H2Teesside Project

Planning Inspectorate Reference: EN070009

Land within the boroughs of Redcar and Cleveland and Stockton-on-Tees, Teesside and within the borough of Hartlepool, County Durham

The H2 Teesside Order

Document Reference: 8.26 Applicant's Response to Deadline 4 Submissions and Compulsory Acquisition Regulations Relevant Representations

The Planning Act 2008

Applicant: H2 Teesside Ltd

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1.0 INTRODUCTION

1.1 Overview

1.1.1 This document has been prepared on behalf of H2Teesside Limited (the 'Applicant'). It relates to an application (the 'Application') for a Development consent Order (a 'DCO'), that was submitted to the Secretary of State for Energy Security and Net Zero ('DESNZ') on 25 March 2024, under Section 37 of the Planning Act 2008 (the 'PA 2008') in respect of the H2Teesside Project (the 'Proposed Development').

1.1.2 The Application has been accepted for examination. The Examination commenced on 29 August 2024.

1.2 The Purpose and Structure of this Document

1.2.1 This document provides the comments of the Applicant in response to the submissions made by Interested Parties at Deadline 4 of the Examination. The Applicant has only responded to new points **not** covered in the following:

- the Written Summary of the Applicant's Oral Submissions at the Compulsory Acquisition Hearing 1 [REP4-015];
- the Applicant's Written Summary of the Applicant's Oral Submissions [REP4-016]; and
- the Examining Authority's Second Written Questions.

1.2.2 As it relates to the Compulsory Acquisition Relevant Representations, the Applicant continues to engage with the relevant parties, including landowners, about their concerns as part of the wider discussions with them. However, this document provides a response to the Relevant Representation received from Mission to Seafarers. In respect of the Forestry Commission Relevant Representation, the Applicant notes confirmation from the Forestry Commission that the Proposed Development does not cause adverse effects to any Ancient Woodland.

1.2.3 Appendices have been provided where they are referred to in the Applicant's response.

2.0 LANDOWNER / ASSET HOLDER INTERESTED PARTIES

Table 2-1: Response to Landowner / Asset Holder Interested Parties Deadline 4 submissions

PARTY	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
CF FERTILISERS	REP4-034 REP4-035	• CF Fertilisers ask to be a consultee on the decommissioning environmental management plan	The dDCO submitted at Deadline 5 has been amended to include CF Fertilisers as a consultee for the decommissioning environmental management plan.
NATARA	REP4-044	• Both parties seek for the Applicant to relocate the hydrogen pipeline proposed to pass through their land.	The Applicant is in discussions with CF Fertilisers regarding the location of the hydrogen pipeline and anticipates that the protective provisions will be agreed to address CF Fertilisers' concerns. Discussions are continuing with Natara on the same point.
CF FERTILISERS	REP4-034 REP4-035		
NAVIGATOR TERMINALS LIMITED	REP4-045 REP4-046	• Navigator have suggested that the Applicant share a construction compound with NZT. • Navigator have also suggested that the Applicant should reduce its flexibility within its land.	In relation to Navigator Terminals' suggestion to reduce the flexibility, the Applicant refers to its response to question 2.6.15 in the Applicant's second written questions. The Applicant is in ongoing technical discussions with Navigator Terminals in relation to the location of various aspects of the Proposed Development and the construction compound areas.
PD TEESPORT	REP4-047 REP4-048 REP4-049	• PDT continue to raise concerns about the interaction between the DCO and the Port's byelaws, its open port duty, and section 22 of the Tees and Hartlepool Port Authority Act 1966.	The Applicant have amended the dDCO submitted at Deadline 5 to align better with the approach taken for the NZT/NEP DCO.
SABIC	REP4-050 REP4-051 REP4-052	• Sabic wishes for there to be clear, unambiguous obligation for there to be trenchless crossings in respect of the Tees and Greatham Creek crossings.	The Framework CEMP has been updated and submitted into the Examination at Deadline 5 to take account of SABIC's comments.
SOUTH TEES GROUP	REP4-056 REP4-057	• STG raise concerns about the Applicant's compulsory acquisition proposals for Phase 2 of the Hydrogen Production Facility. • STG raise concerns about the interaction of the Proposed Development and battery storage proposals being brought forward by NatPower. • STG wishes for the Applicant to provide more detail on the corridor widths for the Proposed Development, and why the Proposed Development proposals cannot be shared with agreed NZT corridors.	The Applicant continues to discuss the matter of the Phase 2 land with STG, and is confident that an approach can be agreed which enables Phase 2 to be brought forward alongside the on-going redevelopment of the Teesworks estate. As part of this, the Applicant is seeking to agree an approach with STG to ensure that the NatPower proposals will be able to come forward without being affected by the Proposed Development. The Applicant cannot provide further detail on the corridor widths for the Proposed Development at this stage. Within the Teesworks estate, STG will be aware that there a number of existing and proposed assets that the Proposed Development will need to take account of, each of which may have knock on implications to other widths within a connection corridor. The detailed design will be dependent on the conclusion of technical discussions with asset owners, pursuant to DCO Protective Provisions, including STG. This includes NZT – clearly where possible the Applicant will look to share corridors with NZT, but H2T is its

PARTY	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
			own project that needs to be able to 'stand on its own two feet' for its various connections and for hydrogen distribution. Finally, it is noted that STG will be consulted on the final routing of the various corridors pursuant to the DCO Requirements. The Applicant received STG's preferred version of Protective Provisions on 13th December. With the time available before Deadline 5, the Applicant was not able to review and incorporate STG's preferred Pprotective Provisions. However, the Applicant will continue to work with STG to negotiate the Protective Provisions.
VODAFONE	REP4-058 REP4-059 REP4-060 REP4-061 REP4-062	• Vodafone has raised concerns about the protection of its assets	The Applicant considers that the protective provisions for the protection of operators of electronic communications code networks included in Schedule 17 of the dDCO provide sufficient protection for Vodafone. The Applicant would welcome discussions with Vodafone if it considers any bespoke protections are needed.

Table 2-2: Response to Sembcorp Deadline 4 submissions

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
SEMBCORP1	Comments on any submissions received at DL1, including LI Rs any updated dDCO and the Applicant's draft itinerary for the ASI [REP2-101]	The Applicant should provide evidence that it considered developing a new multiuser tunnel according to NPS EN1 - "*4.3.15 Applicants are obliged to include in their ES, information about the reasonable alternatives they have studied. This should include an indication of the main reasons for the applicant's choice, taking into account the environmental, social and economic effects and including, where relevant, technical and commercial feasibility*." And the government Guidance on Associated Development "Associated development should be proportionate to the nature and scale of the principal development. However, this core principle should not be read as excluding associated infrastructure development (such as a network connection) that is on a larger scale than is necessary to serve the principal development if that associated infrastructure provides capacity that is likely to be required for another proposed major infrastructure project.3"	As explained in ISH1 the DCO application as submitted includes a hydrogen pipeline crossing under the River Tees to meet the operational needs for H2T, defined in Work No. 6 as "a hydrogen distribution network, being works for the transport of hydrogen gas .". If the pipe was to cater for other developments or uses, it would need to be established that this was nevertheless Associated Development (i.e. development associated with the principal development). That would require a direct relationship with the principal development and assessment against the core principles set out in the Government's Guidance on associated development applications for major infrastructure projects (2013).	Firstly the Applicant's response fails to address the ES flaw in failing to include information on the reasonable alternatives which the Applicant plainly considered; as has been evidenced by the Sembcorp. Secondly, the Applicant seeks to characterise the Government guidance on Associated Development as preventing an applicant providing overcapacity in infrastructure which would benefit another proposed major infrastructure project, when in fact this approach is expressly <u>not</u> excluded from the concept of Associated Development.	The Applicant and Sembcorp Utilities (UK) Limited have had engagement to discuss all points from SEMBCORP1 to SEMBCORP5 and will continue to do so until matters are resolved satisfactorily for both parties. The Applicant notes SEUK (and other Interested Parties') concerns about the precise alignment of the River Tees crossing and is working to resolve them with those parties, which will be able to continue post the DCO process pursuant to the Protective Provisions. In relation to the discussion of Associated Development, the Applicant notes the full wording of the Guidance on Associated Development. The key point of the Guidance is that overcapacity is a case specific consideration, considering matters such as '*whether a future application is proposed to be made by the same or related developer as the current application, the degree of physical proximity of the proposed application to the current application, and the time period in which a future application is proposed to be submitted*'. At the time the Applicant was developing its application, and currently, there has been no timeframe presented for 'a proposed major infrastructure project' being brought forward by any developer, particularly the Applicant, or by SEUK. As such, the Applicant would not have been able to robustly bring forward a scheme

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
					for a tunnel above and beyond the requirements for a hydrogen pipeline.
SEMBCORP2	Responses to comments on Relevant Representations [REP2-102]	1. Draft protective provisions awaited 2. Concerns raised over the capacity of the pipeline corridors and the interrelationship of the various DCO projects in the area Concerns raised over the impact of the Tees crossing on the existing infrastructure and the constraints this could place on future crossings	1. The Applicant has had productive discussions with Sembcorp on the principles for bespoke protective provisions and continues to progress these discussions. The Applicant's legal and technical teams are progressing draft protective provisions for issue to Sembcorp. 2. The Applicant remains committed to ongoing engagement and will continue to work closely with Sembcorp to ensure that any concerns are addressed adequately through protective provisions and other technical discussions. The Applicant believes its pipeline can be accommodated within the pipeline corridor without unduly impacting the potential for future projects based on the engineering design work and site surveys performed and looks forward to continued discussions with Sembcorp in this regard. The Applicant would refer to its input provided during ISH1 [REP1-008] regarding the Tees Crossing. Each new crossing has incrementally added to the difficulty of future crossings. As such, while all previous crossings have been installed in parallel arrangements, there is no available route for the Project's crossing which avoids intersection with existing crossings. The Project has been designed to overcome the additional complexity involved in its own river crossing caused by existing crossings. Any future crossing	Sembcorp remains concerned about the Tees Crossing, both in terms of the severe difficulty this will create for future crossings and the potential for damage to existing sensitive infrastructure as previously outlined.	The Applicant and Sembcorp Utilities (UK) Limited are at a critical stage of negotiations of the protective provisions for the Proposed Development and it would therefore not be constructive for protective provisions to be submitted at deadline 5. The Applicant and Sembcorp Utilities (UK) Limited will continue negotiations but with the Christmas break approaching, it is considered that deadline 7 is a more realistic date by which finalised protective provisions can be submitted.

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
			would similarly have to account for the complexity caused by existing pipelines. This Project may add an additional layer of complexity but in principle this is not new or unacceptable, and it would not render future crossings impossible.		
SEMBCORP3	Responses to the Examining Authority's First Written Questions (ExQ1) [REP2-103]	• Q1.6.62 - Concerns over interference with access to assets for both SembCorp and its Tenants and potentially prevent future tenants and new customers from maturing • 01.9.67 - Draft PPs are yet to be issued Q1.17.1- Access rights remain a concern	The Applicant acknowledges Sembcorp's concerns regarding potential interference with access to assets for both Sembcorp and its tenants, as well as the potential impact on future tenants and new customers. The Applicant considers that access protections will be addressed through negotiation of Protective Provisions (PPs).	Noted.	An update regarding protective provisions is provided at SEMBCORP2 above.
SEMBCORP4	Written Representation [REP2-104]	Part 1- Safety Concerns 2.1. Sembcorp is concerned about the safety of those parts of the Applicant's network comprising above-ground hydrogen pipelines and questions whether, fundamentally, this is a safe approach which is ALARP (as defined in paragraph 20.2.5 of Chapter 20 of the ES). 2.2 Issues include greater propensity for leaks, flammability, detection difficulties, explosivity, risk of asphyxiation, temperature control of above ground hydrogen. 2.3 Proximity of above ground pipelines to other hazardous substances in pre-existing pipelines.	2.1. The Applicant considers safety as its number one priority and will use their many years of experience to ensure that H2Teesside is operated in accordance with its operating management system, to prevent harm to people and the environment. The Applicant is following industry norms to identify, confirm and assesses the hazards related to the project, and ensure that there are processes in place to manage these hazards appropriately, during the operation of H2Teesside. Risks that are identified through this process to require the demonstration of ALARP will do so through established processes. 2.2 These issues are noted and are being considered in the design of theH2Teeside plant and pipeline system. 2.3 The Applicant is aware of site-specific risks introduced by the existing assets in	Sembcorp notes these responses and looks forward to discussing these matters further with the Applicant in the proposed technical meeting.	2.1, 2.2, 2.3, 2.5 – The Applicant has met with SEUK and presented an update of the safety work performed to date to SEUK, and planned work regarding process safety in this phase of work. 2.4 – The Applicant will present the locations of pipelines which are aboveground and buried to SEUK for their information and for feedback as part of the Protective Provisions process, and pursuant to the amendments to Requirement 3 of the DCO that have been made at Deadline 5 which requires Sembcorp to be consulted on the design of the hydrogen pipelines. 2.6 – Escalation events or domino events caused by a loss of containment of the hydrogen pipeline impacting adjacent services will be considered as part of the process safety work performed in this phase. This work will form part of the Safety Case presented to the Health and Safety Executive.

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
		2.4 Above ground leakages compared to buried lines.	Teesside, which includes Major Accident Hazard Pipelines (MAHP), and is aware of the potential for domino effects in the event of a failure. Domino effect, or escalation, will be considered as part of the FEED Phase Quantitative Risk Assessment (QRA). The Applicant will collect information about the existing assets within the pipeline corridor and, if possible, information about the existing site safety plans. The assessment will determine what the increased risk is due to the Hydrogen pipeline. The Applicant will demonstrate to the HSE in the Safety Report that these escalation risks are ALARP. 2.4 Within Teesside, there is limited space for a buried pipeline given the existing above ground pipeline routes throughout the area. The Applicant proposes to install the hydrogen pipeline above ground where there are existing above ground pipeline corridors and where there is not sufficient space for below ground installation. Buried pipeline sections include: Teesworks and Seal Sands pipeline from the H2Teesside plant to the Bran Sands Corridor Greatham Creek pipeline Transmission and Industrial pipeline to Cowpen Bewley. Other pipeline segments will be installed above ground. As part of engineering design, the Applicant will perform Quantitative Risk Assessment which will consider the additional threats to the pipeline from above ground installation, where applicable, and the failure frequency used in the analysis will be adjusted accordingly. The methodology will follow the HSE Guidance Note RR1186: Failure rates for above ground major accident hazard		2.7 The Applicant acknowledges that in its earlier submissions, it had indicated that buffer zones for access and maintenance for existing pipelines is '1 metre in all directions'. However, it recognises that this is not a blanket rule. Instead, the separation distance will be optimised given local conditions such as available space, existing assets, constructability and maintainability. The separation distance will therefore vary along the pipeline corridor given that these conditions vary.. Furthermore, in taking forward the design, potential escalation impacts will be assessed and if escalation events are found to be of concern, alternative mitigation methods such as increasing pipe wall thickness can be implemented instead of buffer distances. As such the hydrogen pipeline can be designed not take up disproportional space The Applicant also notes that in considering set off distances, it will be taking the approach that whilst not all assets are currently in service, they shall be considered as operational in the design in terms of space allocation and safety assessments. These assets may be brought back into service in the future prior to or during H2Teesside operation, therefore the Applicant recognises that they should be considered as such 2.8 Captured in 2.1 above.

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
		2.5 Considering ALARP, SembCorp believes that the risks associated with the Applicants proposed pipeline would be significantly reduced by burying the pipeline, rather than routing above ground. 2.6 Sembcorp is concerned by domino effects caused by interactions with existing COMAH facilities in the Wilton International Site. 2.7 The presence of H2 pipes above ground may disproportionately use up capacity on existing pipeline racking due to greater buffers being required to achieve appropriate separation. 2.8 External interference of above ground pipelines is considered as a specific threat to pipeline integrity as indicated in TD/1 with gas pipelines being buried this significantly reduces this risk	pipelines outside above ground installations. Additional risks to be considered include vandalism, road/rail/aircraft crashes. The methodology for aircrafts follows the HSE Guidance note. 2.5 The Applicant has considered Inherently Safer Design (ISD) to start with and analysis so far has indicated that design falls within the 'Broadly Acceptable' region. Nevertheless, mitigation of risk analysis is being included in the FEED studies to ensure all measures are considered from the hierarchy of controls to ensure an ALARP design. 2.6 The Applicant is engaging with the Competent Authority in relation to COMAH. The Applicant appreciates that the Proposed Development Site is located within an area which has a number of COMAH installations, forming a domino group as described in Regulation 24 of COMAH (See Chapter 20-APP-73). In the design phase of the Project the risk of domino effects will be considered, and appropriate mitigation measures will be adopted to demonstrate ALARP. 2.7 The project will not take up disproportional space. as typical buffers for access and maintenance for pipelines shall be used. This is 1 metre in all directions. The potential escalation impact will be assessed using this distance. If escalation events are found to be a concern, mitigation methods such as increasing pipe wall thickness may be implemented. The majority of existing pipeline corridors are highly congested, however not all assets are in service.		

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
			2.8 IGEM/TD/I Ed. 6 is the primary design code for H2Teesside pipelines, and IGEM/TD/1 Supplement 2 is being applied for the hydrogen lines. During discussions with the Applicant, the Institute of Gas Engineers and Managers (IGEM) recommended that independent professional advice should be sought to confirm the applicability of TD/1 to above ground hydrogen pipelines. The Applicant engaged a competent engineering contractor who are members of IGEM and contributed to the development of IGEM/TD/1. The contractor concluded that IGEM/TD/1 philosophy was applicable for above ground hydrogen pipelines. An appropriate technical meeting has been arranged to discuss this further with Sembcorp.		
SEMBCORP5	Written Representation [REP2-104]	Part 2-Existing Underground River Crossing Assets 2.9 SembCorp has additional concerns relating to the River Tees crossing and the proximity of the Proposed Development to Tunnel 2 as well as Sembcorp's 24" natural gas pipeline and 8" propane pipeline.	The Applicant is in discussions with Sembcorp relating to the proposed crossing of the River Tees. Further investigations and technical assessments are required before a final crossing methodology can be confirmed. The Applicant is committed to working closely with Sembcorp and other stakeholders to ensure that any potential impacts are thoroughly evaluated and mitigated. 2.9 The Applicant has collected information about existing assets crossing the river from historical records. The Applicant will provide information about all existing assets to its specialist subcontractor for design of the Tees Crossing during FEED phase. The specialist subcontractor will review the information and design the H2Teesside Tees Crossing appropriately, with suitable crossing techniques and separation distances.	Whilst Sembcorp notes these responses, it remains concerned about the potential for damage to existing infrastructure under the river. As the detailed design and baseline conditions are not currently available for IPs or the Examining Authority to consider in detail and noting the proposed disapplications in Articles 9(2)(a) and 9(2)(b) of the draft DCO (in respect of important detailed approvals normally required from the Statutory Harbour Authority), it would assist if the Applicant could confirm what alternative or further approval mechanisms the Applicant proposes to ensure that the final design does not compromise existing critical infrastructure and that this is subject to appropriate third party scrutiny. Furthermore, the Applicant's response does not address the issue of monitoring arrangements post construction to	2.9 The Applicant and SEUK will agree a process for approval mechanisms by SEUK of the design of the Tees Crossing, noting that the ambit of such a mechanism will be able to be dealt with by the Protective Provisions. 2.10 – The Applicant considers that this matter has been Closed with Sembcorp. 2.11 – Monitoring arrangements post construction are to be proposed by the Applicant to SEUK. This proposal has not yet taken place but has been taken as an action in the ongoing engagement meetings. This is a matter that will be able to be addressed pursuant to the Protective Provisions and/or any associated private agreement.

REFERENCE	SOURCE DOCUMENT(S)	SEMBCORP ISSUE/ THEME – DEADLINE 2	APPLICANT RESPONSE – DEADLINE 3	SEMBCORP RESPONSE – DEADLINE 4	APPLICANT RESPONSE – DEADLINE 5
		2.10 The methodology of HDD diagonally across existing assets could have adverse impacts on the existing pipelines and tunnels crossing the Tees as all other assets run parallel to each other. 2.11 Concerns about damage inadvertently caused by microbore/HDD method on existing infrastructure through accidental collision, subsidence or vibration. It is not clear to Sembcorp what mitigations and/or separations the Applicant proposes to prevent such damage, nor how any impacts may be monitored, during and post construction	2.10 The crossing angle of existing assets is dictated by land available for construction of the shaft, and available space being taken by existing assets. If there were sufficient space available then the Applicant would have selected a parallel alignment per the philosophy followed by other existing service crossings at this location. Because a parallel alignment is not available, the Applicant proposes to use an appropriate separation distance from other assets considering the selected crossing technology. Typical approach to crossings for pipelines to be at 90-degrees is not applicable as this is a special crossing, and the specific constraints must be considered. Microbored tunnels have been performed in other locations without parallel alignments, for example many tunnels for the London Underground cross services without considering a perpendicular crossing angle. 2.11 The vertical separation distance is currently set at >10m to all assets except the mud return pipeline (0.15m OD) pipeline which is >5m. The Applicant is using a specialist subcontractor to design the Tees Crossing. During the detailed engineering phase, this subcontractor will perform settlement calculations using the known information about soil conditions and existing assets in the area. This calculation will be used to confirm the selected separation distance is suitable. During construction, a settlement monitoring Programme will be used to verify that settlement and vibration are within tolerable limits set by the design.	identify and address any longer term damage arising to surrounding infrastructure. It would assist if the Applicant could identify where and how such mitigation is secured.	

3.0 ENVIRONMENT AGENCY

Table 3-1: Response to Environment Agency'a Deadline 4 submission

REFERENCE	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
EA1	REP4-025	We are satisfied with the Applicants response regarding this point. Once greater knowledge of finalised locations and risks are provided, we will review and comment on them as part of DCO Requirements 11 and 15. We would expect an updated FRA to be submitted as part of the discharge of Requirement 11. This will enable the EA to appropriately assess the flood risk mitigation. The wording of Requirement 11 should be updated to reflect this. The applicant may also want to consider as mitigation, elevating the foundations of the compounds above the design flood level. This can be done by using stilts, piers, or raised platforms.	There is no need for the DCO to require that the FRA is updated once the DCO has been granted. Requirement 11 requires details of flood risk mitigation for both the construction and operation phases, and a flood emergency plan to be approved in consultation with the EA. In order to be able to demonstrate that flood risk is 'mitigated', the Applicant would have to show that they do in fact 'mitigate', which would necessitate some form of modelling to show that they work. If that was not provided then the flood risk would not be able to be shown to be mitigated. It is therefore the details of those mitigation measures that is the important step to ensure flood risk is managed and enable the EA to appropriately assess the flood risk mitigation measures proposed. Updating 'the FRA' itself would be a paper exercise in that context and is not considered necessary.
EA2		The Applicant has determined that most above-ground pipeline corridors are pre-existing and would not be able to be raised but will be assessed for flood resistant design. We accept this approach. Confidence in flood safety would need to be ensured and formalised under Requirements 11 and 15. Newly installed pipework should remain safe throughout its lifetime and not increase flood risk elsewhere. We advise the Applicant to include within the FRA the details that have been provided within their recent response to our comments. We advise the applicant to consider the heights of new and existing pipelines within areas of flood zone 3 against the design flood event and provide details on how they will ensure ongoing flood resilience and flood safety.	The Applicant has updated the FRA at Deadline 5 to account for the EAs comments. Details of how the Applicant will ensure ongoing flood resilience and safety of pipelines within Flood Zone 3 will be provided pursuant to Requirement 11(3), (4) and (6) in the draft DCO.
EA3		The FRA should be routinely updated when details regarding mitigation are known. Whilst mitigation for temporary works may come as part of the finalised Construction Environment Management Plan (CEMP), the final FRA should also include site specific flood risk mitigations and measurements for the temporary compounds in mAOD, relating foundation levels to site specific design flood levels	This is not required. Details of the mitigation measures would be set out in the details that are provided to the EA pursuant to Requirement 11 to the DCO, rather than updating the Proposed Development's FRA.
EA4		We are satisfied with the completed figure which shows that the ambient water salinity is within the expected range.	Noted.
EA8		We require justification about why location D was chosen to represent the ambient concentration, as location B has the highest maximum concentration. We also require an explanation as to why the concentration of benzo(g,h,i)-perylene is expected to increase within the two deepest water layers if the plume is buoyant.	Location D was chosen because it is closest to the proposed discharge point. Location B is closer to the River Tees and water quality in this location may be influenced by diluting River Tees water during the tidal cycle. This is less likely at Location D.

