Sea and Baltic Sea, indicating the location of shipping lanes (dots indicate >10 merchant ships passing per day; due to overlap, in some cases, the dots resemble bold lines; Knust et al. 2003). The light-gray rectangle in panel (b) indicates the area used for aerial counts to analyze the effects of ship traffic on distribution of loons (*Gavia* spp.) across a commercial shipping lane system; hatched areas are Special Protection Areas (SPAs).

essential for appropriate marine spatial planning and conservation management.

The aims of this study were therefore to: (1) test if ship traffic affects the distribution patterns of seabirds; (2) evaluate species-specific flush distances of sensitive seabirds when approached by a ship, and unravel the effects of a suite of environmental parameters on flight behavior; (3) estimate how long a disturbed patch is avoided for, i.e., temporal habitat loss; and (4) examine the possibilities for habituation of seabirds in relation to spatially restricted ship traffic.

For this study, we chose seabird species that have already been described as highly sensitive to shipping activities (Garthe and Hüppop 2004, Bellebaum et al. 2006, Kaiser et al. 2006, Mendel et al. 2008), i.e., Red-throated and Black-throated Loon (*Gavia stellata*; *G. arctica*), Common Eider (*Somateria mollissima*), Long-tailed Duck (*Clangula hyemalis*), Common Scoter (*Melanitta nigra*) and White-winged Scoter (*M. fusca*).

METHODS

Study area

The study was conducted in the offshore zone of the German North Sea (south of 54.2° N; east of 7° E) and Baltic Sea (south of 55° N; west of 15° E; Fig. 1). Two SPAs were established in the North Sea and Baltic Sea in 2004, respectively, under the EU Birds Directive (BMU 2004, Garthe 2006; hatched areas in Fig. 1b). The effects of ship traffic on the distribution patterns of Red-throated and Black-throated Loons were studied across a highly frequented shipping lane in the southern North Sea (light-gray rectangle in Fig. 1b). Species-specific flush distances, habituation, and temporal habitat loss were assessed for all four sea duck species in the Baltic Sea.

Distribution of loons across a commercial shipping lane

Commercial shipping in the German North Sea is particularly intense and highly concentrated within the

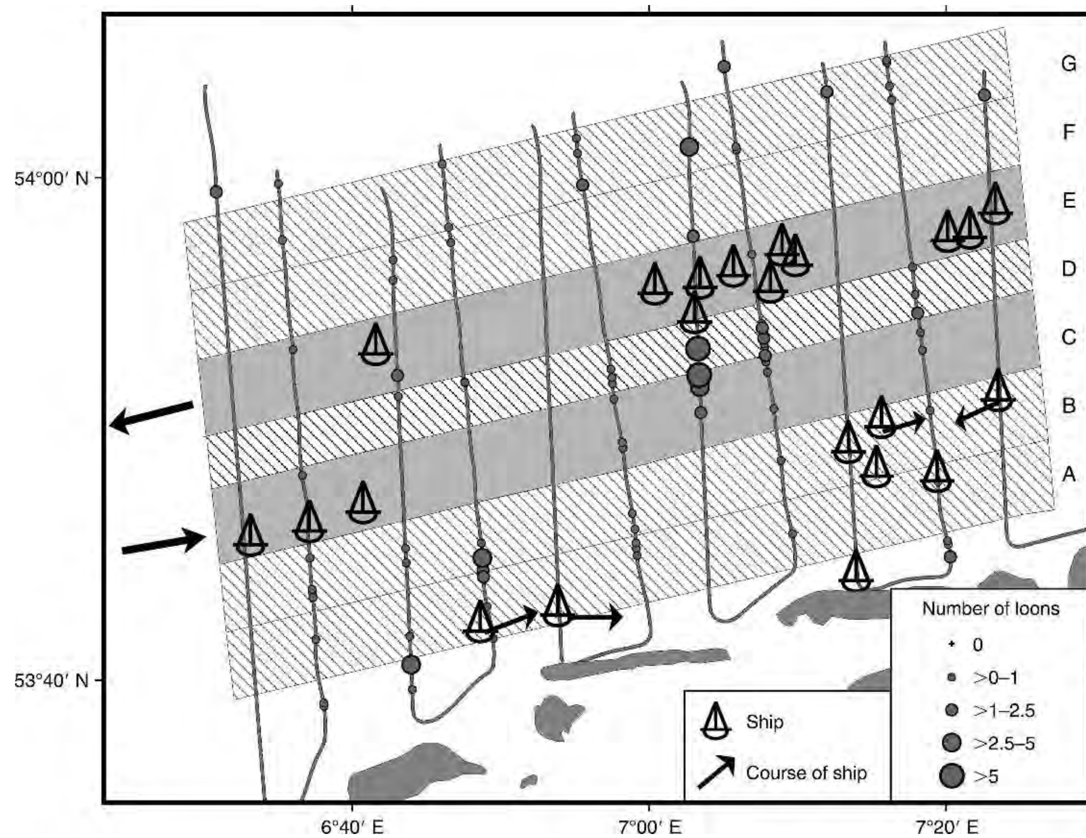

FIG. 2. Example of the distribution of loons recorded during an aerial survey flight in April 2006 (see light-gray rectangle in Fig. 1b) within seven zones (A–G) used for computing avoidance or preference values (see Table 1). Light gray zones (C and E) are areas of intense channeled shipping; diagonally hatched zones are areas of lower shipping intensity. Positions and (in several cases) courses of the ships recorded during the survey are shown.

shipping lanes in the southern area (Knust et al. 2003; Fig. 2). This area provides the opportunity to study the effects of channeled ship traffic on seabirds. All commercial ships must sail within a northern shipping lane when travelling west and in a southern lane when travelling east (zone C = 5.7 km and zone E = 5.5 km wide, respectively; see arrows in Fig. 2). These two shipping lanes are separated by zone D (3.8 km wide). Shipping intensity is particularly low in this zone, as vessels may only cross at right angles, and crossing rarely occurs. Both the shipping lanes and the separation zone exhibit the same water depth as the surrounding waters; however, fishing is prohibited in these areas, whereas it is allowed in the surrounding waters. Smaller, noncommercial ships and recreational vessels are allowed to sail inshore of the eastbound shipping lane in any direction (bands A and B in Fig. 2, each 5 km wide). Shipping is unrestricted north of the westbound shipping lane (bands F and G in Fig. 2, both 5 km wide). The overall numbers of ships are generally much higher within the shipping lanes (C and E) than in all other zones.

Because of their sensitive nature (Garthe and Hüppop 2004, Mendel et al. 2008), we hypothesized that loons would avoid the two shipping lanes as a consequence of disturbance by intense, channeled shipping. Data for Red-throated and Black-throated Loons were pooled, because it was not possible to reliably identify them to species level in aerial surveys. Both species are similarly sensitive to anthropogenic disturbances (e.g., Garthe and Hüppop 2004, Mendel et al. 2008). Avoidance of and preference for each of the seven zones were tested using the selectivity index of Jacobs (1974). In total, three survey flights (for a detailed description of the recording methods, see Diederichs et al. 2002) were conducted across the seven zones during March and April in 2002 and 2006 (for sample sizes, see Table 1). The distribution of loons was tested for homogeneity beforehand. No reduction in loon densities was detected with distance from coast; linear model (LM), $t = -0.003$, $df = 19$, $P = 0.77$.

Flush distances

Flush distances (defined as the linear distance from the observer vessel to the birds at the moment of take-off from the water) were measured for sea ducks on 15 survey days between October 2004 and April 2005. Loons were not included in these analyses because the

Table 1. Selectivity indices for loon (*Gavia* spp.) distribution during three survey flights across seven zones in the German North Sea located within the shipping separation zone.

Date	Area surveyed (km)	Loons (n)	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G
March 2002†	437	19	−0.19	0.01	−1	0.46	−1	0.61	−0.11
March 2006	724	38	0.44	0.1	−0.56	0.54	−0.21	−1	−0.47
April 2006	564	155	−0.12	0.06	0.07	0.54	−0.7	−0.51	0.12

Notes: Two zones (C and E) were located within the shipping lanes, while the others were located outside the shipping lanes (see Fig. 2). Negative values indicate avoidance; positive values indicate preference for the respective zone (−1 = total avoidance; 1 = total preference).

† Coverage of the whole area was achieved during two consecutive survey days; data were recorded by Bioconsult SH, Husum, Germany.

sample sizes were too low. Three different research vessels were used: (1) *MS Haithabu* (25 m long; $n = 219$ measurements), (2) *MS Victor Hensen* (40 m long; $n = 138$ measurements), and (3) *MS Ludwig Prandtl* (31 m long; $n = 189$ measurements). All the ships were similar heights (5–6 m excluding masts). We approached the birds at a constant speed of 18 km/h (maximum possible speed of all vessels used). Only the flush distances of flocks of birds located within 300 m of either side of the ship's track line were measured, as we assumed that flocks too far outside the track line of the vessel would not show comparable flush reactions.