REFERENCE	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
			The concentration of benzo(g,h,i)-perylene is modelled as showing maximum increase in deeper waters for three reasons: 1. The plume dilutes rapidly as it rises and spreads, even at low tide, and modelled concentrations in the surface waters are do not exceed the values used to map the zone of elevated concentrations over a scale which can be resolved by the model. 2. The CORMIX modelling presented in the modelling report [APP-193] shows that the plume only reaches the surface during the low tide and minimum current conditions – the far field model results show average impacts over a number of tidal cycles so this short-duration impact is not visible in the surface layers. 3. The plume only reaches the surface with concentrations of benzo(g,h,i)-perylene above the EQS when tidal currents are extremely low. This only occurs in the CORMIX modelling during the lowest tide and minimum current conditions. At most times in the tidal cycle, the currents increase significantly and the mixing plume is strongly deflected sideways and dilutes rapidly within the deeper water layers. Unlike DIN, there is insufficient mass of benzo(g,h,i)-perylene in the effluent to generate a mixing zone within Tees Bay which results in a measurable increase in benzo(g,h,i)-perylene in the surface layers of the water column.
EA23		The EA are still considering the matter of Protective Provisions and the disapplication of the FRAP.	Noted, the Applicant awaits feedback on this matter.

4.0 MARINE MANAGEMENT ORGANISATION ('MMO')

Table 4-1: Response to MMO's Deadline 4 submission

REFERENCE	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
Framework Construction Environmental Management Plan (REP3-004)	REP4-026	The MMO has reviewed the updated Framework Construction Environmental Management Plan (CEMP) submitted (REP3-004) and notes the following embedded mitigation measures to avoid and/or mitigate any 'frac out' incident: • performing appropriate geotechnical investigations along the trenchless crossing alignment; • designing the bore profile to pass at an appropriate depth below the watercourse (minimum depth assumed to be 10 metres). This will be further determined following ground investigations and the outcome of a frac-out risk assessment; • Designing the bore profile to pass through competent soil layers identified in geotechnical investigations; • the detailed design of the launch and exit points of the HDD to take account of geological layers and the intended drill path; • performing drilling fluid hydrofracture analysis for each drilling operation; • maintaining downhole pressures within recommended limits; • using appropriate downhole pressure monitoring equipment; • using a drilling fluid appropriate for the anticipated ground conditions; • monitoring of drilling fluid parameters during drilling; and • performing regular monitoring of the ground above the bore alignment for drilling fluid leaks to the surface. The MMO welcomes that the final CEMP will include site-specific Hydraulic Fracture Risk Assessment following further investigation of specific ground conditions at the crossing locations, and that any further appropriate mitigation will be developed in line with best construction practice. Furthermore, the MMO welcomes that the final CEMP will include a Pollution Prevention Plan and an Emergency Response Plan. Any remedial action required below Mean High Water Springs (MHWS), will need to be communicated to the MMO. We advise that the following is included in the Response Plan to ensure that any spills are appropriately recorded and managed to minimise the risk to sensitive receptors and the marine environment: *"Any oil, fuel or chemical spill within the marine environment must be reported to the MMO Marine Pollution Response Team within 12 hours."* Additionally, there may be licence implications for any works undertaken below MHWS if there is no Deemed Marine Licence (DML) as part of the Project.	The comments from the MMO are noted. The Applicant has submitted an updated Framework CEMP into the Examination at Deadline 5 to provide for notification to the MMO to be incorporated into the Emergency Response Plan, produced as part of the Final CEMP(s) prior to construction. This is included in Table 7-2 of the Framework CEMP. The Applicant is continuing to engage with the MMO to seek to reach an agreed position that no marine licence is required for the Proposed Development and an exemption from Marine Licensing can be relied upon. This will ensure that the ExA can make a clear recommendation on this point. For clarity, as outlined in Section 5.3 of Chapter 5: Construction Programme and Management of the ES [APP-057], the proposed trenchless techniques will be installed at a minimum depth of 25m below the Tees river bed and Greatham Creek at the deepest point of the crossing and a maximum depth of 60m. As such it is not conceivable that the work below MHWS that could require a Marine Licence could 'significantly adversely affect any part of the environment of the UK marine area or the living resources that it supports'. The launch and reception pits for the proposed trenchless crossings are inland of MHWS and hence are outwith the jurisdiction of the Marine Licencing process. That said, these works will be controlled through the mitigation measures in the Construction Environmental Management Plan (CEMP) to be prepared by the contractor in accordance with the Framework CEMP [APP-043]. The Applicant is content to fulfil Condition 1 of the exemption and commits to notifying the licensing authority in advance of the works being undertaken in each case. The Applicant is confident the Proposed Development will be able to rely on an exemption in place of a Deemed Marine Licence and will be able to fulfil the conditions of this exemption, particularly Condition 2 and is in discussions with NE on this point – noting that the Condition relates to the activities to which the Exemption applies i.e works directly below the river bed (MHWS), not any other aspect of the Proposed Development. In Natural England's submissions to date, the 30m buffer proposed for HDD operations in relation to the SPA boundary has not been queried. The Applicant considers this distance satisfactory unless advised otherwise by Natural England.

REFERENCE	SOURCE DOCUMENT(S)	IP ISSUE/ THEME	APPLICANT RESPONSE
		The MMO notes that to reduce the impact to the Teesmouth and Cleveland Coast Special Protected Area (SPA) for HDD operations any pipe stringing area for Horizontal Directional Drilling (HDD) operations will be established a minimum of 30m away from the boundary of the SPA. The MMO defers to Natural England on whether this is an appropriate distance.	
Applicant's Response to Deadline 2 submissions (REP3-006)		The MMO has reviewed the Document Reference 8.17 Applicant's Response to Deadline 2 submission (REP3-006) and notes that the applicant has reviewed the concerns raised by Natural England and has committed to providing an updated Cumulative Effects Assessment and a Report to Inform Habitats Regulations Assessment at the Deadline 5 response submission. The MMO notes that there are no responses to our deadline 2 representation (REP2- 066) within this document. In our deadline 2 response point 3.1.2, we noted that the Applicant stated that there is an agreed position between the Applicant and MMO on the location of the crossings entry and exit pits being above MHWS. Although the maps originally provided showed that the pits are above MHWS, the MMO queried the data set used to inform the MHWS line. The MMO sought the distances from the pits to MHWS, to ensure that they are a sufficient distance away from marine receptors. The MMO requested that this topic is changed from 'agreed' to 'ongoing discussion' until this clarification is provided. The MMO has now received this information on 21 October 2024, and we are content with both the Ordinance Survey (OS) Mastermap dataset used and the distances to MHWS. Please see Annex 1 for the further information received.	The Applicant welcomes agreement on the dataset used to inform MHWS. Accordingly this matter has been left as 'Agreed' in the updated Statement of Common Ground with the MMO submitted at Deadline 4 [REP4-020].

5.0 NATURAL ENGLAND'S DEADLINE 4 SUBMISSION

Table 5-1: Response to Natural England's Deadline 4 submission

REF NO.	IP ISSUE/ THEME	APPLICANT'S D5 RESPONSE
NE2: Impact Assessment on Birds	At this stage, Natural England's position broadly remains as set out in our Relevant Representations. Discussions with the Applicant are ongoing on this matter. Natural England are waiting for an updated Report to inform HRA to reflect a review of the bird survey data. This is currently being prepared by the Applicant. In addition we anticipate the need for an explicit consideration of the scheme's work phases in order to assess satisfactorily the potential for impacts on the SPA's classified bird species.	A new bird count methodology has been developed by the Applicant and reviewed by Natural England on multiple occasions. Natural England has provided comments and advice throughout this process. Following the establishment of a final version of the methodology, the Applicant is now progressing with the revised calculations and assessment, which are planned for release at Deadline 6A as part of the updated version of the HRA. An appendix detailing the number of birds potentially disturbed during the programmed works across the Proposed Development will be included in a revised HRA by Deadline 6A to provide more clarity. Assessment of visual and noise disturbance impacts on the waterbird assemblage, particularly where works in multiple locations could occur simultaneously, using the NE agreed revised bird count methodology will be included in a revised HRA by Deadline 6A.
NE3: Functionally Linked Land (FLL)	At this stage, Natural England's position broadly remains as set out in our Relevant Representations. Discussions with the Applicant are ongoing on this matter. Natural England understands that bird survey data is available to address this point. The Report to inform HRA should be revised accordingly.	The Applicant has added further consideration of effects to functionally linked land to the Deadline 5 version of the HRA: • Paragraph 4.2.6-7 and Figure 16 a and b discuss the extent of permanent habitat loss, including specific locations. • Paragraphs 6.2.3 to 6.2.13 provide further analysis of these impacts by sector. Habitat use by birds within and outside of the SPA can be divided into roosting and "other behaviours", which are predominantly feeding and loafing[1]. AECOM's count sectors were designed with the intention of providing baseline data for key habitats within the Teesmouth and Cleveland Coast SPA and all land with the potential to provide a supporting function to the SPA that lies outside the SPA boundary and that might be affected by construction and/or operation of the Proposed Development. A further objective of the surveys was to provide baseline data of a sufficient spatial extent to enable robust assessment of potential effects of the Proposed Development on birds irrespective of any association with designated sites. Thus, the presence of a bird count sector outside of the SPA does not necessarily confirm a functional linkage exists at that location, but for the sake of completeness, the report to inform the Habitats Regulations Assessment by default considers the occurrence of birds in every count sector. The functionally linked land marked up on Figure 16b was determined through analysis of the baseline bird count data to identify areas of suitable habitat that overlap the Proposed Development where this would result in habitat losses, or that would otherwise be impacted by noise or visual disturbance outside of the SPA boundary and that supported regular

[1] Loafing is a scientific term applied to bird behaviours not specifically associated with breeding, roosting, feeding or predator avoidance. Loafing birds appear to an observer as being alert but doing nothing.

		occurrence of wetland birds in numbers greater than ones or twos, regardless of their behaviour. Figure 16a and b show the extent of Functionally Linked Land (FLL) that intersects the Proposed Development Site. The Figures also include the following information: • The SPA boundary; • Count sectors surveyed by AECOM; • The Proposed Development Site Boundary; • Wetland bird roosts identified by AECOM's surveys and data supplied by INCA; and • Locations of infrastructure that will result in permanent habitat loss. **Permanent habitat losses (AGIs)** Based on the count data and the ongoing nature of site clearance and industrial activity within Teesworks, the Applicant does not regard any of the habitats within or immediately adjacent to the Main Site as being functionally linked to the SPA. Land within the Main Site is used primarily by loafing and resting birds on an occasional/opportunistic basis and as such it is not critical to, or necessary for, the ecological or behavioural function of birds, nor is the function and integrity of the SPA dependent on it. Aside from the Main Site, the majority of permanent structures (AGIs) are located within or immediately adjacent to existing infrastructure or are in areas that are already undergoing earthworks or other industrial activity that render the habitat unsuitable for anything other than very occasional opportunistic use by small numbers of water birds. These include AGIs that overlap count sector 13 near the Main Site; an AGI within Navigator Terminal (adjacent to count sector 25), and a location between existing pipe racking and Saltholme East Pool (count sector 24). One location (Cowpen Bewley Woodland Park) is within woodland and therefore is too enclosed for wetland birds (consequently this location was not surveyed for wetland birds). Two locations near Saltholme (within AECOM count sector B1 and adjacent to sector G1) are within open grassland habitat but this is enclosed by a substation, a power station, the A1185 to the north and existing pipe racking to the south and is therefore rendered unsuitable for wetland birds. An AGI on the land between Dabholme Gut (Count Sector 18) and Bran Sands Lagoon (count sector 16) overlaps the location of an occasional roost used by teal and lapwing, which occurred on the margin of the proposed development boundary and the lagoon. **Temporary habitat losses** Based on the approach to identifying functional linkages described above, FLL has been identified within parts of Brinefields east of the A178 (AECOM count sectors 2, G4 and G5); and farmland between Saltholme substation and Cowpen Bewley village south of the A1185 (AECOM count sectors B1 – B6). Observations of bird behaviour in these areas during AECOM's surveys has identified these as important for feeding and loafing birds, with roosts occurring elsewhere (as shown on the Figures). Not all areas within the Proposed Development Site will be directly impacted, and the exact working width will be confirmed at detailed design stage. Based upon a worst-case scenario, the areas of direct temporary loss of FLL during construction (determined by measuring the

		area within the red line boundary that overlaps the FLL) would be 21.9 ha in total, and this can be sub-divided as follows: • Based on an indicative programme it has been assumed that between Saltholme substation and Cowpen Bewley, up to 14.15 ha of land would be potentially lost between March and September 2027 (7 months) (aligning with the seasonal restrictions already committed to) – this ensures that works take place here during the months in which non-breeding birds are most numerous, specifically to avoid potential effects on non-breeding SPA birds (noting that these fields were not identified as supporting qualifying breeding species). Therefore, the habitat losses to SPA birds are minimised in this area. • At Brinefields the total area potentially affected is 7.75 ha, however all works will be timed to avoid the non-breeding months, as per Figure 14a, such that potential effects on non-breeding SPA birds are minimised. North of this, as far as the southern Bank of Greatham Creek (within AECOM count Sector G5), the area of FLL habitat lost would be zero, since it does not overlap the Proposed Development Site, however the area identified on the plan is immediately adjacent to the Proposed Development Site where works would potentially be required, in some form, between March and November (as the worst-case scenario 9 months). This area would, however, be screened by closed-board acoustic barriers to control noise and visual disturbance to acceptable levels, therefore potential effects on SPA birds in this area would be adequately controlled. The area measurements provided above are based on losses occurring across the entire red line boundary, where this intersects the functionally linked land identified in the figures, as a worst-case estimate of the potential effects on qualifying species of the SPA. However, actual losses would occur only within the working width, which would be smaller, but cannot be accurately quantified at this stage. **Restoration of FLL following construction** The species recorded using the habitats described above (principally waders and gulls) feed by probing soft ground for invertebrates or other food items below the surface and/or by picking such items off the surface of the substrate. The habitats present in these areas include short sward grassland and arable land in various states of crop rotation from well established crop to recently ploughed ground. The installation of a buried pipeline will require soil to be excavated and stored prior to installation of the pipe, after which the trench will be backfilled. This will create soft, unvegetated surface soils within the working areas that would, regardless of any efforts to restore habitat, provide foraging resources for birds immediately following the construction period. On this basis it is expected that the land would be functional as soon as pipeline installation is completed, construction teams have been demobilised and all construction/working areas have been removed.
NE5: Noise Impact Assessment	At this stage, Natural England's position broadly remains as set out in our Relevant Representations. Discussions with the Applicant are ongoing on this matter. When assessing noise disturbance thresholds, it is imperative to note the type of measurement, otherwise the decibel level is somewhat meaningless. The appropriate threshold is a 55-70 db LAmax. Measurement of a maximum level is necessary to assess	The revised bird count methodology developed in relation to NE2 will be used alongside noise contours showing the noise attenuation provided by the proposed barriers to update the HRA by Deadline 6A. The LA Max contours from impulsive noise are being produced and will be considered in the updated the HRA submitted by Deadline 6A.

	the loud bangs and impulsive noise that can disturb non-breeding waterbirds during construction and operation. If not clarified, the level stated is likely to be an average, which could mask potentially damaging effects of noise on birds.	
NE6: Visual Screening	At this stage, Natural England's position remains as set out in our Relevant Representations. Note that this representation is linked with NE7 and NE8 due to the cumulative effects of visual and noise impacts pathways.	As outlined in NE5, the Noise Technical Note will be submitted by Deadline 6A, providing the noise contours for the proposed barriers including the extended noise and visual barrier at Greatham Creek. Additionally, as noted in NE2, the reviewed bird count methodology—developed with Natural England prior to Deadline 5 through ongoing discussions—will be applied alongside the noise contours, demonstrating the attenuation and protection offered by the proposed barriers. Together, these will inform the updated HRA, which will be submitted by Deadline 6A. If further updates to the noise and visual assessment are required, we will continue liaising with Natural England to fully resolve the matter.
NE7: Quantification of operational visual disturbance sources	Natural England notes that visual disturbance during operation has been screened out as no Likely Significant Effect (LSE) due to habituation. Natural England do not agree with this approach because there are very few instances where habituation with no negative impacts occurs. In most cases of apparent habituation birds are still suffering negative impacts, such as elevated stress levels or reduced foraging rates from increased vigilance. Natural England also note that there is no reference to potential activities along the pipeline corridor during operation, such as inspection visits and maintenance. Natural England request that likely sources of visual disturbance during operation are better quantified and that a robust analysis of impacts is undertaken. This analysis would inform whether any mitigation is required. No additional response from Natural England at Deadline 4	Further to the response provided at D2, the Applicant makes reference to *NatureScot Research Report 1283 - Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species* (Goodship and Furness, 2022)[2]. This review notes that an assessment of bird disturbance needs to be on a site-specific basis, taking into account the context.f It was noted in that report that all bird species assessed in the review were, to some degree, likely to habituate to disturbance and were therefore likely to vary in their response to human disturbance in different areas. The report further notes that if birds are present in a highly disturbed area, then it is likely that these birds will show a high degree of habituation to disturbance and tolerate a shorter disturbance distance (referencing Keller, 1989; Baudains and Lloyd, 2007; Ellenberg et al., 2009; Ross et al., 2015; Vincze et al., 2016). As outlined by the Applicant at D1, the land within and around the Site has been subject to high levels of anthropogenic disturbance for many years. As such, the Applicant concludes that it is appropriate to screen out visual disturbance during operation as no LSE will occur due to habituation and because noise levels during operation have been modelled and indicate that this will be within acceptable levels. The Applicant is continuing to discuss this point with Natural England to reach agreement.
NE8: Sightlines from blast furnace pool	Without clearer information about the height, scale and proximity of the plant's buildings and infrastructure on the adjacent main site Natural England's position remains that uncertainty exists over the scheme's impacts on future use of this pool. We note the bird survey results and believe, that although the pool's use by SPA birds is at a low level, it serves an important function as a refuge when tidal/weather conditions elsewhere in the estuary are less favourable.	The Applicant has addressed these points in the Technical Note provided in **Appendix 2** of this document.

[2] Goodship, N.M. and Furness, R.W. (MacArthur Green) Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. NatureScot Research Report 1283. Appended at **Appendix 1** of this document.

	Mitigation measures to offset uncertainty over the scheme's impacts need further consideration.	
NE10: Ammonia emissions from vehicle and Acid Deposition	The revised HRA concludes that there would be no Likely Significant Impacts from construction traffic on the integrity of the SPA, as the qualifying features (defined as known bird nesting locations) are further than 200m from the roads used by construction (and indeed operational) traffic (para 4.2.89 and Annex G of the revised HRA). Para 4.2.89 also indicates that other construction plant (identified in para 4.2.86) would not be within 200m of avocet or tern nesting sites. It is unclear why the supporting habitat of the qualifying bird species within the SPA is excluded at the screening stage of the construction assessment, as the boundary of the SPA is within 200m. It is also unclear why only nesting sites are considered relevant, and not areas used for feeding, for example. The Conservation Objective for the SPA includes the objective "to maintain or restore the structure and function of the habitats of the qualifying features". This should therefore be considered to be integral to the designation, or evidence provided (within the appropriate assessment) as to why there is no potential for this area and the habitat there to be used (for any purpose) by the qualifying birds. It is most precautionary to assume at the LSE/ screening stage that the qualifying feature is located at the boundary of the site – or could be – and evidence as to why this is not feasible provided in the appropriate assessment. This is especially the case for mobile species such as birds which are not restricted to only known current nest sites. A justification of the inappropriateness of the slag-based dunes nearest to the operational emissions for nesting is undertaken at (for example) section 6.6.5 in the appropriate assessment for operational stack emissions only. This has not included consideration of impacts from the roads/ construction emissions, however, which would be expected to affect a different part of the SPA. As emissions from the roads are not included as a potential source in the assessment, there therefore appears to have been no assessment of ammonia emissions from the roads, as indicated would be carried out in the previous response (road emissions are excluded from the operational assessment - para 4.3.7 – and therefore the operational in combination assessment). As the boundary of the SPA is within 200m of the road, and the conservation objective covers supporting habitat of the qualifying birds, ammonia (and other roadside emissions) should be considered. We recommend that the updated modelling also reflects worst-case ammonia contributions to nitrogen deposition, ensuring any cumulative impacts are fully accounted for. Justification for use of the 3µg/m3 critical level for ammonia for the operational assessment is not provided. The SSSI citation indicates there is a mosaic of habitats within the boundary of the SSSI (underpinning the SPA), and bryophytes may be integral to some of these habitats – the citation refers to mosses in some of the wetter dune slacks, for example – which may be considered to be integral to that habitat. Further	As a reminder (and as explained in the HRA and cited on APIS for Teesmouth & Cleveland Coast SPA), the only SPA bird species sensitive to air quality impacts on their habitat are the nesting terns and avocet. Away from their nesting habitat, the only habitat either species particularly relies on during the nesting season is their foraging habitat. In both cases the supporting foraging habitat is open water. In the case of terns, they fish by plunge diving into the water column. There is no evidence on APIS or elsewhere that fish populations in the open sea or tidal river water column are sensitive to atmospheric nitrogen deposition, and there are no critical loads/levels available for this habitat. Avocet also forage in open water, by 'scything' their bills from side to side in shallow water to catch small prey (aquatic insects and small crustaceans). APIS indicates that nitrogen deposition may be positive for foraging avocets by increasing prey abundance. This is the reason the assessment of air quality impacts on the SPA/Ramsar for both construction and operation focusses on nesting habitat for these two species. Air quality impacts during construction are controlled in the Framework CEMP (5.12), and include good practice to minimise vehicle and plant idling. This is discussed further in the update to the HRA also submitted at Deadline 5. It has been agreed with Natural England in a meeting on 28th November to screen in construction period air quality impacts for appropriate assessment, and to then provide the rationale for no adverse effect on integrity as above. This has been done in the D5 HRA. APIS explicitly states on the Site Relevant Critical Load app that none of the SPA birds are sensitive to ammonia, by which it means the ability of their habitats to support the SPA birds will not be affected. APIS also has columns to list if lichens or bryophytes are integral to any feature for which a site is designated, and for the SPA these are blank; for the SSSI they are either blank or it says 'no'. Nowhere does APIS indicate that lower plants are integral to the interest features of either the SPA or the SSSI. This is therefore the justification for using the higher critical level of 3µg/m3. The Applicant has added this explanation to the Deadline 5 version of the HRA.

	consideration of the affected habitat types and key species/ ecosystems within them should be made before assigning the "higher plant" critical level. We note the consideration of acid deposition in the assessment and accept that this would not have an adverse impact on integrity on the identified protected sites. As well as the SPA – consideration of the impact on the SSSI should be considered. It is unclear if the main EIA has been amended with the revised modelling results.	
NE12: Sources of Operational Pollutants	We commend the closed-loop approach to the carbon capture process, which inherently limits emissions. However, for clarity, it would be valuable to provide more detail on the handling of maintenance phases and any unplanned events that might lead to temporary releases. We recommend including a diagram that details each input, output, and by-product managed within the closed-loop system. Additionally, contingency planning for venting or emergency emissions during maintenance would provide assurance that the system's environmental controls are comprehensive and robust. Consideration of waste emissions should also be provided, and whether there is potential for these to impact the integrity of the protected sites. The response refers to "minimal" amine wastes, but it is not clear whether these have been included within the emissions in the AQ assessment, and therefore the HRA (i.e. included in the N deposition calculations) or if it is assumed they would be taken off site for treatment (in which case the impact of this should be considered). Responses have also not been provided on other non-amine wastes or emissions – such as points 5 (chemical storage), 7 (waste from the pre- treatment of natural gas to remove sulphur species) and 8 (emissions from the 4-yearly major overhaul) in our original response. If these are considered for human health, there should be recognition that they have been assessed for ecological receptors too, as the same pathways/ methods of impact may not occur.	**Overall:** All emissions from the plant will be controlled by the Environment Agency via an Environmental Permit. The Applicant would note that is the appropriate regulatory process for Natural England to provide input on this aspect. The Applicant has provided responses below to the specific points raised to assist Natural England's understanding in this area. **Maintenance:** Typically the plant will be shut down when maintenance is conducted on the process systems. Any liquids contained within the plant will be drained and stored for re-use, or removed off site for disposal at end of life. Any unplanned releases will be contained by hard standing within a bunded area, captured into the site closed drains system and won't be released to the environment. Any CO_2 venting will be limited and infrequent in nature and conducted in a controlled manner. **Unplanned events:** In the event of an unplanned shutdown of the plant, hydrogen gas will be routed to the flare. The system includes a mechanism to prevent amines from reaching the flare and instead are recycled into the system. Flaring emissions have been assessed in the Air Quality assessment [APP-060] and [CR1-045]. **Inputs/Outputs:** Natural gas comes into the plant as the feedstock. Heat, water and oxygen are used to reform the natural gas into hydrogen and CO_2. Excess water that cannot be recycled into the process goes to the waste-water treatment plant and is treated prior to discharge via the outfall to sea. CO_2 is captured by the amine that is contained within a closed loop system so there are no emissions. Amine is cycled round the process between the carbon capture system and the regeneration system. It is not an output from the system, hence the description as 'closed loop'. CO_2 liberated from the regenerated amine is routed onwards to the NEP CO_2 pipeline. The plant will be shut down when amine is changed out. The waste amine is contained and taken off site for disposal. The produced hydrogen is routed to storage and onwards to the hydrogen distribution network. The system does not capture 100% of the CO_2 resulting from the input gas because the boiler used to generate steam burns a mixture of natural gas and hydrogen without all CO_2 removed, and exhaust emissions from this boiler are not captured. **Amine waste:** Where amine cannot be regenerated and re-used this will be drained from the process and taken off site for disposal. Hence this is not relevant to the Air Quality assessment.