A total of 546 flush distances of single individuals or flocks of different sizes were measured (see Fig. 3a for sample sizes of the different species). Among these, 144 values represented birds that did not fly off or were estimated by eye, as the individuals only escaped when the approaching vessel was very close. A total of 202 flush distances were measured using binoculars (7 × 50, Fujinon, Willich, Germany) containing reticles, which allowed the angle between the birds on the water surface and the horizon to be measured (Lerczak and Hobbs 1998). In combination with observer altitude, this provided a measure of distance (Laake et al. 1994). The method of Heinemann (1981) was used for 200 measurements. This method is based on the same geometric principle as the above method, but using calipers instead of binoculars with reticles: Holding the calipers with the observer's arm outstretched, the upper arm of the calipers is positioned on the horizon and the lower arm on the flock of birds. With known observer altitude and arm length, the caliper reading provides the distance of the birds from the observer, using geometric functions. We did not use radar (compare Bellebaum et al. 2006, Kaiser et al. 2006) to measure distances, as this requires very calm conditions and can only be used effectively for flocks of many birds; because we were examining the influences of sea state and flock size on flush distance, it was necessary to estimate flush distances of single individuals and of small flocks during rough conditions. For both methods used, the water surface was constantly scanned using binoculars to ensure that smaller flocks at larger distances were included. We tested for differences between flush distances acquired by the two different methods for each sea duck species. The two methods were not used

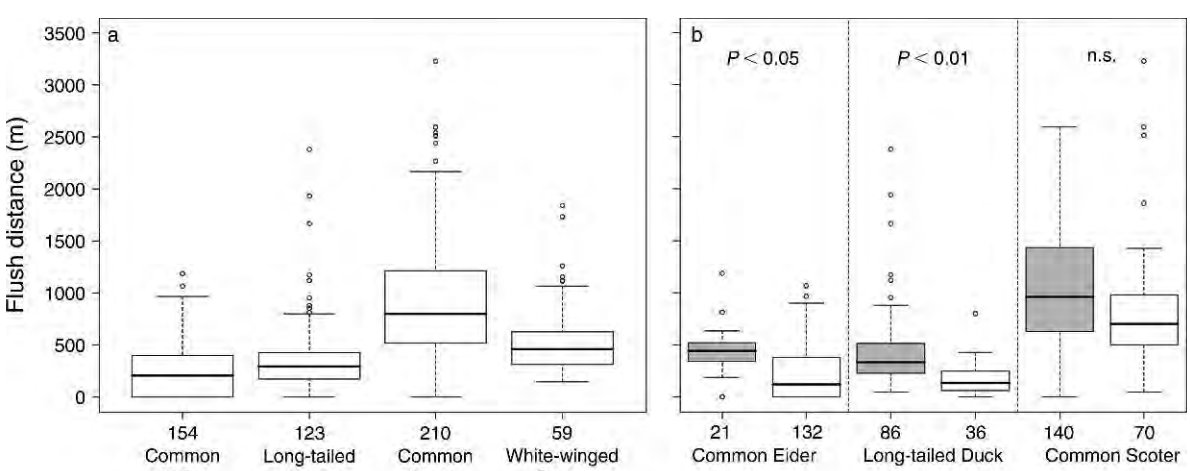

Fig. 3. Flush distances of sea ducks in front of the approaching vessel: (a) for all measurements and (b) separated for measurements outside shipping lanes (gray boxes) and within shipping lanes (open boxes). The bold lines represent the median; boxes are 25% confidence intervals; whiskers are 95% confidence intervals; and dots are outliers. Numbers below the columns depict the sample sizes; "n.s." indicates not significant. Statistical tests were corrected after Bonferroni.

simultaneously for the same flocks of birds. However, all parameters remained similar during all cruises: ship speed (18 km/h in most cases; range = 16.7–20.3 km/h); observer (always the same individual); weather conditions (no rain; wind speed range = 12–38 km/h). The sample sizes for both methods were large and the measurement methods were applied alternately. We therefore considered the comparison between the methods to be reliable, even though they were not tested on exactly the same flocks. The LM detected no significant differences in flush distances between the two methods for any species (Common Eider: $t = 0.4$, df $= 72$, $P = 0.73$; Long-tailed Duck: $t = -1.14$, df $= 100$, $P = 0.26$; Common Scoter: $t = 1.96$, df $= 207$; $P = 0.06$; White-winged Scoter: $t = -0.16$, df $= 56$; $P = 0.87$). Data acquired using both methods were therefore pooled.

Data on flush distances were left-skewed, and they were, therefore, log-transformed, which resulted in a sufficiently normal distribution of the residuals. All analyses of flush distances were therefore performed using LM analysis. This approach was preferred to the use of a general LM with non-normal errors, because it allowed easier interpretation of the modeled parameters. Differences in flush distances among the four duck species were examined using LM (e.g., Chambers 1992) with the Bonferroni correction. The influences of six environmental variables (predictor variables) on flush distances were also modeled using LM analysis: (1) water depth, (2) flock size, (3) state of the sea surface according to an eight-fold relative score following Garthe et al. (2002), (4) type of observer vessel (differences in shape or engine noise may affect flight behavior), (5) month of observation (differences in molting stage may affect take-off capabilities), and (6) location of the flock within or outside a commercial shipping lane. The last parameter was included in the model to take account of possible habituation to temporally and spatially regular ship traffic. Data were classified on the basis of individuals that were located within the track or within 2 km distance of commercial shipping lanes (all such situations are subsequently referred to as "within shipping lanes"), and individuals farther away from shipping lanes (subsequently referred to as "outside shipping lanes"; source Knust et al. 2003). The six predictor variables were standardized to account for differences in their scales. Both linear and quadratic terms were considered for the parameters water depth, flock size, and sea state. Selection of the best model was based on backward selection: The first model used all predictor variables. The predictors that were not significant were then removed from the model step-by-step, starting with the variable with the highest P value. Model improvement was checked using AIC, as well as by comparing both models using analysis of variance (Venables and Ripley 2002). Predictors were removed sequentially until a minimum adequate model was produced. All LMs were performed using the open-source software package R 2.8.1 (R Development Core Team 2007). A linear mixed-effects model was used to test if the data were spatially autocorrelated, using the corExp function in the package nlme (Pinheiro et al. 2008). This revealed no spatial autocorrelation of flush distance data.

Temporary habitat loss

To estimate the time for which a disturbed habitat patch was lost for feeding or resting, numbers of the four sea duck species were recorded using the method for counting seabirds at sea described by Garthe et al. (2002) and Tasker et al. (1984). The observer vessel sailed along a predefined route while seabird counts were carried out. After a defined period of time (90 min or 60 min), the vessel turned and sailed back on the same course. The abundance values for each species before the first disturbance by the observer vessel were compared with those a certain time after the disturbance (numbers of individuals after the disturbance were expressed as a proportion of numbers of individuals before the disturbance).

Results

Distribution of loons across a commercial shipping lane

The three survey flights across the seven zones covering the shipping lane system in the North Sea clearly showed that loons avoided strips C and E (except for strip E during April 2006), where merchant shipping is channeled (Table 1). In contrast, the zone separating the shipping lanes (zone D) was preferred (Table 1; Fig. 2 provides an example of the distribution of 155 loons and 22 ships recorded in April 2006). Index values for the southernmost and northernmost bands were inconsistent among the three survey flights (Table 1).

Flush distances

All sea ducks that escaped in front of the approaching vessel took flight, except for a single Common Eider that dived to escape. Flush distances of Common Eiders (CE), Long-tailed Ducks (LTD), Common Scoters (CS) and White-winged Scoters (WWS) differed significantly from each other, according to LM using the Bonferroni correction: CE vs. LTD, $t = 5.4$, df $= 275$; CE vs. CS, $t = 14.3$, df $= 362$; CE vs. WWS, $t = 6.3$, df $= 211$; LTD vs. CS, $t = 10.8$, df $= 331$; LTD vs. VS, $t = 3.9$, df $= 180$; CS vs. WWS, $t = -5.1$, df $= 267$; $P < 0.001$ for all cases; Fig. 3a).

Flush distances were highest for common scoters (median, 804 m), followed by White-winged Scoters (404 m), Long-tailed Ducks (293 m), and Common Eiders (208 m; Fig. 3a). Flush distances were highly variable within species (particularly in Common Scoters), indicating strong inter-individual variability in reactions. The most extreme example involved one Common Scoter flock that flushed at a distance of 3.2 km. In contrast, several flocks (mainly of Common Eiders) did not fly in front of the approaching vessel, but remained on the sea surface: 29% of all flocks of Common Eiders,

TABLE 2. Output of the linear model relating flush distance to environmental parameters.

Parameter	Common Eider		Long-tailed Duck		Common Scoter		White-winged Scoter	
	t	*P*	*t*	*P*	*t*	*P*	*t*	*P*
Flock size	3.12	**0.002**	4.18	**<0.001**	9.89	**<0.001**	n.s.	n.s.
Flock size (sq.)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	−2.70	**0.009**
Shipping lane	−2.65	**0.009**	−3.10	**0.003**	n.s.	n.s.	n.t.	n.t.
Water depth (m)	n.s.	n.s.	n.s.	n.s.	−2.49	**0.013**	n.t.	n.t.
Water depth (m) (sq.)	n.s.	n.s.	n.s.	n.s.	2.53	**0.012**	n.t.	n.t.
Sea state	2.38	**0.019**	2.90	**0.005**	−3.46	**<0.001**	n.s.	n.s.
Sea state (sq.)	2.49	**0.014**	−2.63	**0.010**	n.s.	n.s.	−2.60	**0.012**
Observer vessel	n.t.	n.t.	n.s.	n.s.	n.s.	n.s.	1.89	*0.064*
Month	n.s.	n.s.	5.51	**<0.001**	n.s.	n.s.	n.t.	n.t.

Notes: For several parameters, both linear and square effects (sq.) were taken into account. Several parameters could not be tested (n.t.) because of inadequate sample sizes. Significant effects ($P < 0.05$) are indicated in boldface; italics indicate $P < 0.1$; and "n.s." indicates not significant. Sample size, degrees of freedom, and R^2 for each species are as follows: Common Eider, $n = 154$, df $= 148$, $R^2 = 0.15$; Long-tailed Duck, $n = 123$, df $= 116$, $R^2 = 0.44$; Common Scoter, $n = 210$, df $= 205$, $R^2 = 0.33$; White-winged Scoter, $n = 59$, df $= 55$, $R^2 = 0.01$. R^2 values represent multiple correlation between flush distance and all of the environmental parameters.

5% of Long-tailed Ducks, 0.5 % of Common Scoters, and 0 % of White-winged Scoters did not take flight.

Environmental parameters were able to partially explain the variability in flush distances. Flock size had the strongest effect, at least for Common Scoters and Long-tailed Ducks (Table 2). Flush distances were positively correlated with flock size (Fig. 4) in all species, except White-winged Scoter, which showed no correlation. Flock size was highest for Common Scoters (median = 8 birds; maximum = 500 birds) and in Long-tailed Ducks (median = 5.5 birds; maximum = 180 birds), followed by Common Eiders (median = 5 birds;

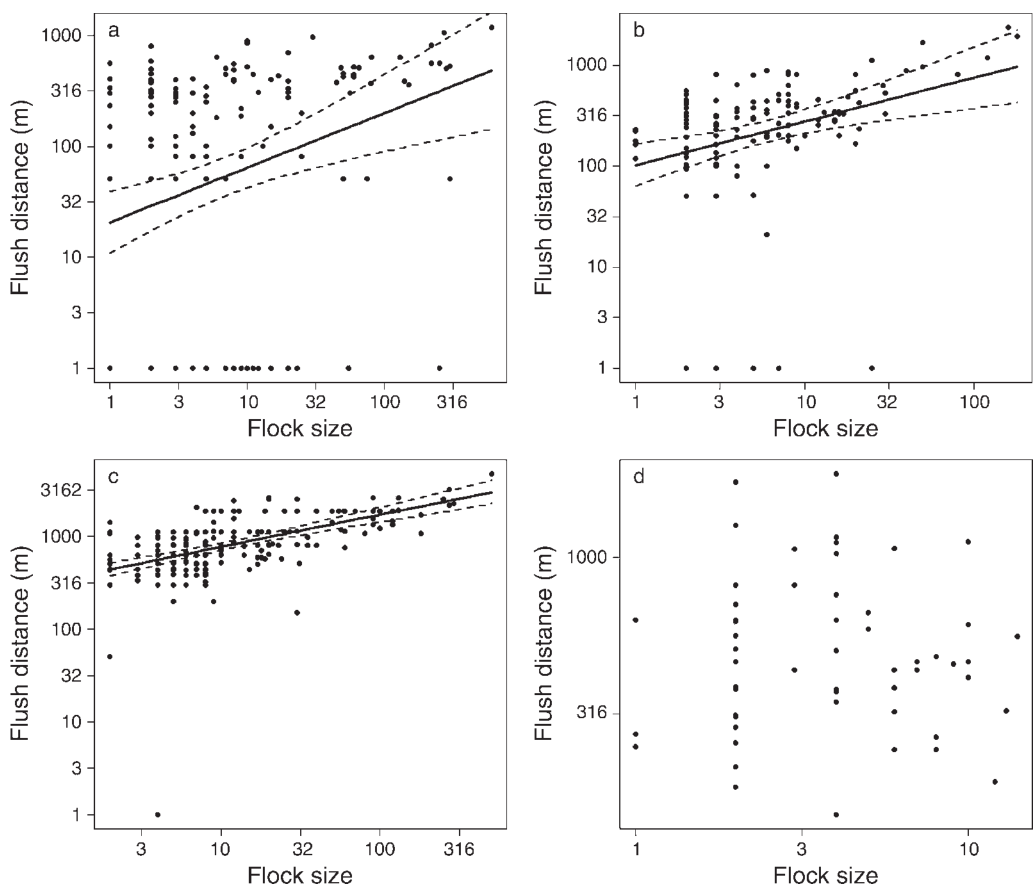

FIG. 4. Flush distances of (a) Common Eiders, (b) Long-tailed Ducks, (c) Common Scoters, and (d) White-winged Scoters in relation to flock size. The solid line is the linear model of flush distance; dashed lines indicate the 95% confidence interval of the model. Note differences in scale of the axes between the species.

maximum = 720 birds), while White-winged Scoters showed the smallest flock sizes (median = 4 birds; maximum = 14 birds). Flocks of >100 individuals were generally scarce for all species. Flock location (i.e., within or outside shipping lanes) had a significant effect on flush distance; flush distances were lower within than outside shipping lanes for both Common Eiders and Long-tailed Ducks (Table 2, Fig. 3b). The importance of the parameter "location of the flock" was emphasized by the fact that 96% of the Common Eider and 100% of the Long-tailed Duck flocks that did not take flight were located within shipping lanes. Sea state also had a strong influence on flush distance; most species flushed at shorter distances with increasing sea state. In contrast, the type of observer vessel and water depth had little or no effect on flush distances. The observation month only had a strong effect on flush distance in Long-tailed Ducks (Table 2).

Temporary habitat loss

For all species, individual numbers were lowest immediately after the disturbance (Table 3). Common Eider and Long-tailed Duck numbers were relatively higher during the first hour after the disturbance, and increased relatively rapidly in subsequent hours, compared with the other species. The increase in numbers was much slower for White-winged Scooter, while Common Scoters did not reach pre-disturbance numbers until after the experiment had finished (Table 3).

Discussion

Effects of ship traffic on loon distribution

The results of this study clearly demonstrate that ship traffic affected species-specific flight reactions in sea ducks, and also influenced the distribution of loons. Loon numbers in shipping lanes were significantly lower than in other areas (particularly compared with the zone of lowest shipping intensity). Food availability is a crucial factor in determining the presence or absence of a species in a certain sea area (e.g., Kube 1996, Kaiser et al. 2006, O'Connell et al. 2007). Thus, profitable feeding sites might be preferred despite high ship abundance, if the energetic costs of disturbance can be compensated for by more efficient feeding. However, at least in the case of piscivorous seabirds such as loons, the possibility that fish prey may also be disturbed by ships must also be considered (e.g., Misund and Aglen 1992), thus reducing effective foraging.

In contrast to sea ducks, loons are not dependent on shallow feeding grounds, because they are not restricted to shellfish banks and (at least in German waters) they are not bound to nearshore waters (Garthe 2006). Their distribution may therefore mirror the sites where conflict with shipping is most intense, as indicated by their avoidance of shipping lanes, compared to their preference for the shipping separation zone. In contrast to Common Eiders that showed shorter flush distances within shipping lanes, the avoidance of shipping lanes by loons suggests that habituation to passing ships is unlikely to occur in this group of species. This is supported by evidence that loons (in contrast to sea ducks) did not habituate to offshore wind turbines in Danish waters, even more than five years after construction (Petersen and Fox 2007, Petersen et al. 2008).

Table 3. Temporary habitat loss by sea ducks.

Species	Disturbed individuals (%) 1–60 min	61–120 min	121–180 min
Common Eider	17	107	. . .
Long-tailed Duck	26	57	113
Common Scoter	4	10	13
White-winged Scoter	3	24	66

Notes: Values indicate the percentage of individuals recorded 1–180 min after disturbance by the observer vessel relative to the number of individuals recorded before the disturbance. The ellipses indicate that the sample size was too low.

Flush distances

Very little information on flush distances of seabirds at sea is currently available in the literature. Using radar, Kaiser et al. (2006) estimated flush distances of common scoters ranging from 1000–2000 m, which were higher than those observed in the current study. There are two possible explanations for this discrepancy: (1) birds within different study sites may respond differently; and (2) the radar measurements performed by Kaiser et al. (2006) involved larger flocks, which we have shown exhibit longer flush distances. Bellebaum et al. (2006) measured flush distances of Long-tailed Ducks and White-winged Scoters in the Baltic Sea, using radar. Their findings for White-winged Scoter were comparable to our findings, while Long-tailed Ducks showed shorter flush distances than those in the current study. This difference might be explained by different environmental conditions, as Bellebaum et al. (2006) performed measurements on two single survey days, with sea states ranging from 0–1.

We found significant interspecific differences in flush distances among the four sea duck species investigated. These differences might be partially explained by differences in wing morphology and take-off capabilities among the species investigated: body mass and wing-loading is higher in Common Eiders than in the other sea duck species (Guillemette 1994, Guillemette and Ouellet 2005), while Common Scoters and Long-tailed Ducks have the lowest wing loadings. To save energy, heavy species with high wing loading should be more reluctant to take off, which could explain the comparatively short flush distances of Common Eiders (as well as the higher proportion of birds that did not take flight at all.

A high degree of the intraspecific variability in flush distances detected in this study could be well explained by differences in flock size and environmental variables:

TABLE 4. Summary of the main results for the species investigated.

Variable	Common Scoter	Long-tailed Duck	Common Eider
Flush distance	very high	moderate to high	low to moderate
Flock size	very high	moderate	moderate to high
Habituation to channeled traffic	no clear habituation found	indications for habituation found	indications for habituation found
Temporary habitat loss	high	low to moderate	low
Others	long period of extensive wing molt accompanied by period of flightlessness;§ molting aggregation during summer in eastern Baltic Sea¶ when recreational traffic is intense†		high proportion of birds located in shipping lanes; high proportion of birds did not take flight; absence of flight reactions may be linked to high wing loading#

† P. Schwemmer and S. Garthe, *personal observations*.
‡ Bellebaum et al. (2006).
§ Mendel et al. (2008).
¶ Sonntag et al. (2004).
# Guillemette (1994).

Flock size especially had a significant positive effect on the flush distances of all sea ducks, except for White-winged Scoters (which showed constantly low flock sizes). This could be explained by the fact that the whole flock took flight whenever the most sensitive individuals within the flock started to escape. The probability of encountering more sensitive individuals is higher in larger flocks, and thus, larger flocks will tend to flush at longer distances than smaller flocks or single individuals. We expected month of observation to affect flock size, as flocking behavior may differ between migration and non-migration periods. This could have had an indirect impact on flush distances. However, no such correlation was identified for any of the species investigated.