		Chemical storage: No emissions are anticipated from chemical storage. Again, in the unlikely event of an unplanned release this will be captured by the closed drain system. **Waste from pre-treatment of natural gas:** Sulphur removed from natural gas will be trapped within removal beds. The filter material used to capture this sulphur will be routinely replaced and the spent material removed and taken off site for disposal. **Major Overhaul:** See information provided regarding maintenance above.
NE14: Cumulative and combined effects	Para 8.3.33 in the Air Quality Chapter [APP-060] indicates that potential cumulative traffic emissions from the construction of the Proposed Development as well as the contribution from traffic associated with other committed schemes in the area, is reflected in the 2026 scenario. Further information about the traffic model should be provided – for example whether it includes allocations in the Local Plan and is therefore a worst case. It is not clear what search terms were used in establishing the long list of other plans/ projects included in Chapter 23 [APP-076] (e.g. para 23.3.14) - for example, no agricultural developments appear to have been listed in Appendix 23A [APP-221] which could have a local impact on Ndep or ammonia concentrations. The approach to identifying in-combination projects relevant to the HRA is also unclear. For example, it seems the in-combination assessment for traffic includes only other vehicle emissions, and not emissions from the (point) sources outlined in Chapter 23 of the ES [APP-076]. In addition, some projects are not included in the in-combination assessment in the HRA (Table 5.1) as their individual assessments did not highlight significant impacts at European sites. However, at screening the requirement is to assess whether several non-significant impacts could add up to a significant one.	The Cumulative and Combined Effects Assessment has been updated for Deadline 5, and the updates from this have been considered in the updated Report to Inform HRA which includes an updated In-Combination Assessment, which is also submitted at Deadline 5. The future year base traffic data in the ES chapter was increased using TEMPRO factors. The TEMPRO database includes an allowance for traffic generated by schemes included within local plans, so on this basis it does include some additional scheme traffic. The search terms used to establish the long list are set out across Chapter 23 [APP-076] Section 3. For clarity, developments which meet the following criteria were considered in developing the long list: • local authority planning applications that represent 'major developments', the definitions and thresholds for which are set out in The Town and Country Planning (Development Management Procedure) (England) Order 2015 (HM Government, 2015); • Development Consent Order (DCO) applications for Nationally Significant Infrastructure Projects (NSIPs) in England, registered on the Register of Applications on the National Infrastructure Planning website (The Inspectorate, 2019b); • any major development projects being progressed through other statutory procedures; • allocations identified in the adopted and emerging development plans of the relevant local planning authorities (LPAs); and • other relevant development plans and projects. The methodology did not include a search by development type, therefore, if for example, agricultural developments that had planning applications submitted within the Proposed Developments Zone of Influence and timeframe, did not meet the criteria outlined above, then they would not be included. The in-combination assessment for traffic only includes other vehicle emissions, and not emissions from point sources as these are either existing and accounted for in the

		background, or in construction and the maximum trips from each development are included in the traffic data.
NE15: Approach to HRA (Air Quality)	The amended HRA includes the requested summary of relevant habitat types, qualifying features, and their associated critical loads (and critical levels for NOx, SOx, and ammonia) – i.e. the critical load/ level for the habitat types supporting the qualifying bird species. It should be noted that the lowest critical load for sand dune habitats is 5kgN/ha/yr, not 10kgN/ha/yr – but this would not affect the conclusion of the assessment, or whether LSE was assumed. The use of 1% alone or in combination to assess whether a project requires appropriate assessment aligns with best practices. In this case, the revised assessment has concluded that annual and 24hr NOx (alone and in combination) and Ndep (alone and in combination) requires further consideration for the Teesmouth protected sites. 24hr NOx in-combination also exceeds 1% at North York Moors SPA/SAC, and Northumbria Coast SPA/SAC, and this does not appear to have been carried through to appropriate assessment (section 4.3.14). However, in practice, 24hr impacts would not alter the annual levels which are relevant for ecosystem impacts, so although this should be included in the appropriate assessment for completeness, we will not require this. It is noted that the assessments do not include Ndep (or NOx or ammonia) arising from the road traffic, as highlighted at NE10. We also require further clarification on cumulative impacts, particularly concerning nitrogen deposition and its indirect effect on the SPA's nesting habitats. Although terns and avocets may not be directly impacted by nitrogen, deposition can alter vegetation structure, leading to encroachment that could affect nesting suitability. This assessment would benefit from clear distinctions between direct and indirect impacts, addressing cumulative impacts as they relate to overall ecosystem stability.	See response to NE10. The Applicant notes that most of Natural England's latest comments on NE15 are either agreeing with our conclusions or where they have picked up on points (e.g. 5kgN vs 10kgN) they have noted it wouldn't affect the assessment. The only point of disagreement or request for further information raised appear to be in the last paragraph on a) the omission of construction traffic emissions and b) consideration of indirect effects on SPA birds i.e. on any other parts of the SPA, both of which are covered in the response to NE10 above.
NE17: Nitrogen Deposition (Ndep)	We appreciate the historical context provided regarding nitrogen deposition levels and understand that these have gradually declined over time. However, the sensitive habitats within the Teesmouth & Cleveland Coast SSSI remain vulnerable, and even minor increases in nitrogen could delay recovery or encourage invasive vegetation. The sites are currently exceeding their lower critical loads for Ndep for sand dunes (5-15kgN/ha/yr). The designation of the SPA (and SSSI) at a time when N loads were higher does not indicate that the site was in Favourable Conservation Status (FCS) at the time of designation and therefore any lowering of these levels must by definition mean the site will remain Favourable. The Habitats Regulations refer to both the 'maintenance and restoration' of features of European importance as a key part of achieving Favourable Conservation Status. If the Directive was written with the intention of simply maintaining sites in their condition at the time of selection or classification, on the	See response to NE10. With regard to SPA birds shifting their nesting locations, the Applicant considers that it has addressed this matter by not only using the most recent (within the past five years) known nesting locations but also the closest known historic nesting location (South Gare) – see the updates to the HRA submitted at Deadline 5. Even here there is a question as to whether habitat could be restored to suitability for nesting terns without harming the botanical SSSI interest that has developed given the extensive vegetation clearance that may be required. Moreover, even rendering habitat physically suitable is no guarantee that terns would return to nest there, as there are many areas of suitable habitat where terns nonetheless do not nest. While there may be older records (such as that from the 1920's that Natural England mentions) the older the record the lower the reason to assume the birds would ever return to nest even if habitat was rendered suitable.

	assumption that this would be sufficient to enable FCS to be achieved, then the word 'restoration' would not have been necessary. It is noted that the qualifying features for the SPA are not the same as the SSSI designated features. Therefore, even if the justification that the nesting bird species would not be adversely affected by changes to their supporting habitat within the SPA is appropriate to demonstrate no AEOI to the SPA, consideration must also be given (outside the HRA) to any harm to the SSSI designation. This can take into account the potentially lesser sensitivity of calcareous dunes compared to acidic/ decalcified dunes (for example, by demonstrating phosphorus limitation in the dunes – as outlined in the report underlying the recent change in critical loads (Bobbink et al 2022 - Review and revision of empirical critical loads of nitrogen for Europe[i])) but this evidence must be provided to apply anything other than the most precautionary lowest point of the critical load range. Overall, in-combination impacts, from this project in-combination with other projects in the area have the potential to undermine the conservation Objective to Restore the site below critical loads. Please provide clarification on cumulative nitrogen sources and confirm that even minor increases will not hinder habitat recovery efforts within the SPA/SSSI. [i] https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2022-10-12_texte_110-2022_review_revision_empirical_critical_loads.pdf With respect to little tern breeding locations we can confirm that the maps provided by Natural England show nesting locations for this species. They were produced in 2013 before the SSSI/SPA/Ramsar extensions. In the UK, the majority of Little Tern nest sites are on the open coast, but they also use a range of other habitats e.g. coastal lagoons (such as at Hodbarrow in Cumbria). Little Tern regularly use a wide range of different nesting habitats in continental Europe, with large populations nesting away from the coast. The maps provided by Natural England show some historic 'inland' nesting locations. The local bird clubs (Durham / Teesmouth) may hold more details about these attempts. The Birds of Durham (Bowey & Newsome 2012) provides some further background to Little Tern use of the estuary e.g. use of a derelict shipyard in the 1920s (this is not plotted on the Natural England maps). There is considerable variation in how regularly the different nest sites have been used and how many birds used them and it is expected that this context would be used in an assessment of impacts on Little Terns, however, it is not correct to say that the maps show locations where there are no reliable records of breeding Little Tern, and where breeding habitats for this species are not found. Little Tern are notorious for regularly shifting colony locations and their unpredictability in site selection, therefore linking an assessment to a single location on Teesmouth would	With regard to impacts on the SSSI, the Applicant had meetings with Natural England on 28th November and 4th December. At those meetings the Applicant clarified that the dunes at Teesmouth & Cleveland Coast SSSI are calcareous as demonstrated by the presence of calcareous vegetation on the dunes. As set out in Bobbink et al 2022 surveys have indicated that calcareous, iron-rich dunes exhibit co-limitation of nitrogen and phosphorus and that phosphorus limitation is a factor in calcareous dunes and 'may lead to fewer botanical responses in calcareous dunes compared with acidic or decalcified dune sites'. There is therefore a justification for considering that the lowest critical load of 5kgN/ha/yr is less appropriate than a slightly higher critical load of 10 kgN/ha/yr as was used on APIS for calcareous dune systems before the critical loads reported on APIS were updated in 2023. Notwithstanding any change in the critical load applied, the Applicant's view remains that if the total nitrogen deposition rate will remain lower with the Proposed Development consented (even allowing for other plans and projects) than it has been historically, it cannot be argued that the Proposed Development will be harming the interest of the SSSI, even by impeding restoration. That is particularly the case given the contribution of the Proposed Development is at the '1% of the upper critical load' level for dismissal as imperceptible..

	not be appropriate e.g. the main Teesmouth Little Tern colony recently moved from Crimdon to Seaton Carew. The scatter of nest locations along the coast (from Crimdon to Coatham Sands) shows that this whole stretch should be considered as potential Little Tern nesting habitat. There have been morphological changes on Coatham Sands which have altered the previous nesting area (an area known as 'the Ducky'), but this does not mean that the whole stretch is unsuitable for Little Tern e.g. small numbers have nested on South Gare in recent years.	
NE18: Operational Emission of amine and amine degradation products	D3 comments from the applicant on NE18 relate to water quality rather than air quality. Therefore, we have no further comments on this and our position remains as in our relevant representations, and as for NE12. As far as we are aware, the requested diagram showing inputs/ outputs/ wastes etc. has not been provided, and there have been no comments on emissions and associated impacts during maintenance.	See response to NE12.
NE19: Update in-combination assessment	At this stage, Natural England's position remains as set out in our Relevant Representations. We note the applicant and ExA's request (relevant ExA Q ref) for clarification on the information we seek. Natural England offers a copy of construction phase overlap in Gantt chart format for context at Annex A Further information sought = Boundaries of schemes with temporal overlap (construction phase) relative to SPA/Ramsar Site – Reason – To illustrate proximity Consideration of bird spp records (breeding, roosting and feeding locations) relative to scheme works phases Consideration of impact pathways and resulting impacts through time for relevant schemes – to include numbers of birds likely to be affected by the project alone and in combination.	The Report to Inform HRA has been updated to include the additional projects and will be submitted at Deadline 5. Figure 17 shows the spatial overlap between the boundary of the Proposed Development, the Other Developments and the SPA and Ramsar sites; temporal overlap is inherent within the shortlisting process in the Cumulative Chapter so all Other Developments shown on the figure can be considered to have temporal overlap with the Proposed Development. The spatial / temporal relationship between the Proposed Development and the Other Developments has been considered within the in-combination assessment section of the HRA, as updated at Deadline 5. The locations of bird roosts are shown on Figures 13-A-9, 13-A-10 and 13-A-11, and supporting narrative on these locations is provided in Tables 13A-9, 13A-10 and 13A-11 within the Ornithology Baseline Report. The use of habitats by birds has been considered within the in-combination assessment of the HRA. Impact pathways have been considered along with temporal overlaps, but the Applicant notes that it is not possible to include numbers of birds impacted for the Proposed Development and in combination because data will have been collected at different times, following different methods; this makes them incomparable. This has been discussed with NE on calls.
NE26: Noise disturbance - Seals	Discussions with the Applicant are ongoing on this matter. Following a conversation with AECOM, Natural England advises that provided HDD operations last no longer than 3 weeks in October, and noise abatement barriers reduce noise by 10dB, there is unlikely to be a significant impact on the seal population of the Teesmouth and Cleveland Coast SSSI from the HDD works at Greatham Creek. Natural England would welcome securing these mitigations through conditions to any licence granted. Natural England's advice remains that pre-construction monitoring is carried out to assess the behaviour of seals in the area under "normal" conditions. Further monitoring should be carried out during construction to assess the efficacy of mitigation measures. If behaviour indicating disturbance is noted, further	The Applicant will submit a Technical Note by Deadline 6A in response to the two rounds of comments provided by Natural England on 29th October 2024 and 19th November 2024. The Applicant has updated the modelling to provide M-weighted adjusted results. To do this, an M-weighted curve has been generated using data provided by Southall et al. (2019). Values have also been updated to use Eb6 as the estimated ambient sound level at the Greatham Creek noise modelling location (in the absence of baseline noise monitoring). The updated M-weighted modelling indicates that, even without noise abatement barriers in place, the M-weighted SELs at Greatham Creek (104 dB, using Eb6 as the ambient) are 30 dB below the TTS threshold (134 dB, per Southall et al., 2019) in a worst-case scenario. Furthermore, the M-weighted SEL value at Greatham Creek is only 4 dB above the ambient sound level (100 dB), a difference unlikely to be perceptible to seals or sufficient to cause

	mitigation must be put in place. This may include more effective sound barriers further muffling of machinery. If monitoring shows that disturbance is not occurring, further mitigation is unlikely to be necessary.	disturbance. However, additional modelling is being explored to consider the change in SEL (using M-weighted noise contours) from the use of noise abatement barriers around the Greatham Creek HDD Venator Site. The addition of noise abatement barriers around the entire HDD site is expected to further reduce the SELs below ambient. The approach to these barriers, and therefore the updated modelling, has been refined. The updated approach using Natural England's methodology, still highlights the minimal potential for disturbance to seals during the HDD works. Therefore, additional monitoring of noise and seal behaviour before and during the works is not considered necessary.
NE28: Consideration of ammonia and acid deposition in the traffic assessment	As outlined in NE10, it is not clear why only known nesting sites are considered to be the qualifying feature, rather than e.g. supporting habitat of the birds. In any case, NE28 is relating to impacts on the SSSI which is designated directly for the sand dune habitat as well as the birds. Therefore our position remains largely as stated in the Relevant Representations, and we maintain that construction and operational traffic impacts to the SSSI (within its boundary) should be considered, including ammonia – as had been understood to have been agreed with the applicant in our D2 response.	See response to NE10
NE29: Scope of Pollutants considered in the construction and operational assessments	Similar responses would apply to those at NE11, and other responses relating to the European sites. However, it should be noted that designated features of the SSSIs are different to the SPA qualifying features, and therefore different impacts may be relevant.	See responses to NE10 and NE15
NE30	Does not exist	
NE31: Impact of pollutants at SSSIs including SSSIs underlying European designations	Please refer to our response under NE17	With regard to impacts on the SSSI, the applicant had meetings with Natural England on 28th November and 4th December. At those meetings the applicant clarified that the dunes at Teesmouth & Cleveland Coast SSSI are calcareous as demonstrated by the presence of calcareous vegetation on the dunes. As set out in Bobbink et al 2022 surveys have indicated that calcareous, iron-rich dunes exhibit co-limitation of nitrogen and phosphorus and that phosphorus limitation is a factor in calcareous dunes and 'may lead to fewer botanical responses in calcareous dunes compared with acidic or decalcified dune sites'. There is therefore a justification for considering that the lowest critical load of 5kgN/ha/yr is less appropriate than a slightly higher critical load of 10 kgN/ha/yr as was used on APIS for calcareous dune systems before the critical loads reported on APIS were updated in 2023. Notwithstanding any change in the critical load applied, the Applicant's view remains that if the total nitrogen deposition rate will remain lower with the Proposed Development consented (even allowing for other plans and projects) than it has been historically it cannot be argued that our scheme will be harming the interest of the SSSI, even by impeding restoration. That is particularly the case given the contribution of the Proposed Development is at the '1% of the upper critical load' level for dismissal as imperceptible.
NE34: BNG Update	Although BNG is not yet a mandatory requirement for NSIPs, we strongly recommend that BNG provision is secured through this development. This will reflect the important role NSIPs must play in delivering the government's environmental targets.	The Applicant would like to draw Natural England's attention to the transcript of Issue Specific Hearing 2 (ISH2) – Part 3 (14 November 2024) [EV6-006], page 28 onwards.

	Early engagement with Natural England on BNG proposals will help maximise outcomes and reduce risks. The biodiversity baseline should include all land contained within the site's red line boundary and proposals can be iteratively refined over time and throughout detailed design. We encourage developers to: • develop their BNG proposals in adherence with well-established BNG principles • use the latest version of the Defra biodiversity metric, adhering to the metric guidance Biodiversity gains should ideally be secured for a minimum of 30 years and be subject to adaptive management and monitoring. BNG plans should be secured by a suitably worded requirement in the DCO.	The main point of the transcript is that whilst the Applicant is not making a commitment to deliver BNG in line with the Principles or Statutory Metric, the Applicant is exploring opportunities for environmental enhancements within Teesside. Discussions are ongoing with various stakeholders, including local trusts, environmental authorities, and conservation organisations. The aim is to deliver strategic environmental enhancements that benefit both habitats and species. These enhancements are not a legal or planning requirement for the project and will not be submitted for consideration in the examination. Instead, they are being pursued voluntarily as part of the Applicant's commitment to responsible development. The Applicant will keep both the Environment Agency and Natural England updated on any progress.
NE35: Soils and best and most versatile agricultural land	The Applicant will continue to discuss this matter with NE through the SoCG between the two parties. In addition, the Applicant recognises this commitment to an update of the Framework CEMP was missed in the Deadline 2 update. Therefore, a revised version of the Framework CEMP has been prepared at Deadline 3 [EN070009/APP/5.12] to incorporate this commitment.	The Applicant has addressed these points in the Technical Note provided in **Appendix 3** of this document.

6.0 COMPULSORY ACQUISITION RELEVANT REPRESENTATIONS

Table 6-1: Response to Compulsory Acquisition Relevant Represenations

PARTY	SOURCE DOCUMENT	IP ISSUE/ THEME	APPLICANT'S RESPONSE

The Mission to Seafarers	RR-050	• Party queried consultation and location of documents.
		• Consultation letter did not provide details how a formal response could be submitted.
		• Was confused about drawings and its colour coding
		• Now includes Seafarer Centre, where previously in March 2023 it did not, and therefore needs to be explained.
		• In view of this, cannot provide comments and an extension is requested.
			The Applicant has proactively engaged with the Mission to Seafarers (MTS). The Applicant contacted the MTS via telephone and initial discussions were held to explain the drawings and why the consultation took place. The Applicant posted hard copies of the drawings as requested. The Applicant also provided further written correspondence (as summarised below) and provided a main point of contact, and welcomed ongoing engagement, noting the upcoming Examination deadline dates and hearings should they wish to participate.
			
			Summary of Applicant's letter:
			• Detailed explanation of the land plans and colour coding;
			• The reasons for consulting the MTS, namely:
			  ○ The Applicant's additional land proposals included the need to use the area of Seal Sands Road for an additional purpose than originally planned (which was just to use the road for the construction of the project), namely to seek rights to use the natural gas pipeline located alongside it;
			  ○ As the MTS has a property interest over Seal Sands Road, namely an access right, the Applicant consulted the Party to ensure the MTS was aware that this access right could be affected by the project;
			  ○ As that access right was always due to be affected by the project, this is why the MTS was consulted in each of the previous consultations that have been carried out by the project.
			• Explained that in order to manage these potential impacts or disruption to access, the Applicant confirmed they would issue communications to all affected stakeholders (including the MTS) in advance.
			• Explained that pursuant to the DCO the Applicant would also be required to put in place a scheme for the notification of any significant construction impacts, and for handling of any complaints received relating to construction impacts, and this would need to be approved by Stockton-on-Tees Borough Council.
			• Explained Planning Inspectorate's procedures once a party submits representations and thus automatically becomes an 'Interested Party'.
			• The MTS advised the Applicant that outdated consultation materials were at Stockton Library, and the Applicant advised that the library has been contacted to ask to remove old materials, noting that the best way to access the up to date information was via the Planning Inspectorate's project website, and a link was re-provided.

7.0 CLIMATE EMERGENCY POLICY AND PLANNING (CEPP)

7.1.1 CEPP's Deadline 4 submissions (REP4-038) raise two issues:

- they consider that the DCO should be amended to secure a minimum 95% capture rate when the development is in commercial operation (the First Matter); and
- they consider that the DCO should be amended to secure compliance with the Low Carbon Hydrogen Standard ('LCHS') (the Second Matter).

7.1.2 The Applicant's response to these Matters is set out below, which supplements and should be considered together with the Applicant's Deadline 3 (AS-040) and Deadline 4 (REP4-014) submissions and summary of oral submissions at ISH2 (REP4-016).

First Matter[3]

7.1.3 As is apparent from the examples provided in CEPP's Deadline 4 submission (but not acknowledged), there is no precedent for a 95% capture rate being required to be achieved by drafting in a DCO. The examples referred to by CEPP are the Keadby 3 DCO; the Net Zero Teesside DCO and the Drax BECCS DCO. As was explained at ISH2, none of those DCOs contains a requirement to achieve a particular capture rate. Rather, the interpretation sections of those DCOs describe the development being *designed* to achieve a particular capture rate. The description of development in those terms does not have the same legal effect as a DCO requirement that secures the achievement of that rate during operation. CEPP's submission fails to acknowledge or grapple with the implications of this key distinction (see for example, paragraph 27 of CEPP's Deadline 4 submission, which suggests that the Keadby 3, NZT and Drax BECCS include requirements for minimum capture rates, which is simply incorrect).

7.1.4 The Secretary of State has not considered it appropriate in any of the Carbon Capture related DCOs made to date, to include a requirement that the development must achieve a particular capture rate given the existence and effect of the environmental permitting regime. There are no distinguishing features of this application which would justify the imposition of a requirement as to the minimum capture rate, and CEPP does not even purport to identify any such feature.

7.1.5 Furthermore, contrary to paragraph 5.1 of CEPP's Deadline 4 submissions, the Applicant has provided evidence as to why the 95% capture rate is technically highly achievable (see the Applicant's Deadline 4 submissions, paragraphs 5.2.15-5.2.2) (REP4-014).

[3] The Applicant does not dwell on the point of the BECCS DCO Examination, but, in light of CEPP's Deadline 4 submission, notes CEPP's submissions at Deadline 9 of that Examination (in making submissions that casted doubt on the Applicant's calculation, as CEPP do for the Proposed Development) that: '*I take the precautionary approach that 95% is unproven, and ridiculously optimistic. 90% is also unproven for full production levels of operation, but I base my calculation on it*'. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010120/EN010120-001518-D9_Climate%20Emergency%20Policy%20and%20Planning_Deadline%209%20Submission.pdf

7.1.6 Notwithstanding CEPP's apparent confusion as to the legal effect of the DCO provisions to which it refers, the Applicant notes that Appendix V to CEPP's Deadline 4 submission in fact requests an amendment to article 2 to the DCO (described as 'Change 1'). The Applicant recognises that there is precedent for this approach in the Keadby 3 and NZT DCOs and accepts that it would be appropriate to include an equivalent provision. The Applicant's proposed amendment is included in Schedule 1 of the draft DCO submitted at Deadline 5, which is drafted to work in the context of the rest of the drafting of the DCO for the Proposed Development.

7.1.7 In Appendix V to the Deadline 4 submission, CEPP proposes a further change (described as 'Change 2') to prevent Works 1A.1 and 1A.2 (the hydrogen units) from being brought into commercial use without Work 7 (the export pipeline) being connected to an operational storage site. No such Requirement is necessary. If the carbon store was not available, the Applicant would not be able to 'capture' carbon. That would mean that the Applicant would not be able to demonstrate to the Environment Agency that the plant had been designed to achieve a 95% carbon capture rate without the connection to the store.

7.1.8 Requirement 27 of the Applicant's DCO already prevents any part of the authorised development commencing until an environmental permit has been granted for the Hydrogen Production Facility. As such, in order to avoid not being able to comply with the permit, the carbon storage system would need to be functional at commencement of operations.

7.1.9 However, further to the ExA's SWQ 2.9.7, the Applicant has provided without prejudice wording in this regard – please see the answer to that question also submitted at Deadline 5.

7.1.10 In respect of CEPP's commentary on the environmental permit for NZT, the approach to the control of emissions needs to be considered in the context of the overall wording of NPS EN-1, and in particular the following:

- Para 4.9.15: *An Environmental Permit will also be required from the Environment Agency (EA) or Natural Resources Wales (NRW) which incorporates conditions for operation of the carbon capture and storage installation, including limits on pollutant emissions*

- Para 4.12.9: *In considering an application for development consent the Secretary of State should focus on whether the development itself is an acceptable use of the land or sea, and the impact of that use, **rather than the control of** processes, **emissions** or discharges themselves;*

- Para 4.12.16: *The Secretary of State should not refuse consent on the basis of pollution impacts unless there is good reason to believe that any relevant necessary operational pollution control permits or licences or other consents will not subsequently be granted. On this basis, it is reasonable for the Secretary of State to consider residual amenity issues only when considering whether the development itself is an acceptable use of the land or sea, and on the impacts of that use*

7.1.11 It is clear therefore that national policy expects emissions to be controlled through the environmental permitting regime rather than the planning regime.

7.1.12 That permitting regime continues to evolve as more becomes known about the most appropriate way to regulate carbon capture operations, but this is reflective of how permitting practice works – for all technologies that have evolved in the lifetime of the Environment Agency, the way that they are regulated has progressed. However, that regulation has developed in the fundamental context of seeking to ensure that the environment is protected (as established by the permitting core guidance referenced in the NPS) and the planning system assumes that the permitting system will operate effectively to achieve that aim.

7.1.13 As such, whilst CEPP may have concerns about how that permitting regime may work in practice, ultimately it is that regime which Parliament has entrusted to ensure that carbon capture projects achieve the necessary environmental outcomes in respect of emissions. It is therefore not appropriate for the DCO regime to seek to duplicate the controls which are appropriately addressed through the permitting regime.

7.1.14 Furthermore, the Applicant notes that there is a question of what is meant by a 95% capture <u>rate</u>. Given the dynamic nature of start-up, shut down and maintenance of the Hydrogen Production Facility, there is the need for an adaptive process, as is provided for by the workings of the NZT permit. A DCO Requirement that simply provided that a 95% capture rate must be achieved would therefore be too uncompromising, and a blunt instrument, for the complexities of a carbon capture enabled hydrogen facility, and thus imprecise and difficult to enforce. In order to address this, any requirement would of necessity involve the creation of a similar or identical series of provisions to that likely to be included in the permit. If the provision was identical, it would serve no separate purpose. If it was different, this would give rise to inconsistent as well as duplicated systems of control. Neither would be appropriate.

7.1.15 The carbon capture rate is ultimately not the factor that ensures the benefits of the Proposed Development are realised. What achieves that is compliance with the LCHS, as seen by the calculations in the Applicant's ES (APP-072).

<u>Second Matter</u>

7.1.16 In respect of the Second Matter, the Applicant has set out in its Deadline 3 and Deadline 4 submissions the relationship between the Low Carbon Hydrogen Agreement ('LCHA') and the LCHS. It is through the LCHA that the Applicant is required to meet the LCHS – that is not the role of the LCHS itself. The Applicant will need to meet the LCHS to comply with the LCHA, and the LCHA is the mechanism by which the Applicant is subsidised for the hydrogen it produces. This is important both for the direct funding and indirect funding implications of the LCHS.

7.1.17 Specifically, the low carbon hydrogen that the Proposed Development will produce will be sold to offtakers to fuel and decarbonise their operations, as they switch from grey hydrogen or natural gas. The support received by the Applicant under the LCHA ensures that the low carbon hydrogen can be sold to offtakers at an affordable price. Government has designed the LCHA specifically to enable producers to deliver a price incentive for end users (offtakers) to switch (p. 13, *Government response to the consultation on a Low Carbon Hydrogen Business Model*, BEIS, 2022). If the Applicant cannot commit to selling LCHS-compliant hydrogen at an affordable price, then those offtakers would not enter into a contract with the Applicant to purchase hydrogen from it.

7.1.18 It is therefore unnecessary for a DCO Requirement to be included in relation to the LCHS, as meeting the LCHS is essential to the on-going feasibility and viability of the Proposed Development.

7.1.19 This context is also important as the Applicant considers that a DCO Requirement requiring compliance with the LCHS would not meet the tests in NPS EN-1 para 4.1.16 that DCO Requirements should be "necessary, relevant to planning, relevant to the development to be consented, enforceable, precise, and reasonable in all other respects". The Applicant has considered each of these tests in turn below:

7.1.20 In terms of necessity:

- Unless the planning balance would be in favour of refusal in the absence of a requirement to control a particular matter, such a requirement is not necessary. In this case, the Project would accord with the relevant National Policy Statement ('NPS') which supports blue hydrogen projects if they are considered low carbon hydrogen. The LCHS is the measure by which the Government will determine if a project is low carbon, compliance with which is required by the LCHA. In other words, the Government has chosen to address this specific issue through a separate mechanism, rather than through development control decision-making.

- Given the legally binding net zero target, the policies and strategies that are in place to seek to achieve that target and the existing and emerging business models and incentives aimed at driving decarbonisation, it is clear that compliance with LCHS is something that the Government will enforce through the LCHA.

- As set out above and in its Deadline 3 and Deadline 4 submissions, the Applicant is commercially reliant (not just incentivised) on meeting the LCHS.

7.1.21 In terms of relevance to planning (and noting the CEPP contentions at paragraph 8-10 of its Deadline 4 submission):

- As a general principle, there is no legal requirement that all benefits which are given weight in the planning balance must be formally secured, in order to be treated as material considerations (or in the language of the Planning Act 2008 ('important and relevant' considerations').

- The Secretary of State is able to attach such weight as is judged appropriate to the benefits associated with the Proposed Development without those benefits being legally secured; it is not necessary for there to be a securing mechanism to underpin any planning judgement as to how much weight s/he gives to the benefits claimed for the Proposed Scheme.

- On the basis of the evidence presented by the Applicant as to the workings of the LCHS/LCHA, the Applicant considers that the Secretary of State can give substantial weight to the decarbonising benefits of the Proposed Development when making a planning judgement, without those benefits being secured by a DCO Requirement.

7.1.22 In terms of reasonableness:

- To achieve the policy objective of developing the UK's hydrogen economy, the necessary standards are set by Government and apply at a national level. In order to meet the UK's decarbonisation goals, an effective market is required to ensure that all parties are on the same playing field – i.e. the application of the LCHS.

- The application of additional limitations and controls at a project level through development control decisions on individual applications would clearly distort this market by imposing controls that will also be subject to the LCHA/LCHS regime.

7.1.23 In terms of enforceability, in the context that it is Local Planning Authorities ('LPAs') who enforce DCO Requirements:

- The nature of the LCHS/LCHA regime presents clear difficulties in formulating a requirement that is reasonable and precise – and enforceable – it would not be enough to simply state that there must be compliance with the LCHS, given the way that the LCHS works. For example, compliance with the LCHS is assessed on the basis of 30 minute 'Reporting Units'. Whether hydrogen is compliant or non-compliant is calculated and monitored using complex calculations arrangements set out in Chapters 7 and 8 of the LCHS and its associated definitions.

- As set out in section 8 of the LCHA, the information provided as part of the monitoring frameworks will cover the supply chains (including elements therefore beyond Teesside and indeed beyond the UK) and will address matters that are unavoidably complex. These will be scrutinised by Government and appointed third parties. Those appointed third parties will have the requisite knowledge and detailed understanding of those schemes and how the Government intends them to apply, as well as access to the relevant data.

- These are not matters that the local planning authority would be expected to have knowledge or detailed understanding of, in order to fulfil their statutory planning function.

- The Applicant notes that much of this is also true for any DCO Requirement requiring 95% carbon capture to be secured given the complexities of the operating of a carbon capture enabled Hydrogen Production Facility – the monitoring requirements of the permitting regime are different from the usual workings of a LPA.

7.1.24 The Applicant therefore considers that it would not be appropriate for DCO Requirements of the sort proposed by CEPP, to be imposed in any DCO made for the Proposed Development. The Applicant therefore does not accept Changes 3 and 4 proposed by CEPP in Appendix V of their Deadline 4 submissions.

APPENDIX 1: NATURESCOT RESEARCH REPORT 1283

NatureScot NàdarAlba Scotland's Nature Agency Buidheann Nàdair na h-Alba

NatureScot Research Report 1283 - Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species

Year of publication: 2022

Authors: Goodship, N.M. and Furness, R.W. (MacArthur Green)

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Keywords

Human disturbance; bird behaviour; Flight Initiation Distance; Alert Distance; Minimum Approach Distance; Buffer zones.

Background

Since 2007, Scottish Natural Heritage (now NatureScot) have referred to bird disturbance distance information presented in Ruddock and Whitfield (2007) to provide advice and guidance relating to casework involving human disturbance and protected bird species present in Scotland. However, since the 2007 publication, new disturbance response information in relation to human activity has become available. The aim of the current report is to update disturbance distances for species presented in Ruddock and Whitfield (2007) as well as to provide disturbance distance information for a range of additional protected bird species that regularly feature in Environmental Impact Assessments (EIAs) but were not included in Ruddock and Whitfield (2007).

NatureScot commissioned MacArthur Green to undertake a literature review to identify distances at which disturbance could be caused by human related activities to a number of protected UK bird species present in Scotland during the breeding and nonbreeding seasons. All potential sources of human disturbance referenced in the literature were included in the review. Bird disturbance distances were recorded in a wide range of environments including inland sites (e.g. uplands, lowlands, inland waterbodies and streams), coastline (e.g. shoreline, intertidal areas and nearshore waters) as well as offshore areas (including islands and offshore waters). The literature was searched for disturbance distances that were measured in terms of Alert Distance (AD), Flight Initiation Distance (FID) and Minimum Approach Distance (MAD), and for qualitative evidence on bird disturbance. The disturbance distances were collated into a Bird Disturbance Response (BDR) database for 65 bird species that were selected by NatureScot. This report provides an account for each species summarising: quantitative information available in terms of AD/FID and MAD, recommended protection buffer distances, the likely sensitivity of each species to human disturbance activities and the quality of information available.

Main findings

- Wild bird disturbance distances caused by a wide range of human related activities are presented for a total of 65 bird species.
- Recommended buffer zones are provided for each species.
- A total of 23 out of 65 protected bird species were assessed as having a high or a medium to high sensitivity to disturbance from human related activities. EIAs in relation to human activity and development will require greatest consideration to potential disturbance impacts for these species with high sensitivity to disturbance, and to apply appropriate mitigation in areas where these species are likely to be present.
- A total of 31 out of 65 species were assessed as having a medium sensitivity to disturbance from human related activities. This means that these species may tolerate some disturbance caused by human related activities, but the extent of disturbance caused to individual birds could depend on a wide range of factors including levels of habituation to disturbance.
- Few species (11 out of 65) were considered to have a low or a low to medium sensitivity to human disturbance. It is important to note that all bird species assessed in this review (including high, medium and low sensitivity species) are likely to vary in their response to human related disturbance in different areas depending on habituation to disturbance and other factors. Therefore, each assessment for future EIAs needs to be on a site-specific basis, taking account where possible of local circumstances that may influence bird sensitivity.
- A number of data gaps in the bird disturbance distance database are identified in this report and recommendations are provided for future research to fill these gaps.

Acknowledgements

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Abbreviations

Alert Distance (AD)

Bird Disturbance Response (BDR)

Environmental Impact Assessment (EIA)

Flight Initiation Distance (FID)

Intergovernmental Panel on Climate Change (IPCC)

Special Protection Area (SPA)

Introduction

Scottish Natural Heritage (hereafter referred to by its operating name 'NatureScot') commissioned MacArthur Green to undertake a literature review to provide a list of disturbance distances caused by human related activities for a selected range of protected bird species. This report updates disturbance distance information presented in Ruddock and Whitfield (2007) which has underpinned NatureScot advice and guidance relating to disturbance. Since 2007, new disturbance response information in relation to human activity has become available for a range of protected bird species present in Scotland; the latest data (published up to summer 2021) are included in the current report. In addition, the current report includes a range of additional protected bird species that regularly feature in Environmental Impact Assessments (EIAs) but were not covered in Ruddock and Whitfield (2007).

This report follows a similar format to the **NatureScot research report 1096** that provided information on the effects of disturbance caused by seaweed hand-harvesting on protected marine and coastal bird species (Goodship and Furness, 2019). Similar to the 2019 report, the current review first created a Bird Disturbance Response (BDR) database providing distances at which disturbance to birds could be caused by human related activities. For each species, the current review summarises disturbance distances in the BDR database and makes suggestions for buffer zones; the overall sensitivity of each species to human disturbance is estimated and the level of confidence in these conclusions within a Scottish context is provided. Knowledge gaps identified during the review process are also presented in this report. Recommendations for potential future monitoring programmes and research are provided with a focus on filling these gaps.

Potential impact pathways causing bird disturbance

A wide range of human activity including recreational pursuits and commercial activity may disturb protected bird species (for examples of types of human disturbance, see The Bird Disturbance Response database section

In the UK, some form of human disturbance occurs in most environments where wild bird species are present during the breeding and nonbreeding seasons. These environments include: inland sites (including uplands, lowlands, inland waterbodies and streams), coastal sites (including the shoreline, intertidal areas and nearshore waters) as well as offshore areas (including islands and offshore waters).

The impact of a human disturbance event (e.g. a pedestrian walking across a moorland, a motorboat out at sea, etc) may directly affect bird behaviour (e.g. disrupting foraging activity while the bird alarm calls, or forcing the bird to fly away from the source of disturbance, etc). This change in behaviour brought about by the disturbance event may mean that birds are disturbed from their initial activity and/or are displaced from their initial chosen location. The effect of disturbance and displacement on birds may change their energy intake/expenditure, alter their breeding success and ultimately impact their survival; some of these changes include, but are not limited to, the following:

- Changes to breeding location, timing of breeding, breeding strategy and success;
- Changes to foraging location, time spent foraging, food source, energy intake and daily energy budgets;
- Changes to roosting location and time spent at rest; and
- Changes to migration routes, stop-over locations and seasonal energy expenditure.

In addition, human disturbance may also indirectly affect bird behaviour through habitat alteration (for example habitat loss though development or agricultural practices) and/or alteration of predator numbers.

Habituation and other factors influencing disturbance distance

This review provides a guide to indicate which species are likely to be disturbed by human activities. However, it is important to keep in mind that a great many factors influence disturbance responses of birds. Even species that are considered to have a low sensitivity to human disturbance (see Assessing sensitivity to disturbance section) may be disturbed in some areas at certain times of the year and more sensitive species will also vary in their disturbance response depending upon the specific situation at the time of the disturbance event. Therefore, each study assessing bird disturbance needs to be on a site-specific basis, taking into account the context.

It is important to note that all bird species assessed in this review are, to some degree, likely to habituate to disturbance and are therefore likely to vary in their response to human disturbance in different areas. If birds are present in a highly disturbed area, then it is likely that these birds will show a high degree of habituation to disturbance and tolerate a shorter disturbance distance (Keller, 1989; Baudains and Lloyd, 2007; Ellenberg *et al*., 2009; Ross *et al*., 2015; Vincze *et al*., 2016). Similarly, if a site is secluded where there is little general disturbance, then birds are more likely to react to human presence at a greater distance (e.g. Bötsch *et al*. 2018; Samia *et al*. 2017). Habituation may be prevented in some locations depending on other factors, such as where birds are exposed to shooting. For example, goosanders *Mergus merganser* can become habituated to people in protected locations such as Hogganfield Loch Local Nature Reserve in Glasgow, where they will feed on grain and bread provided by people and will come within a few metres of people there, and on the River Kelvin, Glasgow, where they will tolerate people walking past them within a few tens of metres (Bob Furness, pers. obs.). In contrast, goosanders on salmon rivers where there has been sustained shooting of goosanders to protect fish stocks, such as the Tweed, will immediately fly away when a person appears over 100m away (Bob Furness, pers. obs.).

The distance at which a bird moves away from a source of human disturbance is often quantified as a Flight Initiation Distance (FID) and this can be understood in terms of a behavioural response involving a trade-off between avoidance of predation risk and acquiring sufficient resources, such as food. Climatic variation is one of the many factors that influence responses to disturbance (Díaz *et al*. 2021); one important factor relevant in Scotland appears to be the effect of cold weather/starvation affecting the behaviour of shorebirds and waterfowl in winter. It is well understood that these birds allow people to approach much more closely under extreme cold weather conditions, because the trade-off between predation risk (represented by an approaching person) and starvation risk (caused by freezing weather preventing foraging) has been altered by extreme cold weather conditions. It should therefore be noted that birds may in adverse conditions be less able to show the 'luxury' of alert behaviour or flight initiation in response to disturbance, although, paradoxically, the impact of disturbance under such severe conditions may be greatly increased. Díaz *et al*. (2021) showed that FIDs of a sample of 229 bird species decreased with increasing temperature and rainfall, which they interpret as demonstrating that FID responds to foraging success (the assumption being that for the bird species studied the foraging success declines with increasing temperature and rainfall). They also found that FIDs were influenced by urbanisation, by latitude, and by bird body mass. Urbanisation has also been shown to strongly reduce FIDs of birds in other studies (e.g. Carlen *et al*., 2021; Charutha *et al*., 2021; Nyatanga *et al*., 2021).

Other factors that may influence disturbance responses of birds include, but are not limited to the following: predation risk, FIDs being shorter in locations with fewer predators (Díaz *et al*., 2021), bird population trend (Díaz *et al*., 2021), what the source of disturbance is (Lethlean *et al*., 2017); species of the focal bird in the study (Blumstein, 2006); individual character of the focal bird, flock size and species construction in which the focal bird is present (Mori *et al*., 2001); the size of the focal bird (Blumstein *et al*., 2004; Mikula *et al*., 2018; Díaz *et al*., 2021), behaviour of the focal bird at the time it is disturbed (Liley *et al*., 2011; Liley and Fearnley, 2012; Lilleyman *et al*., 2016), energetic requirements of the focal bird (Gill *et al*., 2001; Beale and Monaghan, 2004), seasonal constraints (Mikula *et al*., 2018), whether the source of disturbance is visual or acoustic or both and whether the source of disturbance is novel to the focal bird (McLeod *et al*., 2013), disease status of the focal bird (Møller, 2008a), exposure of the birds to hunting pressures (Madsen, 1998a,b; Gnanapragasam *et al*., 2021); to mention just a few.

Weston *et al*. (2021) compared FIDs of African and Australian birds. Controlling for phylogeny, they found smaller FIDs among African species than Australian species when comparing residents, but not migrants. They concluded that resident African birds are more tolerant of humans, perhaps in relation to the history of cohabitation between humans and birds.

In addition, it should be recognised that birds learn to respond in an appropriate way to perceived risks from human activities. For example, whooper swans *Cygnus cygnus* at Hogganfield Loch accept food from people, but recognise that a bird ringer carrying a pole with a hook represents a threat worth avoiding and remain further away under those circumstances (Bernie Zonfrillo, pers. comm.). Eider ducks *Somateria mollissima,* learn the sound of the engine of the powerboat used to chase them away from mussel farms, and move away in anticipation of being chased when they hear the approaching engine noise underwater, but ignore other underwater noises (Ross, 2000). The subtle changes in behaviour of birds as a consequence of learning will alter responses to human disturbance of local populations with specific histories of interacting with people.

Definition of disturbance response (AD/FID)

There are three ways disturbance responses are typically measured, as defined below. As part of the literature review process, evidence of these three responses for each species was collated, where it was available.