In addition to flock size, the location of the flock with respect to the shipping lanes was also important for several species. Individuals within shipping lanes showed shorter flush distances, suggesting that these individuals had become habituated to ship traffic. Other authors have detected habituation in birds that were frequently disturbed (e.g., Burger and Gochfeld 1991, Whittaker and Knight 1998). However, it is difficult to determine if weak responses by animals to disturbance should be classified as habituation. An important prerequisite for true habituation would be that individuals should show a certain degree of philopatry (i.e., staying in a certain area for a long enough time, e.g., because of a rich food supply). This information is currently lacking for the species studied, and the use of telemetry devices could represent the most effective way of studying this further (e.g., Kotzerka et al. 2010). However, long-term seabird surveys have shown that their large-scale distribution patterns remain stable over the seasons (e.g., Garthe et al. 2003), suggesting a certain degree of philopatry. Thus, the weaker response of individuals located in shipping lanes may indeed reflect habituation. The high proportion of common eider flocks located within shipping lanes and their significantly shorter flush distances compared with the other species suggests that habituation was strongest in this species.

Sea state was the third most important environmental parameter influencing flush distances. Flush distances of Common Scoter and Long-tailed Ducks decreased with increasing sea state, possibly because higher waves make it harder for the birds to spot an approaching vessel. It is also possible that birds might feel safer during higher sea states (i.e., during higher winds), as they can take off more easily with the aid of strong winds. Flush distances of Common Eiders, however, were longest during highest sea states, which may be a consequence of their higher wing loading, which makes taking off less energetically expensive during strong winds.

In addition to the environmental parameters investigated, a certain degree of variability in flush distances might be explained by molting state, as wing molt would be expected to increase energetic costs (e.g., Bridge 2004), as well as affecting wing loading and thus take-off capabilities (e.g., Guillemette and Ouellet 2005). Among the species investigated, Common Scoters show the most extensive wing molt, accompanied by a period of flightlessness (Mendel et al. 2008).

Energetic implications

This study only investigated escape reactions, which are the final and most energetically costly result of a disturbance event. However, physiologic reactions, such as an increase in heart rate (e.g., Wilson et al. 1991), will be apparent much sooner. Being alarmed and escaping leads to both a loss of foraging time and increased energy expenditure. Furthermore, foraging is less efficient during, and for a considerable time after, disturbance (e.g., Burger and Gochfeld 1998, Stolen 2003, Merkel et al. 2009). Consequently, birds will have to forage at higher rates to make up for their increased overall energy expenditure. A reduction in feeding time can even result in higher direct mortality (e.g., Mikola et al. 1994). Shorebirds are able to compensate for time lost through disturbances by increasing feeding rates or by increasing total feeding time (Swennen et al. 1989, Urfi et al. 1996). However, feeding time in sea ducks and

TABLE 4. Extended.

Velvet Scoter	Red- and Black-throated Diver
moderate to high	very high†‡
low	low†‡
species not found in shipping lanes	lower densities in shipping lanes
moderate to high	not measured
molting aggregation during summer in Baltic Sea¶ when recreational traffic is intense†	large flight distances may be result of low wing loadings; we observed only escape by flight, not by diving

loons is limited by diving time and the time needed for crushing and digesting shellfish (Guillemette et al. 1992), and therefore cannot be limitlessly extended.

Conclusions and recommendations for management

In conclusion, our findings show that the species investigated showed strong behavioral responses and, possibly more importantly, altered distribution patterns in response to ship traffic. Different species responded differently, as summarized in Table 4.

Disturbance by passing ships does not cause direct seabird mortality, in contrast to other anthropogenic activities such as gill net fishing (e.g., Dagys and Zydelis 2002). However, our data indicate that the current level of shipping intensity can already cause a (temporal) loss of foraging time and resting habitat in seabirds sensitive to human disturbance. Our results are mainly based on effects of merchant traffic, which mainly uses defined shipping routes. In contrast, recreational shipping and fishing vessels are more unpredictable in terms of speed and course and thus their disturbance potential for birds may be enhanced (for case studies, see Burger 1998, Rodgers and Schwikert 2003). The positions of most of these vessels are unrecorded or only partially recorded automatically (Vessel Monitoring System for larger fishing vessels), and information on their overlap with seabird distributions and possible habitats is therefore missing. Reliable data on the distribution of smaller vessels are urgently needed to enable their effects to be studied. The present study suggests that habituation (at least in some species) is only possible in response to constant channeled ship traffic. It is therefore recommended that spatial planning should aim to channel ship traffic wherever possible to avoid habitat fragmentation and to allow for habituation. Further studies are needed to measure the flush distances of other species (such as loons and alcids) and during different seasons (including molting), as well as to relate the behavioral responses to differences in engine noise and sailing speed (e.g., Burger 1998, Rodgers and Schwikert 2003). On this basis, the next step should be an assessment of different scenarios involving spatially changed and enhanced ship traffic, in order to quantify possible habitat loss and to elucidate the energetic consequences.

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East Anglia ONE North Offshore Windfarm

Best Practice Protocol for Minimising Disturbance to Red-Throated Diver

Applicants: East Anglia ONE North Limited
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Applicable to East Anglia ONE North

Revision Summary				
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Glossary of Acronyms

AEoI	Adverse Effect on Integrity
DML	Deemed Marine Licence
MMO	Marine Management Organisation
NE	Natural England
nm	Nautical Mile
PEMP	Project Environmental Management Plan
SPA	Special protection Area

Glossary of Terminology

Applicant	East Anglia ONE North Limited
East Anglia ONE North project	The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia ONE North windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Generation Deemed Marine Licence (DML)	The deemed marine licence in respect of the generation assets set out within Schedule 13 of the draft DCO.
Transmission DML	The deemed marine licence in respect of the transmission assets set out within Schedule 14 of the draft DCO.

1 Introduction

1. This document provides a best practice protocol to minimise disturbance to non-breeding red-throated diver which is a qualifying feature of the Outer Thames Estuary Special Protection Area (the “SPA”). A final best-practice protocol for minimising disturbance to red-throated divers during construction and operation will be adopted and will be provided as part of the project environmental management plan (PEMP) to be approved by the Marine Management Organisation (MMO) and secured under condition 17 of the Generation Deemed Marine Licence (DML) and condition 13 of the Transmission DML.

2. This document has been updated and submitted into the Examination at Deadline 7 to address the following comments from Natural England in their Deadline 4 submission (REP4-087) and has also been updated at Deadline 8.

Natural England comment	Location where addressed
How will it be demonstrated that planned works during construction and operation phases are avoiding the sensitive periods between November and March?	Addressed in ***Section 2***
Where it is not possible to avoid works during the sensitive period how will vessel movements be managed to minimise disturbance to SPA features?	Addressed in ***Section 2***
Provided details of particular works when vessels will be required to leave existing navigational routes through the SPA	Addressed in ***Section 2***
Low flying helicopter flights over the SPA are also likely to cause disturbance. If the use of helicopters is likely then we advise that is also covered under a protocol for minimising disturbance	Addressed in ***Section 3***

2 Vessel Disturbance Mitigation

3. At this stage, the construction and operation and maintenance ports have not been confirmed but are anticipated to include Great Yarmouth for construction and the existing ScottishPower Operations and Maintenance base at Lowestoft. To address the comments made by Natural England, the Applicant commission Anatec Limited to establish vessel transit routes from both ports to the windfarm site avoiding, as far as possible, the SPA with a buffer either side of the route of 2km to account for the range over which red-throated diver are known to flush from vessels in transit. The results of that exercise are shown in ***Figure 1*** where the anticipated ‘direct routes’ from each port to the windfarm site are shown in ‘green’ and the ‘mitigation routes’ in ‘red’.

4. The main component of the SPA overlaps the approaches to both ports and therefore, it is not possible to avoid transiting through this part of the SPA. However, the mitigation routes have been specifically created to follow the navigation approaches to both ports, and thus limit the impact of the Projects' vessel movements to areas of existing navigation routes associated with the ports, where the densities of red-throated diver are typically relatively low.

5. Once beyond the main components of the SPA, vessel traffic from either port has been routed through the gap between the main component and northern component of the SPA. This gap generally allows for a 4km width, with the exception at its narrowest where the gap is orientated northwest -southeast for a short section. At the point the gap is reduced to between 2.75 and 3.30 km, preventing a full 4km width. It should also be noted that alternative mitigation routes could also be used, but avoidance of the SPA beyond the Approaches to the ports would be maintained.

6. All vessels associated with the Project will use an automatic identification system (AIS) which broadcasts the location of the vessel and is monitored by the Projects' Marine Co-ordination Centre. The final ***Best Practice Protocol for minimising disturbance to Red-Throated Diver***, submitted post-consent, should consent be grated, will include details of how the mitigation route (or any alternate mitigation routes) will be communicated, enforced and monitored.

7. The Applicant commits to implementing the measures outlined above and provided in ***Figure 1*** by all project vessels throughout the construction and operation of the Project through the core winter period of 1st November to 1st March inclusive.

8. The situations where these measures would not apply are:

- Installation and maintenance of the export cables, which pass through the SPA; and
- Emergencies and reasons of health and safety, for example, due to inclement weather where the most direct route back to port is required.

9. Such instances would be recorded as part of the monitoring process.

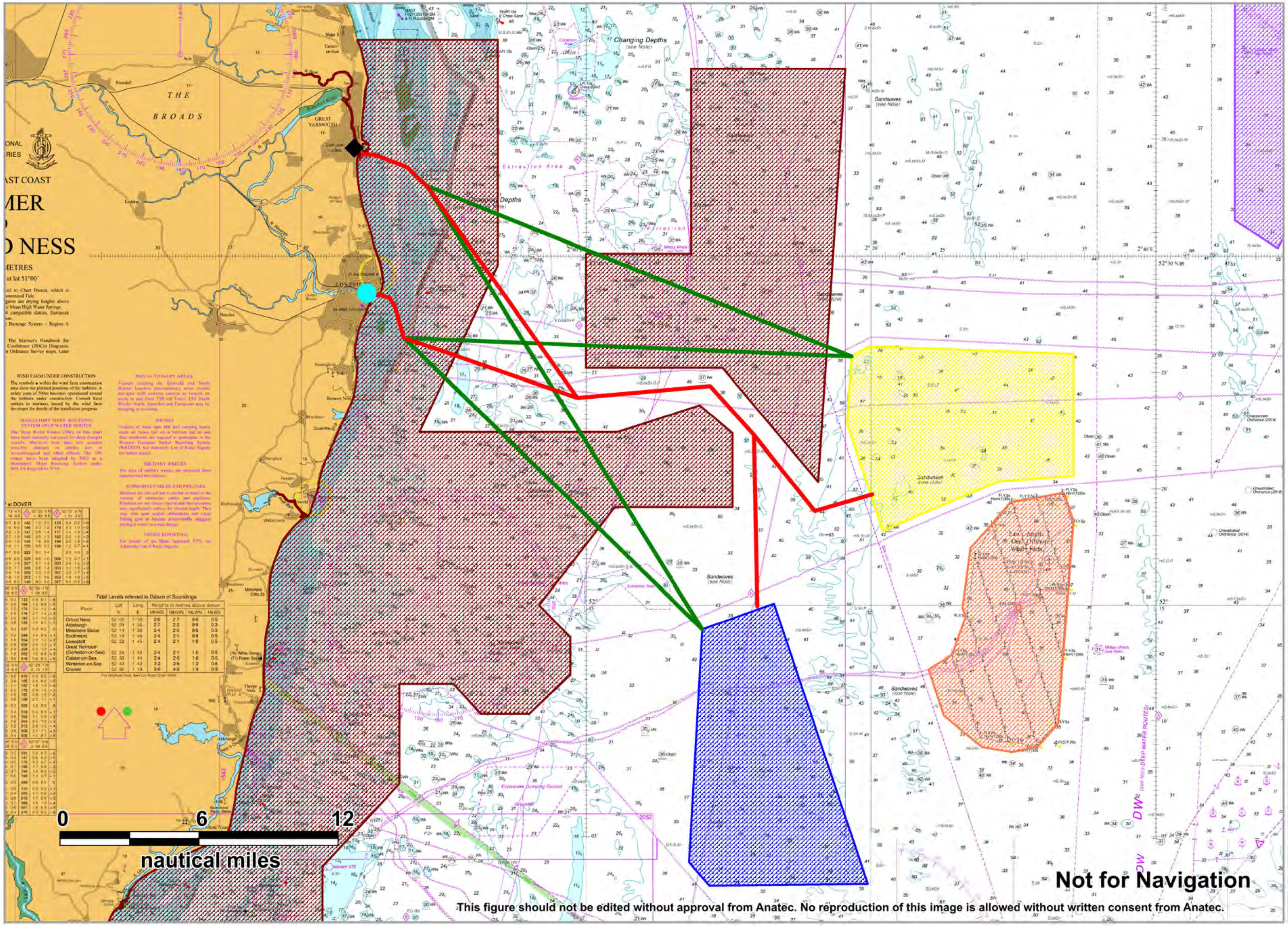
10. Additionally, where relevant, some or all of the following best practice examples, will be included in the PEMP in agreement with the MMO and NE, would still apply to some of the instances outlined above:

- Avoid and minimise vessel traffic, where possible, during the most sensitive time period for red-throated diver between November and March 1st inclusive.
- Restrict vessel movements where possible to existing navigation routes (where the densities of divers are typically relatively low).
- Where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the windfarm sites from port and/or within the windfarm sites (dependent on location) and where possible avoid disturbance to areas with consistently high diver density.
- Avoid over-revving of engines (to minimise noise disturbance).
- Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks).

Should either the final construction and, or operation and maintenance port differ from Great Yarmouth and Lowestoft, the Applicant will update this document within the Project Environmental Management Plan prior to commencement of construction with the location of the new port(s) and undertake vessel transit routing from the new port(s), if required, to the windfarm site avoiding as far as possible the SPA with a buffer either side of the route of 2km between November and March 1st inclusive. Inclusion of this document within the Project Environmental Management Plan is secured under Condition 17(1)(e)(vi) of Schedule 13 and 13(1)(e)(vi) of Schedule 14.

3 Helicopter disturbance

11. If used, helicopters are a potential source of disturbance to red throated diver in the Outer Thames estuary SPA. The minimum safe altitude for helicopters operating offshore is 1000 feet above the highest known obstacle within 5nm, which the Applicant commits to adhering to. It is considered that at these altitudes that any disturbance caused by the visual presence or noise of helicopters will be minimal and will not result in significant disturbance of red-throated diver.



Port

- Great Yarmouth
- Lowestoft

Route Legend

- Direct
- Mitigation

Legend

- Outer Thames Estuary SPA
- EA1 Windfarm Site
- EA1N Windfarm Site
- EA2 Windfarm Site
- EA3 Windfarm Site

PROJECT NAME
East Anglia ONE North and East Anglia TWO

FIGURE TITLE
Outer Thames Estuary SPA Routeing - EA1N and EA2

REVISION: REV 01

DATE: 04/03/2021

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CO-ORDINATE SYSTEM
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Traffic noise reduces foraging efficiency in wild owls

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Anthropogenic noise has been increasing globally. Laboratory experiments suggest that noise disrupts foraging behavior across a range of species, but to reveal the full impacts of noise, we must examine the impacts of noise on foraging behavior among species in the wild. Owls are widespread nocturnal top predators and use prey rustling sounds for localizing prey when hunting. We conducted field experiments to examine the effect of traffic noise on owls' ability to detect prey. Results suggest that foraging efficiency declines with increasing traffic noise levels due to acoustic masking and/or distraction and aversion to traffic noise. Moreover, we estimate that effects of traffic noise on owls' ability to detect prey reach >120 m from a road, which is larger than the distance estimated from captive studies with bats. Our study provides the first evidence that noise reduces foraging efficiency in wild animals, and highlights the possible pervasive impacts of noise.

Anthropogenic noise (hereafter "noise") is increasing globally and mounting evidence suggests that noise can negatively affect wild animals in many ways[1–3]. Of these impacts, masking from noise, where it interferes with an organism's ability to detect or discriminate biologically relevant signals, appears to be especially problematic[4–6]. Although several studies have examined impacts of masking using "quiet *versus* loud designs", to fully understand and reduce the severity of masking, quantifying wildlife responses to a range of noise exposure levels is critical[5–7].

Compromised foraging efficiency in animals, especially in acoustic predators such as owls and bats, is among the main concerns regarding impacts of novel acoustic environments created by noise[8–10]. This is because declines in foraging efficiency likely influence their distributions by altering behavior and reducing habitat suitability[11,12] and thereby may alter predator-prey interactions that have ecosystem-wide consequences[13]. Nevertheless, only a few laboratory experiments with limited sample sizes have examined noise impacts on foraging efficiency, and only in two bat species[8,11,12] and in a single owl species[14]. Thus, to clarify whether negative effects of noise on foraging efficiency in acoustic predators are widespread, we must understand the degree to which noise degrades foraging efficiency in acoustic predators in the wild[5,6].

The objective of this study was to experimentally determine the relationship between foraging efficiency of wild acoustic predators and noise levels common to many landscapes. We studied nocturnal owls because they are specialized acoustic predators, have cosmopolitan distributions, and have different audible ranges and hunting techniques than bats. We conducted novel field playback experiments using two types of sounds, traffic noise (hereafter "TN") and artificial prey rustling sound (hereafter "APRS") (Fig. 1). Playback of TN allowed us to isolate effects of noise from other confounding factors, such as habitat changes, visual disturbance of moving vehicles and lights, etc[15–17]. Because owls localize and attack prey using prey-generated rustling sounds at frequencies spanning 6–8.5 kHz[18], we digitally developed APRS (Fig. 2a) and found that owls in the wild are attracted to playback of these sounds (see supplementary Fig. S1), providing a method for quantifying prey detection among wild owls under a variety of acoustical conditions. In field experiments, we played back APRS at constant amplitude under various TN exposure levels at many locations in northern Japan, and thereby examined the effect of TN on owls' ability to detect APRS. Finally, we estimated the compromised foraging range by noise near roads. To the best of our knowledge, this is the first study to examine effects of different levels of TN on foraging efficiency in acoustic predators in the wild.

Results

We conducted 367 playback experiments in northern Japan (see supplementary Fig. S2), and recorded a total of 92 owls in 76 playback experiments (Table 1). After exclusion of owls that did not satisfy our analytical criteria

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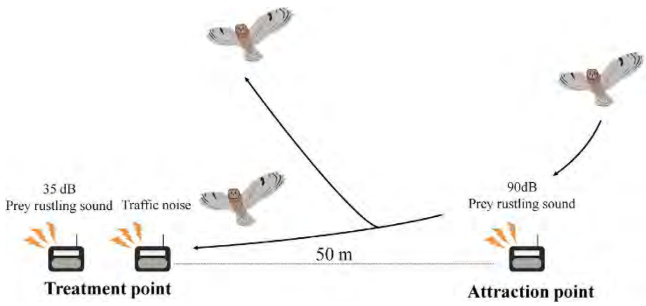

Figure 1. Schematic of the playback experimental set up.