AD: Alert Distance (AD) is defined as the distance at which a bird or group of birds starts to show alert behaviour (e.g. head up, alarm calling, staring at the source of disturbance, aggressive display, chicks startled, crouching or flattening on the nest etc) rather than sleeping, foraging or preening behaviour when approached by a disturbance agent (such as a person, or powerboat) (Livezey *et al*., 2016).

FID: Flight Initiation Distance (FID) is defined as the distance at which a bird or group of birds starts to escape (by walking away, running away, swimming away, taking flight, or diving) when approached by a disturbance agent (such as a person, or powerboat). This distance is assumed to reflect the trade-off between costs of escape (energetic costs of flight plus loss of food intake during the period of disturbance) and the risk associated with staying put (inferred predation risk) (Mikula *et al*., 2018).

MAD: Minimum Approach Distance (MAD) is defined as the minimum distance at which humans should be separated from wildlife to avoid any disturbance to the behaviour of the wildlife (Livezey *et al*., 2016). This distance should be such that the wildlife does not show an alert response to the presence of human activity and does not show flight initiation. Estimates of MAD can therefore be informed by measurement of AD and/or FID. MAD is commonly referred to as a buffer distance which can be determined by management, based on evidence from observed behaviour of birds.

Buffer zone: Buffer zone is defined in this report as a range of buffer distances that can be used to protect birds from human disturbance.

Although the above definitions are convenient for quantification of bird responses to human disturbance, it should be recognised that bird heart rate may be increased by exposure to human disturbance before alert behaviour or flight initiation responses are evident. Increased heart rate and increased levels of stress hormones have physiological costs and so disturbance may have subtle impacts even on birds that are not clearly showing behavioural responses to disturbance.

Buffer Zones

We were asked by NatureScot to recommend buffer zones for each study species and have done so. However, we emphasise that whereas AD and FID measurements are empirical data collected using agreed scientific methods, estimates of buffer zones must be based on policy decisions. Those should, of course, be evidence-based, but need also to consider a wide range of other aspects such as site-specific context, conservation status and importance of the focal population, and other pressures and threats affecting the population. Therefore, the estimates of buffer zones we suggest should be seen as indicative and not fixed limits that would be appropriate in all situations.

It is considered beyond the scope of this report to provide buffer zones for individual disturbance activities. For the majority of species the data isn't available to support such conclusions for the following reasons:

1) There often isn't enough data in a consistent format for any one activity type in a season to be able to confidently state a buffer range;

2) For species which do have a relatively large number of AD/FID records, disturbance distances within a species recorded in different studies can vary widely for a large number of reasons. It may often be the case that the source of activity isn't always the main factor determining the distance at which a bird responds to disturbance;

3) Following from this, there can be a large overlap in the range of disturbance distances recorded for different activities, this makes it very difficult to set a meaningful buffer zone for individual activities;

Due to the reasons listed above, providing individual buffer zones for different activities wasn't possible, however an attempt has been made to suggest a generalised buffer for the breeding season and/or non-breeding season for each species.

For species where it is possible to do so (e.g. Mallard), some text has been added to the species section to say what the highest FID/AD was recorded for different types of activity.

Bird species potentially affected by human disturbance

The 65 bird species that are the focus of this report are those which NatureScot identified could potentially be disturbed by humans on breeding and/or nonbreeding grounds in Scotland and give rise to conservation concerns as a result. The full list of species is presented in Table 1. These species are designated under the Birds Directive (EC Directive on the conservation of wild birds 2009/147) Article 4.1, listed in Annex 1 as being rare or vulnerable, as well as those birds listed under Article 4.2 as being regularly occurring migratory species. These bird species are afforded protection within Natura 2000 sites (including Special Protection Areas (SPAs). All wild bird species in the UK are also protected under the Wildlife and Countryside Act (W&CA) (1981), as amended by the Nature Conservation (Scotland) Act 2004. Some sensitive species are listed on Schedule 1 of the Act and receive enhanced protection against disturbance during the breeding season. Birds listed under Schedule 1A of the Act may not be intentionally or recklessly harassed at any time in the year (e.g. including at roost sites) and the nests of birds listed under Schedule A1 of the Act are protected all though the year, even when not in use (SNH, 2014).

The scientific name along with the common name of each focal species is listed in Table 1; these names are also repeated at the start of each species account. Protected bird groups which may potentially be disturbed by human activities and which are covered in this report include: swans and geese (family *Anatidae*), ducks (family *Anatidae*), grouse (family *Tetraonidae*), divers and grebes (families *Gaviidae* and *Podicipedidae*), diurnal raptors (families *Accipitridae* and *Falconidae*), waders (families *Charadriidae,Haematopodidae, Phalaropidae* and *Scolopacidae*), terns (family *Sternidae*), owls (family *Strigidae and Tytonidae*) and some other species (families *Caprimulgidae, Coraciiformes*, *Fringillidae, Paridae and Rallidae*). These family groups include both breeding and nonbreeding UK species.

Data gaps

This review has identified that, for some species, there is a lack of quantitative information available on AD and FID values. Some of these species with missing quantitative disturbance distance data have been assessed to have a medium or high sensitivity to disturbance through non-quantitative studies. The species listed below have one or fewer AD/FID records from human disturbance in the BDR database. These species therefore represent a data gap for studies (see Recommendations for further research section) investigating the impacts of human activity on bird disturbance:

- White-fronted goose, *Anser albifrons* (one FID pedestrian record);
- Bean goose, *Anser fabalis* (one FID pedestrian record);
- Greater scaup, *Aythya marila* (no AD/FID records);
- Common scoter, *Melanitta nigra* (no AD/FID pedestrian records);
- Slavonian grebe, *Podiceps auratus* (no AD/FID pedestrian records during the breeding season);
- White-tailed eagle, *Haliaeetus albicilla* (no AD/FID pedestrian records);
- Red kite, *Milvus* (no AD/FID pedestrian records);
- Marsh harrier, *Circus aeruginosus* (one FID pedestrian record);
- Hen harrier, *Circus cyaneus* (no AD/FID pedestrian records);
- Honey buzzard, *Pernis apivorus* (one FID pedestrian record);
- Hobby, *Falco subbuteo* (no AD/FID pedestrian records);
- Peregrine falcon, *Falco peregrinus* (no AD/FID pedestrian records);
- Merlin, *Falco columbarius* (one FID pedestrian record);
- Purple sandpiper, *Calidris maritima* (no AD/FID records);
- Red-necked phalarope, *Phalaropus lobatus* (no AD/FID records);
- Little tern, *Sternula albifrons* (no AD/FID records);
- Sandwich tern, *Thalasseus sandvicensis* (no AD/FID records);
- Arctic tern, *Sterna paradisaea* (one FID pedestrian record);
- Short-eared owl, *Asio flammeus* (no AD/FID pedestrian records);
- Tawny owl, *Strix aluco* (one FID pedestrian record);
- Barn owl, *Tyto alba* (no AD/FID pedestrian records);
- Corncrake, *Crex* (one FID pedestrian record); and
- Nightjar, *Caprimulgus europaeus* (one FID pedestrian record).

Study aims

The aim of this study was to collate AD and FID responses of a range of protected bird species to human disturbance, relative to recreation and other activities in Scotland. The outputs of this project will be used by NatureScot to provide advice and guidance to inform decisions on applications relating to disturbance.

The key objective was to carry out a thorough review of literature relating to disturbance responses of the species listed in Table 1 and compile the information into a database. The current report provides a compilation of species accounts which summarise the information held within the database. We encourage the updating of the database as further data become available.

Methods

The Bird Disturbance Response database

A summary of how the BDR database was constructed is provided below, for a full description, please see **NatureScot Research Report 1096** (Goodship and Furness, 2019).

A literature search for information on quantitative disturbance response distances measured worldwide in terms of ADs, FIDs and MADs of focal UK protected bird species was extracted from academic scientific publications as well as ‘grey literature’ reports monitoring disturbance distances. Data were obtained not only from Scottish/UK studies but also from other European and worldwide studies (including those taking place in North America, Australia, Asia and Africa) that had been translated into English.

Studies recording AD/FID and MAD distances during the breeding and nonbreeding season that were included in the BDR database included the following sources of human disturbance:

Sources of human disturbance

- Recreational pedestrian disturbance (e.g. walking, running, cycling, climbing, horse riding, bait digging, egg collecting and hunting);
- Recreational use of nearshore waters (e.g. both motorised and non-motorised watercraft including kayak, jet skis, motorboats, yachts);
- Working vessels (e.g. commercial ferries, fishing vessels, tankers, cruise ships, offshore wind-farm vessels);
- Animal disturbance (e.g. cattle and dogs);
- Agricultural disturbance (e.g. tractors and 4x4 vehicles); and
- Aircraft and drone disturbance.

The BDR database quantitative studies are summarised for each species in the species accounts (see Results – Species accounts section).

Twenty-four (mostly non-UK) species were included in the BDR database as “stand-in species” to supply additional quantitative data for 16 UK species with little available quantitative data. Stand-in species belong to the same family and have similar ecologies compared with their UK counterparts; the following species were included:

Stand in species

- Tundra swan, *Cygnus columbianus* (standing in for whooper swan);
- Tule greater white-fronted goose, *Anser albifrons elgasi* (standing in for Greenland white-fronted goose);
- Brent goose, *Branta bernicla* (standing in for barnacle goose);
- Australasian shoveler, *Anas rhynchotis* (standing in for Northern shoveler);
- Pochard, *Aythya farina* and tufted duck, *Aythya fuligula* (standing in for scaup);
- Great crested grebe, *Podiceps cristatus* (standing in for Slavonian grebe);
- Bald eagle, *Haliaeetus leucocephalus* and African fish eagle, *Haliaeetus vocifer* (standing in for white-tailed eagle);
- Black kite, *Milvus migrans* (standing in for red kite);
- African marsh harrier, *Circus ranivorus* (standing in for marsh harrier);
- Rough-legged buzzard, *Buteo lagopus* (standing in for common buzzard);
- Lesser kestrel, *Falco naumanni* (standing in for kestrel);
- Prairie falcon, *Falco mexicanus* (standing in for peregrine falcon);
- Least tern, *Sterna antillarum* (standing in for little tern);
- Barred owl, *Strix variata* (standing in for tawny owl);
- Azure kingfisher, *Ceyx azureus* and Malachite kingfisher, *Alcedo cristata* (standing in for European kingfisher);
- Willow tit, *Parus montanus*; marsh tit, *Parus palustris*; blue tit, *Parus caeruleus*; coal tit, *Periparus ater* and great tit, *Parus major* (standing in for crested tit); and
- Parrot crossbill, *Loxia pytyopsittacus* (standing in for common crossbill and Scottish crossbill).

Due to small available data sample size and close ecological similarity, two species, common crossbill *Loxia curvirostra* and Scottish crossbill *L. scotica*, were considered together in one account.

In addition to quantitative studies, non-quantitative studies are provided in each species account of this report, primarily to help with assessing sensitivity to disturbance where quantitative data were limited.

Assessing sensitivity to disturbance

The sensitivity of each species to human disturbance was in part assessed through the maximum AD/FID record held within the BDR database as follows:

Sensitivity category

- Maximum recorded AD/FID value > 500m = High sensitivity.
- Maximum recorded AD/FID value between 500 and 50m = Medium sensitivity.
- Maximum recorded AD/FID value <50m = Low sensitivity.

However, in addition to the maximum recorded AD/FID value, non-quantitative information on disturbance response was also used to assess likely sensitivity to disturbance. Non-quantitative information was especially used in the assessment of species where there was limited quantitative data evidence and low agreement between references. Using a combination of quantitative and non-quantitative information, the overall likely sensitivity of each species to human disturbance was evaluated. Species for which quantitative data were scarce tended to be species with low sensitivity to human disturbance, as published studies have tended to focus on the species of high sensitivity.

Assessing the quality of disturbance response distances

The quality of the quantitative AD/FID records held within the BDR database was assessed in terms of “level of evidence” and “degree of agreement” between references in order to determine the level of confidence that should be placed in the conclusions of these studies within a Scottish context (Mastrandrea *et al*., 2010). For each species, a chart (Figure 1) constructed by the Intergovernmental Panel on Climate Change (IPCC; Mastrandrea *et al*., 2010) was used to assess level of evidence and degree of agreement. The principle of the IPCC chart when applied to the current review is that the quality of the quantitative information is most robust when there are multiple, consistent independent lines of high-quality evidence.

Figure 1. A depiction of evidence and agreement statements and their relationship to confidence that was created by the Intergovernmental Panel on Climate Change (IPCC; Mastrandrea et al., 2010).

The matrix has evidence (type, amount, quality and consistency) along the x axis and agreement along the y axis. Confidence increases towards the top-right corner as suggested by the increasing strength of shading where evidence is robust and agreement high. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality

The level of evidence was categorised in terms of “robust”, “medium” or “limited” and was evaluated by combining the total number of AD and FID records (one record = one AD/FID value for each source of disturbance in each reference) during the breeding and nonbreeding seasons, together with the number of named sources of human disturbance (e.g. pedestrian, motorised watercraft, aircraft etc.) as follows:

Level of evidence category

- ≥15 AD/FID records with ≥4 disturbance sources = Robust evidence.
- ≥15 AD/FID records with <4 disturbance sources = Medium evidence.
- 5 to 14 AD/FID records with ≥2 disturbance sources = Medium evidence.
- 5 to 14 AD/FID records with 1 disturbance source = Limited evidence.
- ≤4 AD/FID records with ≤4 disturbance source = Limited evidence.

The degree of agreement between AD/FID records for each species both within the same reference and also between different references was evaluated; the breeding season and nonbreeding seasons were assessed separately. The degree of agreement was categorised in terms of “high” (i.e. AD/FID values were very similar within/between references), “medium” (i.e. there was agreement between some references, other references were dissimilar) or “low” (i.e. little agreement in AD/FID values within/between references).

Assessing buffer zone ranges

The buffer zones suggested in this report to protect each presented bird species from human disturbance during the breeding and nonbreeding seasons are intended as a guide only.

For some species, published studies have previously recommended buffer zones; where these buffer zones are available, they have been incorporated into the suggested buffer range presented in this report. Buffer zones have also been estimated, where possible, from quantitative studies that have recorded AD/FID and MAD distances during the breeding and nonbreeding seasons. For species which lack quantitative data, buffers have been estimated from non-quantitative studies. For species which lack data for one season, or where buffers are considered to be similar between both seasons, a single buffer has been provided to include both breeding and nonbreeding seasons.

A precautionary approach has been used in the estimation of buffer zones in this report; the distance at which birds of the same species respond to disturbance often overlap between different disturbance sources, therefore general buffer zone ranges are presented for the breeding and nonbreeding seasons, rather than specific buffers for different sources of disturbance.

Species accounts – table content

For each species, a table summarising the AD/FID as well as MAD/buffer zones contained within the BDR database is presented. Each table summarises the sensitivity of the species in question to human disturbance, states the quality of quantitative AD/FID records held within the BDR database and provides a suggested buffer zone range to protect the species from human disturbance during the breeding and nonbreeding seasons. Each table contains the following headings and content:

Conservation status

- UK legislation under the Wildlife and Countryside Act 1981, listed in Schedule 1 for birds afforded special protection (Scottish Government, n.d.);
- UK conservation status under Birds of Conservation Concern 5 (BoCC5; Stanbury *et al.,* 2021);
- European legislation under the Birds Directive (European Commission Directive on the conservation of wild birds (2009/147) Article 4.1, listed in Annex 1 as being rare or vulnerable) (European Commission, 2010); and
- European conservation status under the International Union for the Conservation of Nature (IUCN) European Red List of Birds (BirdLife International, 2021a).

UK status

- UK Breeding/wintering/migration status in British Trust for Ornithology (BTO) BirdFacts (BTO, n.d.); and
- Scottish status was also added to this section if different from UK status (Forrester *et al*., 2012).

UK and Scottish population estimate

- Breeding and wintering numbers of birds in the UK (Woodward *et al*., 2020);
- Breeding and wintering numbers of birds in Scotland (Forrester *et al*., 2012); and
- Breeding population of raptors in Scotland/UK (Challis *et al.,* 2020).

UK long-term trend

- UK distribution and trends: BTO Bird Atlas 2007-11 (Balmer *et al*., 2013);
- Scottish distribution and trends: The digital birds of Scotland (Forrester *et al*., 2012); and
- Scottish white-tailed eagle population and future range modelling (Sansom *et al*., 2016).

AD/FID Quantitative disturbance distances

- The start of this section states if the species was included in Ruddock and Whitfield, (2007).
- Disturbance distance AD and FID values (presented in metres) contained in the BDR database are presented; references are provided in the current report and in the BDR database.
- Depending on the information available in the reference, measures of AD/FID may be presented as a single value, mean AD/FID, median AD/FID and/or range (minimum/maximum) of AD/FID values. One or several of these measures for each source of disturbance in each reference represents one record.
- Some references contain multiple AD/FID values for different sources of disturbance.

MAD and/or Buffer zone Quantitative distances

- MADs and buffer zones (presented in metres) contained in the BDR database are presented; references are provided in the current report and in the BDR database.

Ecology and non-quantitative information on disturbance responses

- A brief account of the ecology of each species is provided.
- Non-quantitative information on disturbance response was used to assess sensitivity to disturbance when quantitative data were lacking or assessed as being of poor quality. References are provided in the text and at the end of the report.

Likely sensitivity to disturbance, quality of quantitative information and buffer zone suggestion

- A summary of the sensitivity to human disturbance, the quality of quantitative data and a suggested buffer zone to protect from human disturbance during the breeding and nonbreeding seasons is provided.

Knowledge gaps

- Reference to what data are unavailable for each species.

Results – Species accounts

A summary of each bird species considered in this report is presented in Table 1, information includes: likely sensitivity to disturbance, quality of the quantitative information held within the BDR database and suggested buffer zones for the breeding (BR) and nonbreeding (NBR) seasons.

Buffer zones indicate the potential range of distances to protect the majority of birds from human disturbance; for more precise disturbance distances on a focal species, each assessment should be carried out on a site-specific basis.

Individual species accounts, summarising the data held for each species in the BDR database, are presented in Tables 2 to 66.

Table 1. Summary of likely sensitivity to disturbance, the quality of quantitative information in terms of Alert Distance (AD) and Flight Initiation Distance (FID) and suggested buffer zones during the breeding (BR) and nonbreeding (NBR) seasons considered for each bird species in this report.

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Whooper swan, *Cygnus cygnus*	Medium	Medium agreement Limited evidence	NBR = 200-600m
White-fronted goose, *Anser albifrons*	High	Medium agreement Limited evidence	NBR = 500-1000m
Bean goose, *Anser fabalis*	Medium	* Medium agreement Limited evidence	NBR = 200-600m
Pink-footed goose, *Anser brachyrhychus*	High	Low agreement Limited evidence	BR ≤1000m NBR = 500-1000m
Greylag goose, *Anser anser*	Medium	Medium agreement Limited evidence	BR and NBR = 200-600m
Barnacle goose, *Branta leucopsis*	Low/Medium	Medium agreement Medium evidence	BR and NBR = 50-200m
Common shelduck, *Tadorna tadorna*	High	Medium agreement Medium evidence	BR and NBR = 100-400m
Mallard, *Anas platyrhynchos*	Low/Medium	High agreement High evidence	BR = 50-100m NBR ≥ 100m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Gadwall, *Anas strepera*	Medium	Medium agreement Limited evidence	BR and NBR = 100-200m
Pintail, *Anas acuta*	Medium	Low agreement Limited evidence	BR and NBR = 100-200m
Shoveler, *Anas clypeata*	Medium	Medium agreement Limited evidence	BR and NBR = 100-200m
Eurasian wigeon, *Anas penelope*	High	Low agreement Medium evidence	BR = 100-200m NBR = 200-500m
Greater scaup, *Aythya marila*	High	Medium agreement Limited evidence	NBR = 150-450m
Common eider, *Somateria mollissima*	Medium/High	Medium agreement Medium evidence	BR = 100-200m NBR = 200-500m
Common scoter, *Melanitta nigra*	High	Medium agreement Limited evidence	BR = 300-500m
Common goldeneye, *Bucephala clangula*	High	Low agreement Medium evidence	BR = 100-150m NBR = 150-800m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Capercaillie, *Tetrao urogallus*	Medium/High	Medium agreement Medium evidence	BR (nesting females) and NBR = 100m BR (lekking males) = 500-1000m NBR = 100m
Black grouse, *Tetrao tetrix*	Medium	Medium agreement Medium evidence	BR (nesting females) and NBR = 100-150m BR (lekking males) = 500-750m NBR = 100m
Red-throated diver, *Gavia stellata*	High	Medium agreement Medium evidence	BR = 500-750m NBR = ≤1000m
Black-throated diver, *Gavia arctica*	High	Medium agreement Limited evidence	BR = 500-750m NBR = ≤1000m
Great northern diver, *Gavia immer*	Medium/High	Medium agreement Medium evidence	NBR = 100-350m
Slavonian grebe, *Podiceps auritus*	Medium	Low agreement Limited evidence	BR and NBR = 150-350m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
White-tailed eagle, *Haliaeetus albicilla*	High	Low agreement Medium evidence	BR = 500-1000m NBR = 250-500m
Osprey, *Pandion haliaetus*	Medium/High	Low agreement Medium evidence	BR = 350-750m
Golden eagle, *Aquila chrysaetos*	High	Low agreement Medium evidence	BR = 750-1000m NBR = 250-500m
Red kite, *Milvus milvus*	Medium	Medium agreement Limited evidence	BR and NBR = 150-300m
Marsh harrier, *Circus aeruginosus*	Medium	Low agreement Limited evidence	BR and NBR = 300-500m
Hen harrier, *Circus cyaneus*	Medium	Medium agreement Limited evidence	BR and NBR = 300-750m
Common buzzard, *Buteo*	Low/Medium	Medium agreement Medium evidence	BR and NBR = 100-200m
Honey buzzard, *Pernis apivorus*	Medium	Medium agreement Limited evidence	BR = 100-200m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Northern goshawk, *Accipiter gentilis*	Medium	Medium agreement Limited evidence	BR = 300-500m
Kestrel, *Falco tinnunculus*	Low/Medium	Medium agreement Limited evidence	BR = 100-200m NBR = ≤50m
Eurasian hobby, *Falco subbuteo*	Medium	* Medium agreement Limited evidence	BR = 200-450m
Peregrine falcon, *Falco peregrinus*	Medium	Medium agreement Limited evidence	BR = 500-750m NBR = ≤200m
Merlin, *Falco columbarius*	Medium	Low agreement Limited evidence	BR = 300-500m NBR = ≤200m
Eurasian oystercatcher, *Haematopus ostralegus*	Medium	Medium agreement Robust evidence	BR = 50-100m NBR = 150-300m
Ringed plover, *Charadrius hiaticula*	High	Medium agreement Medium evidence	BR = 100-200m NBR = 100-300m
Grey plover, *Pluvialis squatarola*	Medium	Medium agreement Medium evidence	NBR = 150-300m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Golden plover, *Pluvialis apricaria*	Medium	Medium agreement Medium evidence	BR and NBR = 200-500m
Dunlin, *Calidris alpina*	Medium	Medium agreement Medium evidence	BR = 100-200m NBR = 150-300m
Red knot, *Calidris canutus*	Medium	Medium agreement Medium evidence	NBR = 100-300m
Purple sandpiper, *Calidris maritima*	Low/Medium	No quantitative evidence	BR and NBR <300m
Wood sandpiper, *Tringa glareola*	Medium	High agreement Limited evidence	BR = 150-300m
Common redshank, *Tringa totanus*	Medium	Medium agreement Robust evidence	BR = 100-200m NBR = 200-300m
Greenshank, *Tringa nebularia*	Medium/High	High agreement Robust evidence	BR and NBR = 300-500m
Black-tailed godwit, *Limosa limosa*	Medium	Medium agreement Medium evidence	BR and NBR = 100-200m
Bar-tailed godwit, *Limosa lapponica*	Medium	Medium agreement Medium evidence	NBR = 200-300m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Eurasian curlew, *Numenius arquata*	High	Medium agreement Robust evidence	BR = 200-300m NBR = 200-650m
Whimbrel, *Numenius phaeopus*	Medium	Medium agreement Limited evidence	BR and NBR = 100-300m
Red-necked phalarope, *Phalaropus lobatus*	Low	No quantitative evidence	BR <50m
Little tern, *Sternula albifrons*	Medium	Medium agreement Limited evidence	BR = 100-300m
Sandwich tern, *Thalasseus sandvicensis*	High	No quantitative evidence	BR ≥200m
Common tern, *Sterna hirundo*	Medium/High	Medium agreement Medium evidence	BR = 200-400m
Arctic tern, *Sterna paradisaea*	Medium	Low agreement Limited evidence	BR ≥200m
Roseate tern, *Sterna dougallii*	High	Low agreement Limited evidence	BR ≥200m
Snowy owl, *Bubo scandiacus*	Medium	Low agreement Limited evidence	NBR = 150-500m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Long-eared owl, *Asio otus*	Medium	Low agreement Limited evidence	BR and NBR = 100-300m
Short-eared owl, *Asio flammeus*	Medium/High	Low agreement Limited evidence	BR and NBR = 300-500m
Tawny owl, *Strix aluco*	Low/Medium	* Medium agreement Limited evidence	BR = 50-200m NBR ≥50m
Barn owl, *Tyto alba*	Low	Medium agreement Limited evidence	BR = 50-100m NBR ≥50m
Corncrake, *Crex*	Medium	Low agreement Limited evidence	BR ≥100m
European nightjar, *Caprimulgus europaeus*	Medium/High	Medium agreement Limited evidence	BR = 150-500m
Kingfisher, *Alcedo atthis*	Low/Medium	High agreement Limited evidence	BR and NBR = 50-100m
Crested tit, *Lophophanes cristatus*	Low	High agreement Limited evidence	BR and NBR = 10-50m

Species	Likely sensitivity to disturbance	Quality of quantitative information (AD/FID)	Buffer zone (m) suggestions during the breeding (BR) and nonbreeding (NBR) seasons
Crossbill species, *Loxia spp*	Low	Medium agreement Medium evidence	BR and NBR = 50-200m

* One or zero AD/FID record is available; degree of agreement is based on MAD records and/or non-quantitative information.