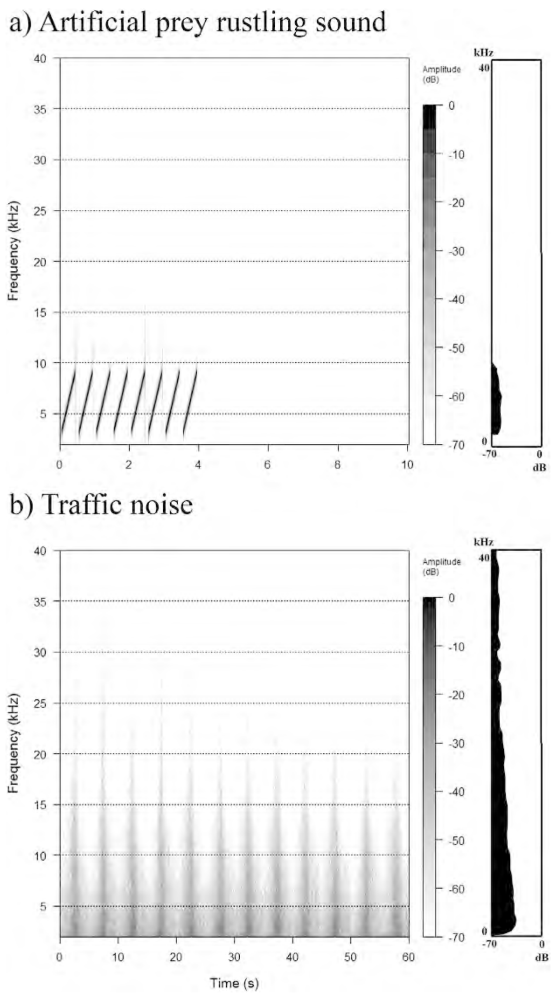

Figure 2. Spectral characters, relative amplitudes (left panel) and power spectra (right panel) of (**a**) ARPS and (**b**) TN.

	Yufutsu	Sendai	Total
Number of study plots	45	58	103
Number of experiments	210	157	367
Number of owls	21	71	92
long-eared owl	7	29	36
short-eared owl	14	39	53
ural owl	0	3	3

Table 1. Summary of field experiments.

Variables	Model rank 1	2	3	4	β	SE
Traffic noise level						
Distance from road	+	+			−0.30	0.01
Distance from road^2	+		+		0.00	0.00
df	4	3	3	2		
ΔAICc	0.00	115.80	199.44	295.71		
Weight	1.00	0.00	0.00	0.00		
Owls' prey detectability						
Trafic noise	+	+	+		−0.07	0.02
Species_ID		+	+			
TN X SP_ID			+			
df	4	5	6	3		
ΔAICc	0.00	2.28	4.60	17.07		
Weight	0.70	0.23	0.07	0.00		

Table 2. Results of GLM examining how TN decreases with distance from a road and GLMM examining effects of TN on owl's ability to detect prey. For GLM, we treated SPL as a response variable, and distance from a road (m) and its quadratic term as explanatory variables. For GLMM, we treated whether owls detected APRS at the treatment point as the response variable, SPL of TN, species ID and interaction of these variables as explanatory variables and plot ID and Study region (Yufutsu or Sendai) as random variables. Variables included in models are indicated with plus sign. "TN X SP_ID" indicates the interaction term between traffic noise and species ID and "Weight" refers to Akaike Weights. Parameter estimates (β) and its standard errors (SE) in the best models are also given.

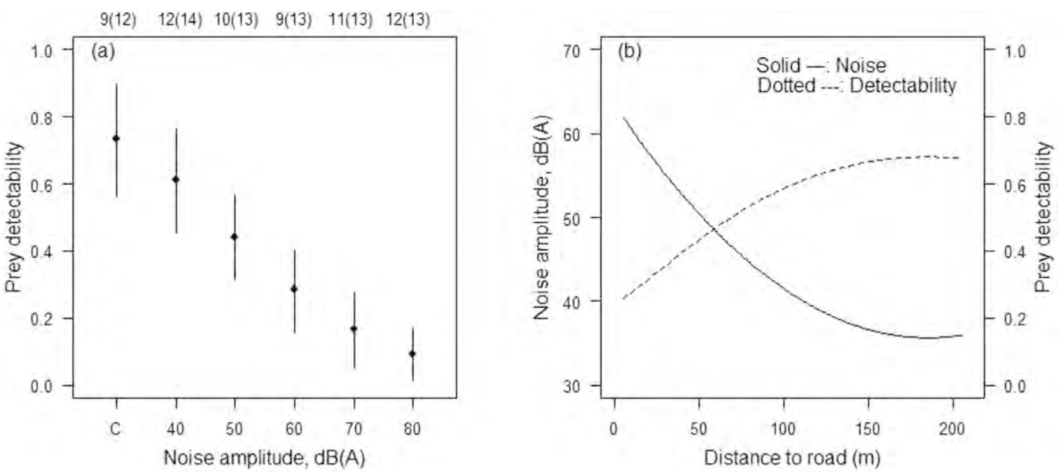

Figure 3. (**a**) Estimated owls' ability to detect prey under noise exposure levels (with 95% CI). "C" indicates control experiments. Detectability at C is estimated using average background sound level (32 dB). Top figures indicate number of experiments (number of owls analyzed). (**b**) Relationships between road distances and noise levels and owls' prey detectability. The owls' ability to detect prey was estimated based on linear regression equation presented in (**a**).

($n = 14$, see "Materials and Methods"), we analyzed 78 owls in 63 playback experiments (45 short-eared owls *Asio flammeus* and 33 long-eared owls *Asio otus*). The best model included sound pressure level (SPL) of TN and suggested owls' ability to detect prey was negatively associated with SPL of TN (Table 2, Fig. 3a). Species ID and the interaction term had no association with owls' ability to detect prey (Table 2).

In addition, to estimate relationship between road distances and owls' ability to detect prey, we also measured SPL of TN at various distances from road. Result of model selection showed SPL of TN attenuated quadratically with distance from road (Table 2, Fig. 3b), indicating impacts of traffic noise on owls' ability to detect prey has the potential to reach >120 m from a road (Fig. 3b). In other words, owls' ability to detect prey was impacted even at the lowest level of TN (40 dB[A]) and was approximately 17% lower than detections in ambient sound conditions (Fig. 3a).

Discussion

Using a novel field-based experimental approach, we show that owls' ability to detect prey is negatively impacted by increases in TN. Masking of the signal occurs when there is spectral and temporal overlap between the signal and noise[5]. Because APRS experience considerable spectral overlap by TN (Fig. 2a,b), reduction of owls' ability to detect prey could be caused by increasing acoustic masking with increasing amplitude of TN[11,12], although whether the signal was masked depends on the acoustic processing abilities of the owls and how they hear sound in noise. Additionally, it is not mutually exclusive that distraction and/or avoidance to TN play some role for explaining decreases in prey detection. For example, previous works with bats suggests that distraction/avoidance to noise had larger impact on bats' ability to detect prey than masking[8].

Owls' ability to detect prey was impacted even at the lowest level of TN (40 dB[A]) and was approximately 17% lower than that of ambient conditions (Fig. 3a). This corresponds to a distance of 120 m estimated from our model predicting noise levels from distance to the road and is twice the distance estimated for impacts on bats' prey detectability due to TN[9]. Methodological differences between laboratory and field studies could explain these differences. For example, laboratory experiments conducted in a restricted area could overestimate prey detectability of acoustic predators because in a confined laboratory setting they circle above the experimental foraging area in flight and may have more chances to detect their prey. In contrast, in the field acoustic predators typically forage in linear flight and would have fewer opportunities to detect prey sounds[11]. Alternatively, such difference may be, at least partially, due to differences of audible range and/or sensitivity to sounds between birds and bats (i.e., owls cannot detect sounds at frequencies above 15 kHz[18] while echolocating bats use sounds at frequencies up to 120 kHz)[11] and differences in prey-generated rustling sounds between the experiments.

Masking of real or artificial prey rustling sounds by traffic noise should invariably reduce foraging efficiency to some degree. However, hunting owls may be able to take advantage of directional masking release where rustling sounds and background noise propagate from different directions. Distraction, in which owls attend to traffic noise rather than rustling sounds, could also explain declines in prey detectability and could operate along side masking. However, it is also possible that distraction or compromised attention could decrease with habituation to traffic noise over time. Distinguishing among these potential mechanisms must be a next step. Additionally, it is also critical to understand whether declines in prey detection scale to responses most relevant to population persistence, such as site abandonment or impact actual foraging success, body condition and reproductive success of animals occupying noisy areas[11,19,20].

In addition, there are several differences between this study and natural conditions. First, omnidirectional TN used here differs from horizontal TN propagation from roadways that wild owls encounter in nature. Thus, future work evaluating how directional masking release changes detection of APRS is needed. Second, we used a representative TN sound recording in the experiments based on comparisons among several TN sounds. Although this isolates noise amplitude as a single factor that varied among treatment levels, it also does not reflect TN variation due to variable traffic speeds, densities and environmental conditions, indicating that future work should focus on how possible TN variation affects owls' ability to detect prey. Moreover, high frequency components of TN attenuate faster with distance from roads than lower frequency components, suggesting overestimation of the masking effects of TN playbacks at amplitudes reflective of 55, 105, 155, 205 m from the road. However, because APRS playbacks were louder than natural prey rustling sounds and APRS might be easier for owls to detect than actual prey rustling sounds with broadband energy, effects of TN on owls' prey detection may extend well-beyond our 120 m estimate.

Despite the need to parse the effects of how directional masking release, real versus artificial prey sounds and high frequency components simultaneously contribute to estimated impacts with respect to distance from roads, we provide the first evidence that noise reduces foraging efficiency in a wild predator in a natural situation. Additionally, our analysis of sound level attenuation with distance from the road suggests that declines in prey detection occur at distances twice that estimated for bats from lab studies[11], at least in our study region. Nevertheless, given our playback is representative of traffic noise propagating from other roadways (see supplementary Fig. S3), it is likely that impairment of foraging at similar distances is generalizable to other roadways. Moreover, a recently published captive study showed that experimental playback of compressor noise, which has similar power spectrum with traffic noise, negatively impacts hunting behavior of northern saw-whet owls (*Aegolius acadius*) at sound levels as low as 46 dB(A), which corresponds to approximately 800 m from compressor stations[14]. These potentially sizable footprints from energy-sector and traffic noise highlight the pervasive impacts of noise on acoustic predators because many sources of noise, including road densities, are high and increasing[4]. For example, 83% of the continental US is within 1061 m of a road[21], and globally, >25 million kilometers of new roads are anticipated by 2050[22]. Key to fully understanding noise-impacts on acoustic predators will require knowledge of how the magnitude of noise-impacts varies depending on road densities, arrangements and traffic volumes and speeds. Moreover, it is critical to understand how common prey species respond to roadways and traffic and determine whether the cumulative effects are additive, synergistic or even antagonistic, as some nocturnal small mammals appear to increase in noise exposed areas[23] and along roadways[24]. Regardless of the shape of these interactions, it is likely that wild owls and other acoustically-oriented predators will continue to be impacted by noise.

Methods

(a) Preparation of the traffic noise for playback experiments. Vehicle noise was recorded at the prefectural road #1046 in Yufutsu plain, central Hokkaido, late December 2014. The recording was conducted between 22:00 to 02:00 on a clear day when wind speeds were less than 1 m/s. We set a recorder (PCM-D100, Sony Corporation, Tokyo, Japan; frequency response ± 2 dB between 20 Hz and 45 kHz) with a sound pressure meter (Sound Level Meter TYPE 6236, ACO CO., LTD, Miyazaki, Japan) at a height of 1.5 m and 5 m distance from the road. Then, for each of 20 passing vehicles at constant speed (60 km/h), we recorded its noise and measured its sound pressure level (SPL) as the A-weighted equivalent continuous noise level during five seconds at nearest distance to a vehicle (L_{eq} [5 s], fast response time, re. 20 μPa, A-weighting). For these, we used the A-weighted filter because this filter provides better measurement of acoustic energy relevant to birds at frequencies between 1.0 and 9.5 kHz[25], which cover entire frequency range used by hunting owls[18]. Finally, we created a 1 min exemplar of TN sound consisting of 12 vehicle pass-by events, which contained energy up to 40 kHz, but had the most energy below 10 kHz (Fig. 2b). This traffic level was found along roads in many national parks, national forests, and protected areas globally[19]. Although it is better to use different TN sounds in each playback experiment to capture potential heterogeneity in traffic noise present in different locations or times, because our primary interest is to quantify effect of amplitude alone on owls' ability to detect prey, we used this single TN sound file in all playback experiments based on comparisons of frequency spectra among several TN sounds recorded at different locations (see supplementary Fig. S3). We also created a 1 min control sound file that had no acoustic energy. In addition, to understand how sound levels attenuate with distance from the roadway, for each of 20 passing vehicles at known speed (i.e., 60 km/h), we measured its sound pressure level (SPL) as the A-weighted equivalent continuous noise level during five seconds at nearest distance to a vehicle (e.g., LAeq [5 s]) at 5, 55, 105, 155, and 205 m from the road.

(b) Preparation of the artificial prey rustling sound for playback experiments. When small-mammals walk on the ground, they produce rustling sounds which are short and contain a wide range of frequencies[18]. Owls can precisely locate these rustling sounds, especially at frequencies between 6 and 8.5 kHz[18]. Because they respond strongly to stimuli at these frequencies, we created sound files consisting of an upsweeping element of 0.4 s in duration spanning 3.0–9.0 kHz separated by 0.1 s (sampling rate: 192 kHz). For each file, the elements were repeated eight times, followed by 6 s with no acoustic energy (Fig. 2a). This 10 s section was then repeated six times to create a one-minute artificial prey rustling sound, which is similar in structure to rustling sounds made by actual prey[18]. All sound analyses and clip generation were conducted in Sound Forge Audio Studio 10.0 (Sony, Tokyo, Japan).

(c) Study area and field playback experiments. To make certain that we could obtain sufficient sample sizes, we selected two study areas in northern Japan where many owls overwinter. Specifically, field experiments were conducted in Yufutsu plain, central Hokkaido and in Sendai plain, northern Honshu (see Supplementary Fig. S2). Both landscapes are predominantly agricultural fields and semi-natural grasslands (see Supplementary Fig. S2), providing suitable environments for our target study species. We established 103 playback experimental plots in these two areas (45 in Yufutsu plain and 58 in Sendai plain, northern Honshu) (see Supplementary Fig. S2). In the study area, an individual short-eared owl territory size was estimated to be approximately 5 ha (M. Senzaki, personal observations), which nearly equals an area with 130 m radius. Thus, to prevent double sampling, adjacent plots were spaced by $>$500 m. In addition, we did not establish plots in areas with tall trees or streetlights to prevent potential effects of these factors on sound propagation or owls' behaviors respectively. Playback experiments were conducted at least once in each plot between 1700–0500 h on both clear and cloudy nights, when wind speeds were $<$2 m/s, from December 2014 to March 2015, which corresponded with owls' wintering periods. The average number of playback experiments at each plot ($\pm$SD) was 3.56 $\pm$ 1.23. When owls were sampled in a plot, we did not conduct any additional playback experiments in the same plot three or more days to minimize effects of habituation.

A plot consisted of an attraction and treatment point spaced 50 m apart (Fig. 1) with one and two speakers (PDX-B11: Yamaha, Hamamatsu, Japan; frequency response $\pm$ 10 dB between 55–20 kHz) connected with players (WALKMAN NW-E080, Sony Corporation, Tokyo, Japan), respectively. Although traffic noise propagates horizontally across the landscape, and mimicking directional propagation can be carefully controlled in laboratory conditions[11,12], we set all speakers on the ground facing upwards to ensure omnidirectional propagation of attraction and treatment point sounds across the landscape. This ensures fairly equal amplitudes of playback sounds in all directions, which was important when owls could approach from any direction. On nights when background SPL $\leq$ 35 dB(LAeq[1 min]), we broadcasted TN or the silent sound file with no acoustic energy (hereafter "control sound") from one speaker at the treatment point until the end of the experiment. Amplitude of TN was randomly chosen to be approximately 40, 50, 60, 70, or 80 dB(LAeq [5 s]) at 1.5 m height above the speaker, representing sound levels measured at different distances from a roadway. After 1 min of TN broadcast at the treatment point, we first broadcast APRS at 90 max dB(A) at a height of 1.5 m above the attraction point speaker for 1 min to attract owls from the larger surrounding area. When the playback was finished, we immediately broadcast APRS at 35 max dB(A) at a height of 1.5 m above the second speaker at the treatment point for 1 min. Although 35 dB(A) is louder than natural prey sounds[11,12], we used the value to ensure that owls at attraction points could detect APRS at treatment points at least under control playback conditions. We tracked owls attracted to the attraction point and determined whether they could subsequently detect APRS at the treatment point. Owls that actively entered the range within 10 m from the attraction/treatment point (e.g., owls hovering and/or flying circular over the speaker) were determined to detect APRS in each point. When we observed attacks and/or chases between attracted owls and/or when we could not determine whether owls in attraction points were detecting APRS in treatment points because they landed on the ground, they were not included in subsequent analyses. We also excluded experiments with no owls detected from any analysis. Because flying owls could be observed at approximately 50 m distance from an observer, observations were conducted 30 m from both attraction and treatment points using a night scope (ATN Night Spirit XT, California, USA) and binoculars (MONARCH 8 $\times$ 42, NIKON CORPORATION, Tokyo, Japan).

(d) Data analysis. We used Generalized Linear Model (GLM) with Gaussian error to examine how TN decreases with distance from a road. We treated SPL as a response variable, and distance from a road (m) and its quadratic term (m^2) as explanatory variables.

We examined effects of TN on owl's ability to detect prey using Generalized Linear Mixed Model (GLMM) with Binomial error. We treated whether owls detected APRS at the treatment point as the response variable, SPL of TN, or ambient SPL measured prior to the start of control trials, species ID (long- or short-eared owl) and the interaction of these variables as explanatory variables. Plot ID and Study region (Yufutsu or Sendai) were treated as random variables. Although identifying whether the same individuals were recorded within a specific plot was difficult due to low light levels, treating plot ID as a random effect can account for possible repeated sampling of the same individuals. For experiments with control sound, SPL measured before the start of the experiments was used. We constructed models for the combinations of all possible covariates, ranked them by Akaike's information criterion for small sample size (AICc), and considered covariates in the best model as meaningful predictors. These analyses were conducted using "lme4" (v. 1.1–5)[26] and "MuMIn"(v. 1.9.13)[27] with R software (v. 2.15.3)[28].

(e) Ethical statement. All experiments were performed in accordance with relevant guidelines and regulations. All experimental protocols were approved by the Japanese Ministry of the Environment.

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Author Contributions

M.S. designed the study, carried out the field experiments and drafted the manuscript. Y.Y. participated in the design of the study and helped draft the manuscript. C.D.F. and F.N. helped draft the manuscript. All authors gave final approval for publication.