Species: Swans and geese

Whooper swan, *Cygnus cygnus*

Conservation Status

UK: Amber List, Schedule 1 European: Least Concern, Annex 1

UK status

Scarce Breeder, Winter Migrant

UK and Scottish population estimate

UK population = 28 breeding pairs, 19,500 individuals in winter (Woodward *et al*., 2020); Scottish population = 3-7 breeding pairs, 4,142 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+488%) over 25 years.

Range increases of 35% and 16% of overwintering birds have been identified in Britain and Ireland respectively, consistent with an increase in the Icelandic breeding population (Balmer *et al*., 2013).

AD/FID Quantitative disturbance distances

Whooper swan was not included in Ruddock and Whitfield (2007).

Breeding season (Whooper swan):

Surveyor walking in a rural habitat in Denmark: FID = 155m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID = 21.7m (n = 10) (Jiang and Møller, 2017).

Breeding season (Tundra swan, *Cygnus columbianus*, stand in species for Whooper swan):

Surveyor walking in Europe: FID = 78m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season (Whooper swan):

Surveyor walking in Europe: FID = 155m (n = 1) (Møller, 2008a).

Nonbreeding season (Tundra swan, *Cygnus columbianus*, stand in species for Whooper swan):

Surveyor walking in Europe: FID = 200m (n = 1) (Møller, 2008a).

MAD and/or Buffer zone Quantitative distances

No MAD or buffer zones available for Whooper swan.

Ecology and non-quantitative information on disturbance responses

The Icelandic population of whooper swan overwinters exclusively in Britain and Ireland (Balmer *et al*., 2013). The highest densities are widespread in lowland areas of Scotland, northern and eastern England as well as Ireland; in Scotland and northern England the main notable absence is in highland areas (Balmer *et al*., 2013). Whooper swans overwinter in wetland areas including shallow, reed-fringed inland waterbodies in amongst grasslands and heaths or surrounded by forests or reedbeds, rivers, estuaries and shallow marine areas (Snow and Perrins, 1998). This species feeds almost entirely on aquatic vegetation in fresh and saline waters, but when this is not available, whooper swans will also forage in stubble fields and arable crops; increasingly, birds forage in flood lands and other wetlands in late winter and early spring (Snow and Perrins, 1998). Very few birds breed in the UK, some records stem from injured birds, although confirmed records in Shetland and the Outer Hebrides could reflect an expansion in breeding range (Balmer *et al*., 2013).

Whooper swans are known to be sensitive to human presence and “demands immunity from disturbance” (Snow and Perrins, 1998); several studies have shown that this species increases the time spent vigilant when disturbed (Rees *et al*., 2005; Black and Rees, 1984; Brazil, 1981). In China, several factors may have contributed to the decline in the number of whooper swans present during the breeding season; as well as factors to do with climate and habitat change, factors such as hunting, increased disturbance from tourists and an increase in human development projects (e.g. highways, mining, hydroelectric dam and oil field exploitation) have all contributed to the decline in the whooper swan population (Ma and Cai, 2002). In Scotland, the majority of deaths are from human-related causes, many due to collisions with overhead wires; this species is also susceptible to lead poisoning by ingesting spent gunshot (Forrester *et al*., 2012). Overwintering whooper swans in Scotland are known to adapt their activity patterns and foraging locations in response to disturbance, for example disturbance from farmers and dogs have led to abandonment of foraging areas and displacement between fields (Brazil, 1981).

However, whooper swans can habituate to some types of human activity, especially if the source of disturbance is predictable. In a study at Rongcheng Lake in China, an important wintering ground for migratory birds, Liu *et al.*, (2018) found that overwintering whooper swans became less sensitive to human visitors feeding the birds as the daily disturbance frequency became higher or as the natural food supply depleted. In a similar study at the Black Cart floodplain in Scotland, Rees *et al*. (2005) found that the distance at which >5% of a flock of whooper swans became alert because of human activity decreased with the number of previous disturbance incidents in the day, indicating that the swans became less sensitive to disturbance events if daily disturbance frequency was high, although there was no evidence that habituation to disturbance persisted over long periods. Rees *et al*. (2005) also found that the time taken for the birds to resume undisturbed behaviour varied with the duration of the disturbance event, which in turn depended on the type of disturbance involved, with pedestrians alerting the birds for longer periods than vehicles and aircraft. Small numbers of whooper swans winter at Hogganfield Loch, Glasgow, where they join mute swans, ducks and geese that feed on bread and grain from the hand. Although whooper swans at this site are slightly less ‘tame’ than mute swans, they will come to within 1 m of people providing food (Bernie Zonfrillo, pers. comm.).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Nonbreeding season buffer zone = 200-600m

Whooper swan is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for whooper swan, but the maximum FID value recorded for this species when approached by a pedestrian is 155m during both the breeding and nonbreeding seasons.

In the UK, whooper swan has the potential to be disturbed on roosting and foraging grounds during the nonbreeding season. Due to the scarcity of breeding whooper swans in the UK, this species is unlikely to be encountered on breeding grounds by humans. There are no published buffer zones for whooper swan, but from studies on geese, a minimum buffer zone of 200-600m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Lack of studies measuring AD/FID for a range of sources of disturbance, and clear evidence that habituation can occur but apparently to very different extents at different sites.

White-fronted goose, *Anser albifrons*

Conservation Status

UK: Red List

European: Least Concern, Annex 1

UK status

Winter Migrant

UK and Scottish population estimate

UK white-fronted goose population = 0-1 breeding pairs, 14,000 individuals in winter (Woodward *et al*., 2020). Scottish population has declined since Forrester *et al*. (2012) estimated a wintering population of c.16,000 individuals.

UK long-term trend

The European subspecies (*albifrons*) breeding population has increased but distribution has shifted eastwards; winter population declines have been recorded at most sites in Britain although the range expanded by 36% between 1981/84 – 2007/11 (Balmer *et al*., 2013). The Greenland subspecies (*flavirostris*) continues to show a long-term decline in breeding numbers, winter numbers in Britain have declined since a peak in 1998/99 (Balmer *et al*., 2013; Forrester *et al*., 2012).

AD/FID Quantitative disturbance distances

Greenland white-fronted goose was not included in Ruddock and Whitfield (2007).

Nonbreeding season (Greenland white-fronted goose):

Hunting in Denmark: Min/Max FID = 200 to 500m (n = 400 to 600) (Fox and Madsen, 1997).

Nonbreeding season (tule greater white-fronted goose, *Anser albifrons elgasi*, stand in species for Greenland white-fronted goose):

Pedestrian (general) in the USA: Mean FID = 47m (n = 6); Min/Max FID = 25 to 100 (Ackerman *et al*., 2004).

MAD and/or Buffer zone Quantitative distances

No MAD or buffer zone available for white-fronted goose.

Ecology and non-quantitative information on disturbance responses

Two subspecies of arctic breeding white-fronted goose overwinter in the UK; the European (*albifrons*) subspecies which breeds in Russia winters mainly in southern England and the Greenland-breeding (*flavirostris*) subspecies winters mainly in Ireland and western and northern Scotland (Balmer *et al*., 2013; Wernham *et al*., 2002). In Britain, Islay and the Severn Estuary are two important overwintering sites (Balmer *et al*., 2013). In Scotland, numbers have declined in recent years due to chronic low productivity in the Greenland population; small foraging flocks on traditional peatland sites have been lost, coincident with a shift towards managed grasslands (Balmer *et al*., 2013). In the UK, white fronted geese forage in lowland areas including grasslands, arable fields and wetlands (Snow and Perrins, 1998)

This species is considered sensitive to human disturbance (Fox and Stroud, 2002; Forrester *et al*., 2012). Stroud *et al*. (2012) identified aircraft/helicopters, human disturbance of roost sites, and deliberate and accidental human disturbance from farmland feeding sites as likely to cause significant local, but not population-scale, impacts on Greenland white-fronted geese.

There is anecdotal evidence suggesting that this species avoids human activity more than other geese; for example, the flock that winters at southeast Loch Lomond is rarely seen from local roads because it tends to frequent fields that are not visible from roads (Fox *et al*., 2012). In contrast to that anecdotal observation, statistical analysis of detailed survey data on habitat use by Greenland white-fronted geese wintering in Islay found a tendency for goose numbers to be higher closer to roads (Griffin *et al*., 2020). However, that was thought likely to be due to counting bias (increased detection of goose flocks close to roads from vehicles used for these surveys). There was a very clear effect of shooting disturbance on the time-energy budgets of Greenland white-fronted geese on Islay (Griffin *et al*., 2020). Effects were proportional to the distance from the disturbance and became detectable where shooting occurred within ca. 800 m from Greenland white-fronted goose flocks. Greenland white-fronted goose flocks disturbed by shooting were prone to flushing, and when not flushed tended to reduce feeding time and increase vigilance for 3-5 minutes after the event (Griffin *et al*., 2020). The effect of shooting disturbance on Greenland white-fronted goose behaviour was much more acute than other causes of disturbance such as road or farm vehicles or birds of prey. Nevertheless, road vehicles were responsible for the largest numbers of flushes of Greenland white-fronted geese in Islay (Griffin *et al*., 2020). Marksmen vehicles caused particular disturbance, presumably because the geese learned to associate them with shooting (Griffin *et al*., 2020). Norriss and Wilson (1988) showed that disturbance has been an important factor affecting rates of population change in Ireland, with flocks with a restricted feeding range being more likely to suffer local population declines as a result of disturbance. Therefore, quantifying and reducing human disturbance of wintering Greenland white-fronted geese is recommended in the species action framework (Urquhart *et al*., 2015).

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Limited evidence

Nonbreeding season buffer zone = 500-1000m

Greenland white-fronted goose is assessed to have a high sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for white-fronted goose, the maximum FID value recorded for this species when disturbed by hunting activities during the nonbreeding season is 500m.

In the UK, white-fronted goose has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season. There are no published buffer zones for white-fronted goose, but from other studies on geese, a minimum buffer zone of 500-1000m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

There are very few published studies measuring AD/FID for white-fronted goose. Disturbance distance studies are required for a range of human activity for this species.

Bean goose, *Anser fabalis*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Escaped Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 230 (Taiga) individuals in winter (Woodward *et al*., 2020); Scottish population = c.250 individuals in winter, 10-100 during passage (Forrester *et al*., 2012).

UK long-term trend

Decreased considerably since early 20th century. Possibly increased slightly 1981-84 to 2007-11, but some local losses too (Balmer *et al*., 2013). Numbers in Scotland (mainly at Slamannan) increased between 1978 and 2004 (Forrester *et al*., 2012).

AD/FID Quantitative disturbance distances

Bean goose was not included in Ruddock and Whitfield (2007).

Nonbreeding season:

Hunting in Denmark: Min/Max FID = 200 to 500m (Fox and Madsen, 1997).

MAD and/or Buffer zone Quantitative distances

No MAD or buffer zone available for bean goose.

Ecology and non-quantitative disturbance responses

In Britain, bean geese (mainly the subspecies Taiga bean goose, *Anser fabalis fabalis*) overwinter in small numbers; the main concentrated wintering areas are on the Slamannan Plateau, Stirlingshire and in the Yare Valley, Norfork (Balmer *et al*., 2013) after migrating from breeding grounds across Western Siberia to Scandinavia (Wernham *et al*., 2002). Outside these main winter areas, the wintering range includes Orkney, Shetland, northeast Scotland, East Anglia, southeast and northwest England, although these areas may support few birds or birds for short periods only (Balmer *et al*., 2013). Bean geese forage on arable land, rough pasture and marshy areas (Snow and Perrins, 1998; Thom, 1986), mostly close to the coast, but also at some marshy inland sites (Balmer *et al*., 2013).

Bean geese were once a common winter visitor to Scotland, but numbers have fallen greatly since the early 20th century, in part due to changes in agriculture and climate changes (Thom, 1986), but increased human disturbance may play a role in the decline (BCM Environmental Services Limited, 2011).

Bean geese may be susceptible to hunting disturbance, although protected, in appearance they look similar to pink-footed geese (Thom, 1986). There are very few studies available investigating disturbance distances in this species, the upper disturbance for hunting activities has been reported to be 500m (Fox and Madsen 1997).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Nonbreeding season buffer zone = 200-600m

Bean goose is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for bean goose, the maximum FID value recorded for this species when disturbed by hunting activities during the nonbreeding season is 500m.

In the UK, bean goose has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season. A minimum buffer zone of 200-600m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

There are very few published studies measuring AD/FID for bean goose. Disturbance distance studies are required for a range of human activity for this species.

Pink-footed goose, *Anser brachyrhychus*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Winter Migrant

UK and Scottish population estimate

UK population = 510,000 individuals in winter (Woodward *et al*., 2020);

Scottish population = 200,000 individuals in October, 100,000-150,000 individuals in winter/spring (Forrester *et al*., 2012).

UK long-term trend

There has been a strong increase in the winter population (Balmer *et al*., 2013). Population increased from 90,000 in 1981/84 to 360,000 in 2007/11 (Balmer *et al*., 2013) and this increased to 510,000 in 2015/16 (Woodward *et al*., 2020). The British range doubled in size between 1981/84 – 2007/11 (Balmer *et al*., 2013).

AD/FID Quantitative disturbance distances

Pink-footed goose was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Mean FID = 61m (n = 4); Min/Max FID = 43 to 78m (Díaz *et al*., 2021).

Surveyor walking in tundra habitat in Svalbard: Range of mean FID = 41.7 to 175.0m (n = 24) (Madsen *et al*., 2009).

Migratory season:

Hunting in a farmland habitat in Denmark: Range of mean FID decreased from 500 to 350m following the closure of the hunting season (Madsen, 1985).

Nonbreeding season:

Hunting in a nearshore habitat in Denmark: Min/Max FID = 350 to 500m (n = 400 to 600) (Fox and Madsen, 1997).

MAD and/or Buffer zone Quantitative distances Breeding season:

Surveyor walking in tundra habitat in Svalbard: Buffer zone = 1000m (Madsen *et al*., 2009).

Ecology and non-quantitative disturbance responses

Pink-footed geese breeding in Iceland and eastern Greenland, migrate almost exclusively to Britain to overwinter (Balmer *et al*., 2013). Large concentrations of feeding and roosting flocks are recorded along the east coast and central-eastern lowlands of Scotland, Solway Firth as well as in a broad band across England from Lincolnshire to Norfolk with the highest densities close to the coast (Balmer *et al*., 2013). In the spring, this species migrates north back to breeding grounds, flocks stage in central and northern Scotland which accounts for large numbers of nonbreeding records recorded in April and early May (Balmer *et al*., 2013). Pink-footed geese generally avoid upland areas, this species favours foraging areas on flat intensively farmed lowland areas (e.g. improved or fertilised grasslands, stubble fields, pastures and newly sown cereal fields) but will also feed on extensive areas of saltmarsh in estuaries (Balmer *et al*., 2013; Snow and Perrins, 1998).

Pink-footed geese are sensitive to disturbance (JNCC, 2012) and there is potential for disturbance at roost sites in the winter which may shift locally in response to disturbance (Mitchell and Hearn, 2004). Overwintering roost sites in the UK include estuaries, large lakes and reservoirs, usually close to feeding grounds (Snow and Perrins, 1998). In Scotland, favoured winter daytime roosting sites include estuarine mudflats, lochs and reservoirs (Forrester *et al*., 2007). On foraging grounds on arable fields, pink-footed geese are highly responsive to disturbance from surrounding roads (Gill *et al*., 1996). A paper reviewed by Korschgen and Dahlgren, (1992) recorded that pink-footed geese were disturbed at a distance of 500m when more than 20 cars per day used a road during autumn; it was also noted that as few as 10 cars per day affected habitat use by geese and a buffer zone of 500m was suggested to render habitat acceptable to flocks of pink-footed geese.

Mitchell and Hearn (2004) have found that the main determinant of roost choice is lack of human disturbance, especially hunting disturbance; other factors such as exposure, shoreline vegetation, including trees, and availability of grazing appear to be unimportant. Hunting is known to alter the distribution of pink-footed geese; in the major staging areas in Denmark, disturbance from hunting can result in the emigration of almost the entire population to the Netherlands within one day (see Väänänen, 2001 for review).

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone ≤1000m

Nonbreeding season buffer zone = 500-1000m

Pink-footed goose is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for pink-footed goose is 500m when disturbed by hunting activities during the nonbreeding season. The maximum FID value recorded during the breeding season is a mean of 175m when approached by a pedestrian. A buffer zone of 1000m has been reported to protect pink-footed geese from pedestrian disturbance.

In the UK, pink-footed goose has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. A buffer zone up to 1000m is suggested to protect nesting birds and a buffer zone of 500-1000m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

There are few published studies measuring AD/FID for pink-footed goose. Disturbance distance studies are required for a range of human activity for this species.

Greylag goose, *Anser*

Conservation Status

UK: Amber List, Schedule 1 – Part II

European: Least Concern

UK status

Introduced/Resident Breeder, Winter Migrant

UK and Scottish population estimate

UK population = 47,000 breeding pairs, 230,000 individuals in winter (Woodward *et al*., 2020); Scottish population = at least 25,000 native/naturalised birds present all year round, with a further 85,000+ arriving from Iceland to winter in Scotland in the early 2000s (Forrester *et al*., 2012), although that number of migrants has decreased in recent years.

UK long-term trend

Population has increased considerably between 1981/84 – 2007-11, much of the increase has been of the resident population (Balmer *et al*., 2013).

AD/FID Quantitative disturbance distances

Greylag goose was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Mean FID = 180m (n = 4); Min/Max FID = 180 to 180m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Norway: Mean FID = 12.4 (n = 24); Min/Max FID = 6 to 20m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Poland: FID = 77 (n = 1) (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Poland: Mean FID = 50.8 (n = 2); Min/Max FID = 49 to 52.4m (Díaz *et al*., 2021).

Nonbreeding season:

Surveyor walking in a wetland habitat in Denmark: Range of mean FID = 171 to 230m (n = 7 to 24) (Bregnballe *et al*., 2009).

MAD and/or Buffer zone Quantitative distances

No MAD or buffer zone available for greylag goose.

Ecology and non-quantitative disturbance responses

Greylag geese are widespread in the UK both during the breeding and nonbreeding seasons; three populations occur in the UK (native Scottish, reintroduced and Icelandic populations) but ranges now overlap to such an extent that it is impossible to separate them (Balmer *et al*., 2013). The resident British/Irish greylag goose population is now widespread throughout England (except the southwest and in north and southwest Wales) and Scotland (except the uplands and northeast); resident birds are sedentary, breeding and nonbreeding distributions are similar (Balmer *et al*., 2013). Resident birds breed near wetlands and occasionally on ledges of steep rocky slopes and tall heather, especially in Scotland (Snow and Perrins, 1998).

The Icelandic greylag goose population breeds in Iceland and winters in Britain (with smaller numbers wintering in Ireland, Norway and the Faeroe Islands); the majority of Icelandic birds winter in Scotland particularly in Orkney, Caithness and in east-central Scotland, with smaller numbers in southern Scotland, England and Wales (Balmer *et al*., 2013; Wernham *et al*., 2002). All greylag geese prefer foraging areas on low-lying agricultural land (Balmer *et al*., 2013), but this species will also forage on grasslands as well as fresh or saline shallow water areas (Snow and Perrins, 1998). Greylag geese show a strong preference for large, open fields that offer a clear view of potential predators (Newton and Campbell, 1973) although smaller fields may be used during the winter (see Hearn and Mitchell, 2004 for review).

Greylag geese generally show more tolerance towards human disturbance compared with other geese species present in the UK; birds on breeding grounds, roosting sites and in foraging areas may tolerate some degree of disturbance (Díaz *et al*., 2021; Hearn and Mitchell, 2004). However, this species will move away from areas that have high levels of human activity such as roads and human habitation. Keller (1991), found that overwintering greylag geese were heavily impacted by roads; in northeast Scotland, birds were not found within 100m of the nearest road and the median distance was 400m. In the Netherlands, Feige *et al*. (2008) found that this species will not breed or forage within a minimum distance of 100m of human buildings.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 200-600m

Nonbreeding season buffer zone = 200-600m

Greylag goose is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for greylag goose when approached by a pedestrian is a mean of 180m during the breeding season and a mean of 230m during the nonbreeding season.

In the UK, greylag goose has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. There are no published buffer zones for greylag goose, but from other studies on geese, a minimum buffer zone of 200-600m is suggested to protect breeding and nonbreeding birds from pedestrian disturbance.

Knowledge gaps

There are few published studies measuring AD/FID for greylag goose. Disturbance distance studies are required for a range of human activity for this species.

Barnacle goose, *Branta leucopsis*

Conservation Status

UK: Amber List

European: Least Concern, Annex 1

UK status

Escaped Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 1,550 breeding pairs, 105,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 70,000 in winter (Forrester *et al*., 2012).

UK long-term trend

Prolonged increase in wintering numbers over recent decades (Balmer *et al*., 2013). The breeding range of the resident population has increased by 88% between 1988/91 – 2007/11; the growth of the Greenland population has also increased the number of overwintering birds (Balmer *et al*., 2013).

AD/FID Quantitative disturbance distances

Barnacle goose was not included in Ruddock and Whitfield (2007).

Breeding season (barnacle goose):

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 5 to 20.1m (n = 4) (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID 12.6m (n = 4) (Jiang and Møller, 2017).

Surveyor walking in tundra habitat in Svalbard: Range of Mean FID = 7.5 to 27.0m (n = 162) (Madsen *et al*., 2009).

Breeding season (brent goose, *Branta bernicla*, stand in species for barnacle goose):

Surveyor walking in a rural habitat in Denmark: FID = 20m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID 23.5m (n = 6) (Jiang and Møller, 2017).

Nonbreeding season (brent goose):

Pedestrian (general) in a shoreline habitat in England: Min/Max AD = 23 to 150m (n = 45); Median FID = 51.5m; Min/Max FID = 5 to 178m (n = 89) (Liley *et al*., 2010).

MAD and/or Buffer zone Quantitative distances

No MAD or buffer zone available for barnacle goose.

Ecology and non-quantitative disturbance responses

Although small numbers of barnacle geese are resident in England and Wales, the majority of this species migrates from breeding grounds in Svalbard and Greenland to overwinter in the UK (Balmer *et al*., 2013; Wernham *et al*., 2002). The wintering populations of barnacle geese are widely distributed around the coasts, estuaries and wetland areas of the UK; birds recorded along the coast and islands of northwestern Scotland are largely from the Greenland-breeding population, whilst birds on the Solway Firth and on the east coast of Britain are largely from the Svalbard population (Balmer *et al*., 2013). Breeding and nonbreeding resident birds are more widely distributed and may also occupy inland areas, particularly in England (Balmer *et al*., 2013). This species feeds on grasslands grazed by farm animals or on autumn stubbles (Snow and Perrins, 1998), the overwintering migratory populations may feed in inland areas, but these are often within a few kilometres of their coastal wintering locations (Balmer *et al*., 2013).

Barnacle geese are regarded as vulnerable to human disturbance on breeding grounds (Madsen *et al*., 2009) as well as over hunting grounds during migration (Madsen and Fox, 1995). However, numbers of barnacle geese overwintering in the UK has increased rapidly over the last 40 years and this has resulted in conflict in agricultural areas (see Percival *et al*., 1997 for review). On Islay in Scotland, where approximately two-thirds of the East-Greenland breeding population overwinter, Percival *et al*. (1997) found that tactics to scare birds (e.g. people walking towards birds until they took flight, the use of gas guns and plastic tape) from an agricultural area, resulted in some birds moving towards undisturbed sites, but many individuals persisted in using the heavily disturbed sites, suggesting that some individuals and family groups have a high tolerance of disturbance on nonbreeding grounds.

Barnacle goose have become resident in parts of Sweden, including urban Stockholm. In this city barnacle geese live in public parks and feed on roadside verges and grass-covered roundabouts (Bob Furness pers. obs.). They show very little response to the presence of people, and have clearly habituated to this urban environment, illustrating the wide range of behavioural responses that are context-dependent.

Likely sensitivity to disturbance = Low/Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 50-200m

Nonbreeding season buffer zone = 50-200m

Barnacle goose is assessed to have a low to medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are limited for barnacle goose. The maximum FID value recorded for barnacle goose when approached by a pedestrian is a mean of 27m during the breeding season; for brent goose, the maximum FID is 178m during the nonbreeding season.

In the UK, barnacle goose has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. There are no published buffer zones for barnacle goose, but from the range of published FID values, a buffer zone of 50-200m is suggested to protect breeding and nonbreeding birds from pedestrian disturbance.

Knowledge gaps

There are few published studies measuring AD/FID for barnacle goose specifically. Disturbance distance studies are required for a range of human activity for this species.

Species: Ducks

Common shelduck, *Tadorna tadorna*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Migrant/Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = at least 7,850 breeding pairs, 51,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 1,750 breeding pairs, 7,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

The UK breeding range increased by 17% between 1981/84 – 2007/11, but the population increased only by 2% between 1995 – 2010; range increases are associated with the continued colonisation of inland breeding sites (Balmer *et al*., 2013). Increased winter ranges are consistent with breeding ranges, however, despite this, winter population trends in the UK and Ireland show shallow, steady declines since the mid-1990s (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Common shelduck was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 35 to 52m (n = 18), Min/Max FID = 18 to 70m (Díaz *et al*., 2021).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 178.4m (n = 22) (Dwyer, 2010).

Surveyor walking in Europe: Mean FID = 36.30m (n = 10) (Møller and Erritzøe, 2010).

Surveyor walking in Europe: Mean FID = 48.6m (n = 7) (Møller, 2008a).

Surveyor walking over mudflats in Denmark: Mean FID = 225m (n = 102), Min/Max FID = 55 to 700m (Laursen *et al*., 2005).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median AD = 50 (n = 3), Min/Max AD = 50 to 70m; Range of median FID = 40 to 62.5m (n = >6), Min/Max FID = 25 to 100m (Liley *et al*., 2011).

Pedestrian (general) along the shoreline in England: Median FID = 77.5m (n= 8), Min/Max FID = 50 to 140m (Liley *et al*., 2010).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Range of mean FID = 148 to 250m; Min/Max FID = 99 to 300m (Smit and Visser, 1993).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 220m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 400m (Laursen *et al*., 2017).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Pedestrian walking/running along footpaths or the presence of railways close to intertidal areas in England: Buffer zone = 100m, although a buffer zone of 200m may be needed to protect a mix of intertidal species (Burton *et al*., 2002a)

Ecology and non-quantitative information on disturbance responses

In the UK, shelducks are found in most coastal regions where there is suitable lowland habitat (e.g. estuaries, muddy shores and coastal marshes) (Balmer *et al*., 2013); this species also increasingly breeds at inland sites (e.g. farmland, lakes, reservoirs and pig fields), particularly those in northern, central and southern England (Balmer *et al*., 2013). Shelducks feed mainly on salt-water molluscs when by the coast, but this species will also feed on aquatic invertebrates and plant material (Snow and Perrins, 1998). Breeding and nonbreeding distributions are similar; the highest concentrations of breeding shelduck are recorded along the East Anglian coastline, the Lancashire and Cumbrian marshes, the Uists and Orkney, as well as the area inland of the Wash extending into the Fens and Breckland (Balmer *et al*., 2013). Shelduck is generally a hole nesting species, nests are commonly located in tree hollows up to 8m above ground and mammal holes (e.g. rabbits) are also used; more rarely, this species may nest on the ground in the open or in dense vegetation up to 1km away from water (Snow and Perrins, 1998). Shelducks breeding in the UK do not migrate to an overwintering area, but the majority (≥90%) do have a well-defined moult migration to the Helgoland Bight of the Wadden Sea (Wernham *et al*., 2002). The moult migration starts as early as mid-June with birds gradually returning to the UK during mid-winter; a small number of birds remain in the UK to moult (Wernham *et al*., 2002).

Shelducks are potentially vulnerable to human disturbance, particularly during the moulting period when birds are completely flightless and are therefore more vulnerable to disturbance and predation (Salomonsen, 1968). Shelduck moulting areas are usually situated in places where there is relatively little disturbance, such as difficult to access mudflats (e.g. Meininger and Snoek, 1992; Bryant and Leng, 1975). Disturbance may also impact shelduck on their winter foraging grounds, Burton *et al*. (2002a) indicated that shelduck counts were significantly lower on English estuarine count sectors that were closer to footpaths, after curlew, shelduck was the second species most likely to take flight when disturbed by walkers. Burton *et al*. (2002a) also found that numbers of shelduck were reduced on count sections within 100m of railways, furthermore, Burton *et al*. (2002b) found that construction work around Cardiff Bay tended to reduce the densities of shelduck, although this tendency was not statistically significant in their study.

Although shelduck is not a quarry species, hunting is one of the principal causes of mortality in fledged shelducks in Scotland (Forrester *et al*., 2012). Forrester *et al*., 2012 identified a gap in current knowledge relating to human disturbance and shelduck and posed the question of whether the increase in breeding shelduck at inland sites is in response to human disturbance in coastal areas.

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-400m

Nonbreeding season buffer zone = 100-400m

Common shelduck is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for common shelduck when approached by a pedestrian is 70m during the breeding season and 700m during the nonbreeding season, although generally FID values recorded during the nonbreeding season are less than 500m. For non-motorised watercraft, mean FID values up to 400m have been recorded during the nonbreeding season

In the UK, shelduck has the potential to be disturbed on breeding grounds as well as on moulting, foraging and roosting grounds during the nonbreeding season; as a hole nesting species shelduck may be less likely to be disturbed when on the nest. A buffer zone of 100-400m is suggested to protect both breeding and nonbreeding shelduck from pedestrian and boating disturbance, although a buffer zone at the lower end of this range may be sufficient to protect nesting birds during the breeding season.

Knowledge gaps

Further studies are required to record AD/FID during the breeding season. Limited information on buffer zones.

Mallard, *Anas platyrhynchos*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Introduced/Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = at least 61,000-145,000 breeding pairs, 675,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 17,000-43,000 breeding pairs, 65,000-90,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

The UK breeding population increased by 20% between 1995-2010, range increased by 2% and 8% in Britain and Ireland respectively between 1988/91 - 2007/11 (Balmer *et al*., 2013). In contrast, although the range of wintering UK birds is similar to the breeding season, the wintering population has declined by 39% since around 1990 which is likely due to a reduction in overwintering European breeding migrants (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Mallard was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Scotland: Mean FID = 20m (n = 3), Min/Max FID = 4 to 28m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Spain: Range of mean FID = 10.8 to 20m (n = 19), Min/Max FID = 0.7 to 30.1m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Spain: Range of mean FID = 2.8 to 12m (n = 16), Min/Max FID = 1.4 to 12m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in France: Range of mean FID = 4.8 to 8m (n = 40), Min/Max FID = 3 to 15m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in France: Range of mean FID = 2 to 7.5m (n = 98), Min/Max FID = 0 to 13m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Hungary: Range of mean FID = 4.8 to 17.9m (n = 15), Min/Max FID = 2.4 to 28.6m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Hungary: Range of mean FID = 3.4 to 3.8m (n = 16), Min/Max FID = 0.6 to 8.3m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Czech Republic: Mean FID = 56.5m (n = 4), Min/Max FID = 38 to 68m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Czech Republic: Range of mean FID = 1 to 14m (n = 25), Min/Max FID = 0 to 15m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 12 to 57m (n = 70), Min/Max FID = 4 to 75m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Denmark: Range of mean FID = 5 to 11.1m (n = 29), Min/Max FID = 2 to 19m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Norway: Range of mean FID = 8.5 to 11.9m (n = 18), Min/Max FID = 4 to 18m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Norway: Range of mean FID = 4.5 to 6.1m (n = 38), Min/Max FID = 2 to 8m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Finland: Mean FID = 30m (n = 2) (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Finland: Range of mean FID = 6.5 to 7.9m (n = 9), Min/Max FID = 2 to 16m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Poland: Range of mean FID = 6 to 88m (n = 22), Min/Max FID = 0.7 to 98m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Poland: Range of mean FID = 3 to 73.9m (n = 30), Min/Max FID = 0.5 to 16.1m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Estonia: Range of mean FID = 19.1 to 38.3m (n = 4), Min/Max FID = 11.3 to 38.3m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Estonia: Range of mean FID = 4.1 to 6m (n = 10), Min/Max FID = 0.8 to 7.5m (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID = 9.9m (n = 339) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 162.52m (n = 7) (Dwyer, 2010).

Surveyor walking in Europe: Mean FID = 13.42m (n = 89) (Møller and Erritzøe, 2010).

Surveyor walking in Europe: Mean FID = 14.60m (n = 77) (Møller, 2008a).

Surveyor walking over mudflats in Denmark: Mean FID = 236m (n = 25), Min/Max FID = 60 to 400m (Laursen *et al*., 2005).

Surveyor walking in wetlands in Denmark: Range of mean FID = 108 to 195m (n = 5 to 188) (Bregnballe *et al*., 2009).

Surveyor walking in a range of habitats in Australia: Mean FID = 12.8m (n = 3) (Weston *et al*., 2012).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Range of median FID = 30 to 40m (n = 3), Min/Max FID = 30 to 50m (Liley *et al*., 2011).

Pedestrian (general) along the shoreline in England: AD = 50 (n = 1); Median FID = 25m (n= 5), Min/Max FID = 10 to 50m (Liley *et al*., 2010).

Motorised watercraft (motorboat) in nearshore waters off Denmark: Mean FID = 110m (Laursen *et al*., 2017).

Motorised watercraft (motorboat) on a lake in Japan: Mean FID = 99.30m (n = 28) (Mori *et al*., 2001).

Non-motorised watercraft (inflatable boat) in nearshore waters off Denmark: Mean FID = 100m (Laursen *et al*., 2017).

Non-motorised watercraft (rowing boat) in nearshore waters off Denmark: Mean FID = 85m; Min/Max FID = 80 to 90m (Laursen *et al*., 2017).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 50m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 280m (Laursen *et al*., 2017).

Non-motorised watercraft (kite surfer) in nearshore waters off Denmark: Mean FID = 40m (Laursen *et al*., 2017).

Non-motorised watercraft (Sailing dinghy) on Brent Reservoir, England: Mean FID = 100m (Batten, 1977).

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Mean FID = 18m (Borgmann, 2012).

Drone (operated by a surveyor) in a zoo in France: Min/Max AD = 4 to 8m (n = 9); Min/Max FID = 4 to 8m (n = 4) (Vas *et al.,* 2015).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 27m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season (Mallard):

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Buffer zone = 83m (Borgmann, 2012).

Nonbreeding season (Groups of dabbling ducks, *Anas* sp. including gadwall, mallard and pintail):

Pedestrian leisure boats in a range of habitats and locations: Buffer zone = 108m (Borgmann, 2012).

Ecology and non-quantitative information on disturbance responses

Mallard is a common, widespread and adaptable resident species in the UK; its absence is only notable in mountainous areas and non-aquatic habitats (Balmer *et al*., 2013). In the UK, this species is sedentary or dispersive over short distances, distribution is similar in both the breeding and nonbreeding seasons; the highest densities are found in lowland aquatic areas (Balmer *et al*. 2013; Wernham *et al*., 2002). Mallards inhabit a wide range of aquatic environments, large or small, including standing or flowing freshwater, ponds, canals, irrigation networks, sewage farms, brackish estuaries and shallow sheltered coastlines (Snow and Perrins, 1998). The breeding season can be greatly prolonged for this species, ground nests are usually concealed by vegetation, but birds will also nest under boulders, inside hollow trees and on man-made structures - nest boxes and baskets are readily used (Snow and Perrins, 1998).

In the winter, resident mallards are joined by European breeders which migrate south and west to overwinter in areas that include the UK (Wernham *et al*., 2002). Mallards are omnivorous and opportunistic with a wide diet consuming both plant and animal matter depending upon location and season; food can be obtained from water by pecking and sieving, dabbling and upending and also by grazing on land like geese or wigeon (Forrester *et al*., 2012; Snow and Perrins, 1998). This species will readily consume bread and other items offered by humans.

Mallards are known to be tolerant of humans and have adapted well to human environments; this species is a common occurrence on garden ponds, park lakes and sewage farms (see Woodward *et al*., 2015 for review). This species can habituate to human activity, especially if the source of disturbance is predictable, such as frequently used navigation routes used by boats or areas close to harbours (Platteeuw and Henkins, 1997). Mallards were considered to be one of the most tolerant species towards disturbance from water-based recreational activities on inland waterbodies in England and Wales (Tuite *et al*., 1984). Mallards have been noted to have shorter FIDs in response to an approaching human compared to other dabbling ducks, suggesting that they are more tolerant than the other members of the same family (Mori *et al*., 2001).

However, despite this species renowned tolerance of humans, habituation to human disturbance does vary between habitats; Díaz *et al*., 2021 showed that mallard FID values in urban habitats are generally lower than FID in rural habitats where human activity is likely to be much lower. During the breeding season, especially early on during incubation, mallards are known to be disturbed by humans. A literature review by Sinnott (2000) noted that in Montana, breeding mallards were more sensitive to disturbance from pedestrians and cyclists than from vehicles. In Iowa, disturbance from surveyors monitoring the use of artificial nests has been shown to cause a 10% nest abandonment rate (see Korschgen and Dahlgren, 1992 for review). A paper review by Korschgen and Dahlgren (1992) also noted that breeding mallards may be sensitive to disturbance from fishing activity; in Germany, the breeding stock of ducks (including mallard) at two small ponds declined by 85% due to disturbance from anglers and at the Seney National Wildlife Refuge in Michigan, mallards fail to nest in areas open to fishing.

The distribution of overwintering mallards in the UK is known to be strongly influenced by the presence of anglers (Cryer *et al*., 1987); as anglers and wintering ducks are attracted to the same limited areas, human presence can cause feeding or roosting birds to leave the area prematurely (Bell and Austin, 1985) which may have a detrimental effect on energy intake and expenditure (Knapton *et al*., 2000). Wildfowling disturbance on estuaries in the UK is also known to redistribute mallards (Madsen, 1994; Hirons and Thomas, 1993) and this species may congregate in refuge areas during the hunting season (see Sinnott, 2000 for review).

Likely sensitivity to disturbance = Low/Medium

Quantitative information = High agreement & High evidence

Breeding season buffer zone = 50-100m

Nonbreeding season buffer zone ≥ 100m

Mallard is assessed to have a low to medium sensitivity to human disturbance.

The maximum FID value recorded for mallard is 98m when approached by a pedestrian during the breeding season, although generally FID values recorded during the breeding season are less than 50m. The maximum FID value recorded during the nonbreeding season is 400m when approached by a pedestrian, although generally FID values are less than 200m; for motorised watercraft mean FID values of c.100m have been recorded and a range of mean FID values between 18-280m have been recorded for non-motorised watercraft.

In the UK, mallard has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. A buffer zone of 50-100m is suggested to protect nesting birds and a buffer zone ≥ 100m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian and boating disturbance.

Knowledge gaps

Mallard is relatively well studied, although the AD/FID values recorded during the breeding season is limited to one study.

Gadwall, *Anas strepera*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Migrant/Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = at least 1,250-3,200 breeding pairs, 31,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 100-150 breeding pairs, fewer than 150 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

The British breeding population increased by 83% between 1995 – 2010 corresponding with a large range expansion; in Ireland this is still a scarce breeding species (Balmer *et al*., 2013). UK wintering numbers also increased by 312% between 1983/84 – 2008/09 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Gadwall was not included in Ruddock and Whitfield (2007).

Breeding season (Gadwall):

Surveyor walking in Europe: FID = 55m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season (Gadwall):

Pedestrian (general) along the shoreline in England: Min/Max FID = 50 to 60m (n= 2) (Liley *et al*., 2010).

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Mean FID = 65m (Borgmann, 2012).

Motorised watercraft (motorboat) on a lake in Japan: Mean FID = 64.5m (n = 19) (Mori *et al*., 2001).

Nonbreeding season (Groups of dabbling ducks, *Anas* sp. including gadwall, mallard and pintail):

Pedestrian leisure (general) in a range of habitats and locations: Mean FID = 100m (Borgmann, 2012).

Unknown season (Gadwall):

Surveyor walking around a lake in Pakistan: Mean FID = 20m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season (Gadwall):

Commercial vehicle/machine (construction activity in England): Buffer zone = 200m (Wallis *et al*., 2019).

Nonbreeding season (Groups of dabbling ducks, *Anas* sp. including gadwall, mallard and pintail):

Pedestrian leisure boats in a range of habitats and locations: Buffer zone = 108m (Borgmann, 2012).

Ecology and non-quantitative information on disturbance responses

Gadwall is a resident species in the UK but is largely absent across much of Scotland, except in eastern Scotland, the Uists and Orkney (Balmer *et al*., 2013). Much of the current UK breeding population of gadwall is descended from an original breeding stock of wild caught birds at Dersingham Decoy, Norfolk around 1850, since this time the population has spread and now extends throughout much of the lowlands of central, eastern and northwest England (Balmer *et al*., 2013). The preferred habitat of gadwall is in lowland wetland areas that have fairly shallow, standing or slow-flowing open water with cover in the form of emergent vegetation, dry banks and islands; eggs are laid on the ground in a nest that is formed of a slight hollow lined with vegetation (Snow and Perrins, 1998). The increase in the number of reservoirs and particularly gravel pits has aided the spread of this species in Britain (Balmer *et al*., 2013; Briggs *et al*., 2012).

After the breeding season, resident gadwalls are joined by winter migrants from Iceland and the near Continent; the distribution of UK birds is slightly wider during the nonbreeding season compared to the breeding season due to dispersal from natal grounds, more inland sites are used by overwintering birds (Balmer *et al*., 2013) and some passage birds pass through the UK to overwinter in France, Spain and the Mediterranean (Wernham *et al*., 2002). Gadwall is a herbivorous species feeding on aquatic plants, but birds will also occasionally graze on land and eat cereal grains (Snow and Perrins, 1998).

Gadwalls are potentially sensitive to human disturbance, especially in areas where there are high levels of recreational disturbance. In the Netherlands, Platteeuw and Henkins (1997) report that overwintering gadwall and shovelers will often fly away from recreational disturbance (including water sports, anglers and swimmers) “at several hundreds of meters”. A study in a national park the south-eastern Virginia which has a high level of human recreational disturbance indicated that out of seven species of dabbling ducks, gadwall was one of the species most sensitive to disturbance (Pease *et al*., 2005). These sorts of disturbance events can impact activity budgets as gadwalls will spend more time displaying alert activity in areas of disturbance rather than feeding or resting (Paulus, 1984). A study by Briggs *et al*. (2012) found that gadwall can alter their habitat use in response to disturbance; birds have been shown to adjust their site preferences and patterns of site use in response to human disturbance in the southwest London area and consistently avoid areas where there is a high level of disturbance (e.g. water-skiing).

However, gadwall response to human disturbance varies. Mori *et al*. (2001) found that gadwall responded to pedestrian approach at relatively short distances in single-species flocks compared with some other wildfowl species. Conomy *et al*. (1998) found that gadwall were generally not disturbed by aircraft activity in North Carolina.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-200m

Gadwall is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for gadwall when approached by a pedestrian is a mean of 55m during the breeding season and 60m during the nonbreeding season; for motorised and non-motorised watercraft, mean FID values of c.65m have been recorded during the nonbreeding season.

In the UK, gadwall has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. A minimum buffer zone of 100-200m is suggested to protect both breeding and nonbreeding gadwall from pedestrian and boating disturbance.

Knowledge gaps

Further studies are required to record AD/FID during the breeding season. Limited information on buffer zones.

Pintail, *Anas acuta*

Conservation Status

UK: Amber List, Schedule 1

European: Vulnerable

UK status

Resident/Migrant Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 27 breeding pairs, 20,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 20-30 breeding pairs, fewer than 4,000-4,500 (occasionally up to 9,000) individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a weak decrease in breeding birds (-45%) over 25 years.

The small UK breeding population decreased in range by 32% between 1968/72 – 2007/11, the number of confirmed breeding records has also declined (Balmer *et al*., 2013). In contrast, the wintering ranged increased by 34% between 1981/84 – 2007/11, this corresponds with a long-term increase in numbers wintering in Britain since the early 1970s, although there has been a decline since the mid-2000s which may be due to a shift in the core wintering range (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Pintail was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: FID = 34.8m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season:

Pedestrian (general) along the shoreline in England: FID = 100m (n = 1) (Liley *et al*., 2010).

Surveyor walking in a range of habitats Sir Lanka: Mean FID = 49.7 (n = 17); Min/Max FID = 20 to 82m (Gnanapragasam *et al*., 2021).