Additional Information

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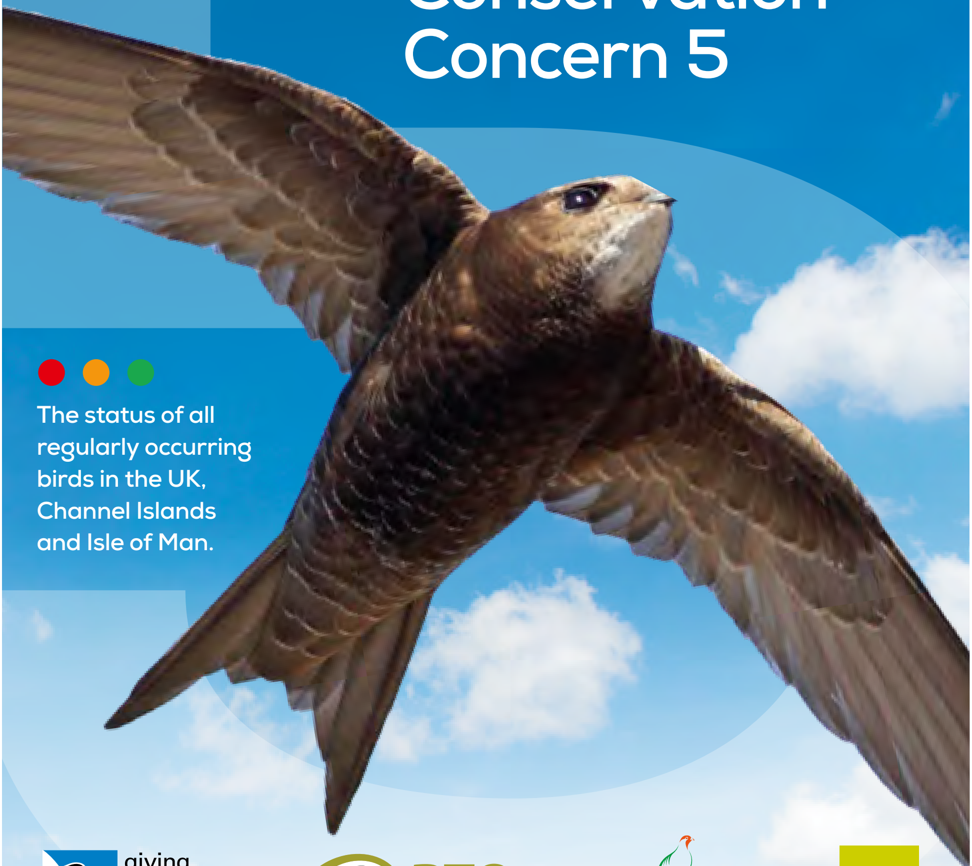
Birds of Conservation Concern 5



The status of all regularly occurring birds in the UK, Channel Islands and Isle of Man.

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***Birds of Conservation Concern* is compiled by a coalition of the UK's leading bird conservation and monitoring organisations and reviews the status of all regularly occurring birds in the UK, Channel Islands and Isle of Man.**

This is the 5th Birds of Conservation Concern review, with the first published in 1996. The bird species that breed or overwinter here have been assessed against a set of objective criteria and placed on the Green, Amber or Red lists to indicate an increasing level of conservation concern. Data delays prevented an assessment of breeding seabirds (apart from Leach's storm-petrel), so their status was carried over from *Birds of Conservation Concern 4*.

The quantitative criteria assessed the historical decline, recent trends in population and range, population size, localisation and international importance of each species, as well as its global and European threat status.

The assessments show that the status of UK bird populations continues to decline. Since the last review in 2015, the golden oriole has been lost as a breeding species. In addition, the length of the Red list has grown by three; 11 species have been added, but six have moved to Amber and two are now no longer assessed as they have either ceased breeding in the UK or were excluded from the process for other reasons. The length of the Amber list has also grown by seven species.

The Birds of Conservation Concern 5 Red list

Grey partridge	Lapwing	Grasshopper warbler
Ptarmigan [g]	Whimbrel	House martin [a]
Capercaillie	Curlew	Wood warbler
Black grouse	Black-tailed godwit	Starling
Bewick's swan [a]	Ruff	Mistle thrush
White-fronted goose	Dunlin [a]	Fieldfare
Long-tailed duck	Purple sandpiper [a]	Ring ouzel
Velvet scoter	Woodcock	Spotted flycatcher
Common scoter	Red-necked phalarope	Nightingale
Goldeneye [a]	Kittiwake	Whinchat
Smew [a]	Herring gull	House sparrow
Pochard	Roseate tern	Tree sparrow
Scaup	Arctic skua	Tree pipit
Red-necked grebe	Puffin	Yellow wagtail
Slavonian grebe	Hen harrier	Hawfinch
Turtle dove	Montagu's harrier [a]	Greenfinch [g]
Swift [a]	Lesser spotted woodpecker	Twite
Cuckoo	Merlin	Linnet
Corncrake	Red-backed shrike	Redpoll
Leach's storm-petrel [a]	Marsh tit	Corn bunting
Balearic shearwater	Willow tit	Cirl bunting
Shag	Skylark	Yellowhammer
Dotterel	Marsh warbler	
Ringed plover	Savi's warbler	

a - species on the Amber list previously, g - species on the Green list previously

The Birds of Conservation Concern 5 Amber list

Quail	Stone-curlew	Tawny owl
Whooper swan	Oystercatcher	Osprey
Brent goose	Avocet	Honey-buzzard
Barnacle goose	Black-winged stilt [na]	Marsh harrier
Greylag goose	Grey plover	Sparrowhawk [g]
Bean goose	Bar-tailed godwit	White-tailed eagle [r]
Pink-footed goose	Turnstone	Kestrel
Eider	Knot	Rook [g]
Red-breasted merganser [g]	Curlew sandpiper	Shorelark
Shelduck	Sanderling	Sedge warbler [g]
Garganey	Snipe	Yellow-browed warbler [na]
Shoveler	Common sandpiper	Willow warbler
Gadwall	Green sandpiper	Common whitethroat [g]
Wigeon	Spotted redshank	Dartford warbler
Mallard	Greenshank	Short-toed treecreeper
Pintail	Redshank	Wren [g]
Teal	Wood sandpiper	Dipper
Black-necked grebe	Black-headed gull	Song thrush [r]
Stock dove	Mediterranean gull	Redwing [r]
Woodpigeon [g]	Common gull	Pied flycatcher [r]
Nightjar	Lesser black-backed gull	Black redstart [r]
Spotted crake	Yellow-legged gull	Common redstart
Moorhen [g]	Caspian gull	Wheatear [g]
Crane	Iceland gull	Dunnock
Black-throated diver	Glaucous gull	Meadow pipit
Great northern diver	Great black-backed gull	Water pipit
European storm-petrel	Little tern	Grey wagtail [r]
Northern fulmar	Common tern	Bullfinch
Manx shearwater	Arctic tern	Parrot crossbill
Spoonbill	Sandwich tern	Scottish crossbill
Bittern	Great skua	Lapland bunting
Little bittern [na]	Black guillemot	Snow bunting
Cattle egret [na]	Razorbill	Reed bunting
Great white egret [na]	Guillemot	
Gannet	Short-eared owl	

r - species on the Red list previously, g - species on the Green list previously, na - not assessed previously

Birds of Conservation Concern 5 Former breeding species

Great bustard	Black tern	Wryneck
Kentish plover	Great auk	Golden oriole [r]
Temminck's stint	Snowy owl	Serin

r - species on the Red list previously

Themes from Birds of Conservation Concern 5

This assessment adds to a wealth of existing evidence that shows many of our bird populations are in trouble. At 70 species, the Red list is now longer than ever before, and is almost double the length of that in the first review in 1996. New Red-listed species include swift, house martin, ptarmigan, purple sandpiper, Montagu's harrier and greenfinch.

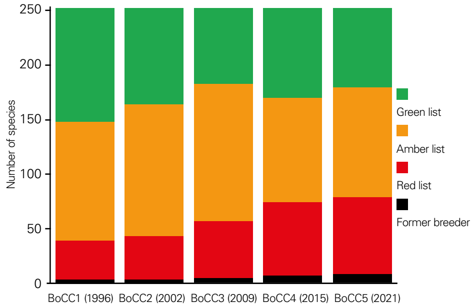
Previous reviews have highlighted the worrying plight of farmland, woodland and upland birds. There has been no improvement in the overall status of species associated with farmland and upland; indeed, more species have been Red-listed.

The status of long-distance Afro-Palearctic migrants that spend the non-breeding season in sub-Saharan Africa, particularly the humid tropics, continues to decline.

We also raise concerns over the status of our wintering wildfowl and wader populations, with Bewick's swan, goldeneye, smew and dunlin also joining the Red list. Pressures are wide-ranging and are complicated by 'short-stopping', whereby species have shifted their wintering grounds north-eastwards in response to increased temperatures caused by climate change.

There is also a worrying trend towards more of the UK's regularly occurring species being classed as threatened with global extinction; with the addition of Leach's storm-petrel and kittiwake, this increases the list to nine bird species.

It is not all bad news. Thanks to successful reintroduction projects, the white-tailed eagle



moves from the Red to Amber list. Song thrush, pied flycatcher, grey wagtail, redwing and black redstart also moved off the Red list to Amber, but the first three species remain close to the Red list threshold.

The UK has seen continued colonisation by new bird species, and we added four new breeding species (great white egret, cattle egret, little bittern and black-winged stilt) and one non-breeding species (yellow-browed warbler) to this review. While we welcome these additions to our wildlife, we should simultaneously recognise that the arrival of new species here owes much to man-induced climate change.

The full details of this assessment, including the Green list, can be found at Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. 2021. The status of our bird populations: the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain. British Birds 114: 723-747. Available online at **https://britishbirds.co.uk/content/status-our-bird-populations**.

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