Nonbreeding season (Groups of dabbling ducks, *Anas* sp. including gadwall, mallard and pintail):

Pedestrian leisure (general) in a range of habitats and locations: Mean FID = 100m (Borgmann, 2012).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 25m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season (Groups of dabbling ducks, *Anas* sp. including gadwall, mallard and pintail):

Pedestrian leisure boats in a range of habitats and locations: Buffer zone = 108m (Borgmann, 2012).

Ecology and non-quantitative information on disturbance responses

Pintail is a rare and localised breeder in the UK, main breeding clusters are located in Orkney, North Uist, Tiree, East Anglian coast and the Ouse Washes with a few isolated records elsewhere (Balmer *et al*., 2013). This species breeds on lowland wetlands which may be on coastlines; the nest (a slight hollow lined with vegetation) is on the ground in short vegetational cover (Snow and Perrins, 1998).

Overwintering pintail in the UK, or those that pass through on migration, come from widely dispersed breeding grounds that include Iceland, Fennoscandia and the Baltic States (Wernham *et al*., 2002). In the UK, wintering pintails aggregate in large numbers at relatively few sites; the Burry Inlet, South Wales and the Welsh Dee Estuary are key sites (Balmer *et al*., 2013). Pintail is an omnivorous species feeding on a wide variety of plant and animal materials (Snow and Perrins, 1998) birds show a preference for feeding in estuaries as well as marshes, floodplains, sheltered coastlands and agricultural areas (Balmer *et al*., 2013). Unlike most ducks, pintail have more nocturnal habits and tend to forage in the evenings or at night and they spend much of the day resting or roosting.

Pintail is potentially sensitive to disturbance. Due to the aggregated distribution of this species, it is vulnerable to localised, stochastic events; recreation/tourism disturbance of staging and wintering pintail is considered of significance in several countries (European Commission, 2007a). Pintails are sensitive to hunting pressures. In Greece, hunting activity can cause mass displacement of ducks from the most important feeding areas; pintails and shovelers may completely stop feeding on shooting days (summarised in Madsen and Fox, 1995). Management of hunting disturbance can influence local distribution and abundance; in Denmark, the establishment of refuge areas where hunting is banned has increased pintail numbers. Maximum counts increased from less than 100 to over 4,000 pintail at a single site (Ulvshale Nyord) (Madsen 1998b).

However, pintails are known to tolerate some human presence. For example, at a study site in Iberia, this species feeds in rice paddies at night and commutes to an adjacent reservoir to roost during the day (Parejo *et al*., 2019). In comparison to other species of dabbling duck, pintail in some situations may have a higher tolerance of human disturbance; a study in a national park in south-eastern Virginia, which has a high level of human recreational disturbance, indicated that out of seven species of dabbling ducks (American black duck, gadwall, mallard, American wigeon, shoveler and green-winged teal), pintail was the least sensitive to disturbance (Pease *et al*., 2005). In another study at a national wildlife refuge in New Mexico, which has high levels of ecotourism, Taylor *et al*. (2019) found that behavioural response to human disturbance depended on the energy reserves of pintail; during a cold winter pintail did not show a significant energetic response to disturbance, therefore the authors suggested that under cold conditions, energy was conserved for short-term survival rather than used to respond to disturbance.

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-200m

Pintail is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for pintail when approached by a pedestrian is a mean of 35m during the breeding season and 100m during the nonbreeding season.

In the UK, pintail has potential to be disturbed on breeding grounds and foraging areas, although human disturbance is more likely on roosting grounds during the nonbreeding season. A minimum buffer zone of 100-200m is suggested to protect both breeding and nonbreeding pintail from pedestrian disturbance.

Knowledge gaps

Further studies are required to record AD/FID during the breeding season. Limited information on buffer zones.

Shoveler, *Anas clypeata*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Migrant Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,100 breeding pairs, 19,500 individuals in winter (Woodward *et al*., 2020); Scottish population = 260-390 breeding pairs, 400-750 individuals in winter, 1,100-1,600 individuals during passage (Forrester *et al*., 2012).

UK long-term trend

The overall range size increased by 36% between 1981/84 – 2007/11, the majority of these gains have been in Britain, particularly in Orkney (Balmer *et al*., 2013). Breeding numbers remained relatively stable between 1968/72 – 2007/11, some fluctuation in distribution is associated with availability of suitable breeding wetlands. Wintering numbers increased by 70% between 1983/84 -2008/09 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Shoveler was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: FID = 28m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season:

Pedestrian (general) along the shoreline in England: Min/Max AD = 30 to 150m (n= 2), Min/Max FID = 15 to 100m (n = 3) (Liley *et al*., 2010).

Motorised watercraft (motorboat) on a lake in Japan: Mean FID = 114.2m (n = 12) (Mori *et al*., 2001).

Nonbreeding season (Australasian shoveler, *Anas rhynchotis*, stand in species for Northern shoveler):

Surveyor walking in a range of habitats in Australia: FID = 19.2m (n = 1) (Weston *et al*., 2012).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 22m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Commercial vehicle/machine (construction activity in England): Buffer zone = 200m (Wallis *et al*., 2019).

Ecology and non-quantitative information on disturbance responses

Shovelers are relatively scarce and local breeders in the UK. This species is largely absent across much of Scotland, except in the central lowlands and in the Uists and Orkney (Balmer *et al*., 2013). Shovelers have a dispersed distribution in southern and eastern England, their preferred habitat is in lowland areas including floodplains, reservoirs and gravel pits with associated wetland areas and some coastal estuaries (Balmer *et al*., 2013; Briggs *et al*., 2012); key breeding sites include the Lower Derwent, Yorkshire and Ouse and Nene Washes (Balmer *et al*., 2013). This species is a ground nesting bird, often on grass or rushes close to water (Snow and Perrins, 1998).

Wintering shoveler ranges are similar to their breeding areas (Balmer *et al*., 2013). Birds wintering in the UK are likely to be a mix of some resident birds and continental breeders, although some UK breeding birds will migrate to overwinter off northwestern Europe and North Africa (Wernham *et al*., 2002).

High overwintering concentrations are found along major waterways such as the Severn Trent, Thames and Great Ouse (Balmer *et al*., 2013). Shovelers are omnivorous and have a specialised bill for filtering water to feed on plankton, molluscs, insects and plant matter (Snow and Perrins, 1998).

Shovelers are potentially vulnerable to human disturbance in their wetland breeding and wintering areas; this species has been shown to alter its habitat use in response to disturbance (Briggs *et al*., 2012). In a study in the southwest London area, Briggs *et al*. (2012) found that wintering shovelers inhabiting inland waterbodies avoided disturbed areas (e.g. those used for recreational watersports) and used alternative sites in the event of isolated disturbance events; shovelers in this area showed a preference for reservoirs with other areas of water nearby which may serve act as alternative refuges in the event of disturbance. Tuite *et al*. (1984) listed wintering shoveler as one of the wildfowl species more susceptible to disturbance from water-based recreational activities on inland waterbodies in England and Wales; the greatest disturbance can be caused by power boating, with coarse fishing, sailing and rowing also important. In the Netherlands, Platteeuw and Henkins (1997) report that overwintering shovelers and gadwall will often fly away from a disturbance event “at several hundreds of meters”. However, other studies suggest that shovelers may be less sensitive to disturbance than other species of duck, especially gadwall, which share similar habitats. Pease *et al*. (2005) found that shovelers showed a strong flight response to human disturbance (e.g. people walking, biking and vehicles), although this was likely because shovelers were often closest to the source of disturbance compared with other species of dabbling duck. A paper review by Korschgen and Dahlgren (1992) noted that breeding shovelers may be sensitive to disturbance from fishing activity; in Germany, the breeding stock of ducks (including shovelers) at two small ponds declined by 85% due to disturbance from anglers.

Shovelers are sensitive to hunting pressures. In Greece, shovelers and pintails may completely stop feeding on shooting days (summarised in Madsen and Fox, 1995) and in Denmark, the establishment of refuge areas where hunting is banned has almost doubled the autumn and winter national totals of shoveler and wigeon (Madsen, 1998b). Shovelers in Denmark usually leave early before the hunting season starts, but the creation of refuges has encouraged some birds to stay in the country for longer (Väänänen, 2001).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-200m

Shoveler is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for shoveler when approached by a pedestrian is a mean of 28m during the breeding season and 100m (AD = 150m) during the nonbreeding season. A mean FID value of 114m has been recorded for shoveler when approached by watercraft during the nonbreeding season.

In the UK, shoveler has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. A minimum buffer zone of 100-200m is suggested to protect both breeding and nonbreeding shoveler from pedestrian and boating disturbance.

Knowledge gaps

Further studies are required to record AD/FID during the breeding season. Limited information on buffer zones.

Eurasian wigeon, *Anas penelope*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 200 breeding pairs, 450,000 individuals in winter (Woodward *et al*., 2020); Scottish winter population = 76,000-96,000 individuals (Forrester *et al*., 2012). Scottish breeding population may have declined since Forrester *et al*. (2012) estimated 240-400 breeding pairs.

UK long-term trend

Changes in breeding distribution suggest a decline in the Scottish uplands and gains in the islands, but there is some uncertainty over changes in breeding numbers (Balmer *et al*., 2013). Winter range expanded by 27% in Britain between 1981/84 – 2007/11, in Ireland there has been a 6% increase in range despite reported declines in numbers since the mid-1990s (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Wigeon was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: Mean FID 9.5m (n = 3) (Jiang and Møller, 2017).

Surveyor walking in an urban habitat in Finland: Range of mean FID = 4 to 4.4m (n = 18), Min/Max FID = 1 to 9m (Díaz *et al*., 2021).

Nonbreeding season:

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median FID = 60m (n = 6), Min/Max FID = 50 to 100m (Liley *et al*., 2011).

Pedestrian (general) along the shoreline in England: Min/Max AD = 30 to 125m (n = 8); Median FID = 75.5m; Min/Max FID = 20 to 100m (n = 22) (Liley *et al*., 2010).

Surveyor walking in Denmark: Mean FID = 269m (n = 42), Min/Max FID = 150 to 1000m (Laursen *et al*., 2005).

Surveyor walking over mudflats in Scotland: Mean FID = 151m (n = 7) (Dwyer, 2010).

Surveyor walking in wetland habitat in Denmark: Range of mean FID = 117 to 205m (n = 5 to 26) (Bregnballe *et al*., 2009).

Surveyor walking in Sir Lanka: Mean FID = 41.5 (n = 2); Min/Max FID = 27 to 56m (Gnanapragasam *et al*., 2021).

Surveyor on motorboat on a lake in Japan: Mean FID = 67.7m (n = 38) (Mori *et al*., 2001).

Non-motorised watercraft (hunting punt) in Denmark: Mean FID = 100m

Non-motorised watercraft (fishing boat) in Denmark: Mean FID = 200m

Non-motorised watercraft (wind surfer) in Denmark: Mean FID = 700m

(Fox and Madsen, 1997).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 230m (Laursen *et al*., 2017).

Non-motorised watercraft (motorboat) in nearshore waters off Denmark: Mean FID = 250m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 500m (Laursen *et al*., 2017).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 36m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Pedestrian walking/running around Strangford Lough in Ireland: Buffer zone = 250m (Mathers *et al*., 2000).

Commercial vehicle/machine (construction activity in England): Buffer zone = 200m (Wallis *et al*., 2019).

Ecology and non-quantitative disturbance responses

In the UK, Eurasian wigeon is an uncommon and localised breeder on lowland freshwater areas; the main breeding areas are in northern Scotland (Fife to the eastern Highlands north to Sutherland and Caithness, the Northern Isles and the Uists), as well as in the Pennines in England (Balmer *et al*., 2013). This species breeds under the cover of coniferous or deciduous wooded areas, close to or potentially fairly distant from water (Snow and Perrins, 1998).

During the nonbreeding season, wigeons are much more widespread around the UK; resident breeders are joined by overwintering birds from Iceland, Fennoscandia and Russia and have a preference for coastal areas (Balmer *et al*., 2013). The highest concentrations of wintering wigeon are recorded in the Northern Isles, inner Moray Firth, parts of central Scotland, large river valleys and estuaries in southern and eastern England as well as lakes in the west midlands of Ireland (Balmer *et al*., 2013). During the nonbreeding season, wigeons generally roost on the coast close to feeding grounds. Wigeon are vegetarian feeding on a diet of leaves, stems and roots (Snow and Perrins, 1998). This species can feed both during the day and night; where the feeding grounds are subject to daytime disturbance the birds may spend the day on the roost (Owen and Williams, 1976).

In a study at Strangford Loch, North Eastern Ireland, Mathers *et al*. (2000) record that overwintering wigeons are sensitive to human disturbance (particularly walking pedestrians) while foraging which is limited by tidal patterns; the study concluded that disturbance could have contributed to the decline of wigeon in Strangford Loch, although it is probably not the only factor involved. Wigeons are vulnerable to hunting disturbance, Madsen and Fox (1995) report that mobile shooting punts can cause greater disturbance than stationary ones; wigeons disturbed for a second time by a mobile punt took 168 minutes to resume feeding whereas fishing boats caused 20 minutes of disturbance. As wigeons can spend most of the daylight hours foraging during the autumn and winter, Madsen and Fox, (1995) note that birds can lose up 25% of foraging time on days with repeated disturbance. On the Exe Estuary, Fox *et al*. (1993) noted that just one disturbance incident at the wrong time can deter birds from feeding until the next tidal cycle.

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 200-500m

Eurasian wigeon is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for wigeon when approached by a pedestrian is a mean of 9.5m during the breeding season and a mean of 269m (max FID = 1000m) during the nonbreeding season, although generally, mean FID values recorded for pedestrian disturbance are less 200m. Mean FID values recorded for wigeon when approached by watercraft during the non-breeding season range from 100 to 700m.

In the UK, wigeon has the potential to be disturbed on breeding grounds, although human disturbance is more likely on roosting and foraging grounds at the coast during the nonbreeding season. A buffer zone of 100-200m is suggested to protect nesting wigeon and a buffer zone of 200-500m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian and boating disturbance.

Knowledge gaps

Few studies specify habituation to disturbance when recording AD/FID during the nonbreeding season.

Greater scaup, *Aythya marila*

Conservation Status

UK: Red List; Schedule 1

European: Least Concern

UK status

Scarce Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 0-1 breeding pairs, 6,400 individuals in winter (Woodward *et al.*, 2020); Scottish population = 4,000-8,000 individuals in winter (Forrester *et al.*, 2012).

UK long-term trend

Scaup population has weakly declined since a massive decline in Scottish wintering population in 1970s (Balmer *et al*., 2013; Forrester *et al*., 2012). The winter range did expand by 57% between 1981/84 – 2007/11, but numbers in Britain have generally declined since 1970, although numbers in Northern Ireland have shown a large increase (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Greater scaup was not included in Ruddock and Whitfield (2007).

No AD/FID distance available for scaup

Breeding season (pochard, *Aythya ferina*, stand in species for scaup):

Surveyor walking in a rural habitat in Denmark: FID = 10m (n = 1) (Díaz *et al*., 2021).

Breeding season (tufted duck, *Aythya fuligula*, stand in species for scaup):

Surveyor walking in a rural habitat in Denmark: FID = 10.7m (n = 34), Min/Max FID = 8 to 14 (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Finland: FID = 28m (n = 2), Min/Max FID = 26 to 30 (Díaz *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season (Scaup):

Surveyor walking around inland waterbodies in the USA: Mean MAD = 146.4m (Trulio and White, 2017).

Watercraft (recreational boating) along the Mississippi river in the USA: Buffer zone = 450m (Havera *et al*., 1992).

Ecology and non-quantitative disturbance responses

In the UK, greater scaup is a very scarce breeder. This species mainly breeds on Arctic and sub-Arctic tundra; the breeding range in Europe stretches from western Siberia through European Russia to northern Fennoscandia and Iceland (Balmer *et al*., 2013; Wernham *et al*., 2002). In the past there have been several breeding records in Scotland particularly in base-rich or brackish waters in Orkney and the Outer Hebrides, but none since at least 1989 (Forrester *et al*., 2012; Snow and Perrins, 1998). The last confirmed breeding record was in Ireland (Co. Armagh) in 1999 (Balmer *et al*., 2013).

In the nonbreeding season, greater scaup winter on shallow coastal waters generally less than 10m deep (especially in the vicinity of sewage outlets), as well as sheltered bays, estuaries and brackish waters; it can also be found inland on large lakes and reservoirs (Snow and Perrins, 1998). The greatest numbers of wintering birds are found along the coast of northern and western Britain as well as northeastern and southwestern Ireland, wintering strongholds include the Dee, the Solway Firth, Loch Ryan, Ayrshire coast, Islay, the Firth of Forth and the Moray Firth and Lough Neagh (Balmer *et al*., 2013). Scaup are omnivorous feeding predominantly on molluscs (Snow and Perrins, 1998) mainly at night and they tend to flock together to roost on the sea during the day (Marchowski *et al*., 2015; Rare Breeding Birds Panel, 2020a).

The number of wintering scaup in the EU underwent a very large decline (> 50%) between 1990-2000, the reasons for this decline are largely unknown, but human disturbance is suspected to be important (European Commission, 2009). Increased disturbance from recreational activities from 1990 onwards may have reduced the amount of available wintering habitats, especially daytime roosts (European Commission, 2009). In the UK, human disturbance has been identified as one of the key threats to this species (Furness, 2016) and scaup at sea have been identified as having a high vulnerability to disturbance by boats (Furness *et al*., 2013). Mendel *et al*. (2008) has also identified scaup as highly sensitive to human disturbance and boat activity in coastal areas. During migration to and from breeding grounds, Knapton *et al*. (2000) found that mixed species flocks of diving ducks, including greater scaup, feeding on staging grounds at Lake Erie in North America, are frequently disturbed by human activity. Havera *et al*. (1992) suggest that during spring and autumn migration, minimum buffer zones of 450m should be used to protect rafting diving ducks from boating activity.

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Limited evidence

Nonbreeding season buffer zone = 150-450m

Scaup is assessed to have a high sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for greater scaup. Studies measuring FID on other *Aythya* species (pochard and tufted duck) suggest that flushing distance is relatively low (<50m) during the breeding season and a buffer zone of 450m has been reported to protect migrating scaup from watercraft disturbance.

In the UK, scaup has the potential to be disturbed on roosting and foraging grounds at the coast during the nonbreeding season. Due to the scarcity of breeding scaup in the UK, this species is unlikely to be encountered on breeding grounds by humans. A buffer zone of 150-450m is suggested to protect roosting and foraging scaup during the nonbreeding season from pedestrian and boating disturbance.

Knowledge gaps

Lack of studies providing AD/FID for a range of disturbance types during the nonbreeding season.

Common eider, *Somateria mollissima*

Conservation Status

UK: Amber List

European: Endangered

UK status

Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 37,000 breeding pairs, 86,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 20,000 nesting females, 64,500 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

The distribution of breeding eiders has changed in the UK over the last 50 years. The breeding population increased in northwest Wales, Morecambe Bay and the Isle of Man between 1968/72 – 2007/11; in Northern Ireland, the population was ten times greater between 1977 – 2009 (Balmer *et al*., 2013). However, in western Scotland and Shetland, the population size and range has decreased (possibly as a result of predation, conflict with mussel farms and oil-pollution); declines in breeding numbers have also been noted elsewhere in Europe (Balmer *et al*., 2013). The overall winter range size has remained largely unchanged between 1981/84 – 2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Common eider was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: Mean FID = 51.3m (n = 4) (Jiang and Møller, 2017).

Surveyor walking towards nest site in the Canadian Arctic: Mean FID = 16m (n = 69), Max FID = 70m (Mallory, 2016).

Nonbreeding season:

Motorised watercraft (high speed ferry service route) in the southern Kattegat Sea, Denmark: Min/Max FID = 0 to 1000m (n = 969) (Larsen and Laubek, 2005).

Motorised watercraft (large commercial fishing ship) in the German North Sea: Median FID = 208m (n = 154), Maximum FID = 3200m (Schwemmer *et al*., 2011).

Motorised watercraft (surveyor approaching moulting eiders in a motorboat) in nearshore waters around Norway: Mean AD = 330m (n = 48), Min/Max AD = 150 to 600; Mean FID = 177m (n = 48), Min/Max FID = 30 to 400m (Dehnhard *et al*., 2020).

Aircraft (helicopter) flying over males and nonbreeding females close to a gravel runway in the Canadian Arctic: Mead FID = 500m (Mallory, 2016).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Motorised watercraft (motorboat) around small offshore islands in Sweden: Buffer zone = 200m (Gotmark *et al.,* 1989).

Ecology and non-quantitative information on disturbance responses

Eiders are seaducks associated with marine habitats during both the breeding and nonbreeding seasons; UK breeding birds are at the southernmost edge of the species' Arctic range (Wernham *et al*., 2002). In the UK, breeding eiders are mainly recorded around the coast in northern areas including: most of Scotland, northern England, Isle of Man, North Wales and Northern Ireland (Balmer *et al*., 2013). This ground nesting species favours shoreline habitats and islands, but some birds are known to nest up to 3km inland (Snow and Perrins, 1998). The nest is composed of a slight hollow lined with available material, and large quantities of small feathers and down, and is often under the shelter of a rock or vegetation (Snow and Perrins, 1998).

Eiders in the UK are generally sedentary or disperse only short distances between breeding and nonbreeding grounds. During the nonbreeding season, birds located in eastern coastal areas may be joined by some overwintering continental eiders (Wernham *et al*., 2002). In the winter, eiders may be found around much of the coastline of Britain with the exception of the Solway Firth, Cardigan Bay and the Bristol Channel; the highest concentrations are to be found in northern areas (Balmer *et al*., 2013). All year round, eiders feed very close to the coast in water up to 3m deep, primarily on molluscs and crustaceans (Snow and Perrins, 1998), although this species roosts in open water away from feeding areas in shallow water (Merkel and Mosbech, 2008) where they are less likely to be disturbed.

Common eiders are able to habituate to some types of human activity (e.g. pedestrians and aircraft) and this species can tolerate relatively high levels of human disturbance. During the breeding season, incubating female eiders can sit tightly on the nest, for example, on Craigleith Island in Scotland, some females will allow pedestrian approach to within 1-2m before flushing, although other individuals will flush at a greater distance (Goodship 2021, *pers. obs.*). On the Mingan archipelago in Canada, Bolduc and Guillemette (2003) found that eider nesting success was not impacted by the frequency of human visitors, but the timing of visits was important to avoid exposing eggs to predators. In Norway, Stein and Ims (2016) have shown that the absence of eiders from nests due to human disturbance can increase egg predation risk by a factor of 6.42 for an increase of one additional daily disturbance. Bolduc and Guillemette (2003) suggested that researchers and wildlife managers should visit eider colonies as late as possible and avoid visiting colonies associated with high densities of eider egg predators. On Nasaruvaalik Island in the Canadian High Arctic, Mallory (2016) found that female eiders breeding next to a gravel runway allowed the wings of an aircraft to pass over them while still remaining on the nest. Dierschke *et al*. (2016) have found that the presence of offshore wind farms does not affect eider distribution.

However, boating activity, particularly boats that are moving quickly through eider foraging, roosting and moulting areas, have been shown to cause disturbance. In a study on wintering eider in southwest Greenland, Merkel *et al*. (2009) found that disturbance from boats could reduce foraging activity by up to 60% on a daily basis; eiders attempted to compensate for lost feeding opportunities by feeding more often, moving to sub-optimal foraging locations and switching to night-time feeding. Responses to boats may be especially strong in Greenland because this species is hunted from boats there. Jarrett *et al*., 2018 found that eider flight activity increases in the presence of marine activity including slow vessels/craft (including motorised and non-motorised boats for pleasure and commercial activities) and fast powerboats. The same authors found that eiders have a very low response rate within the 200-300m distance band from a passing ferry (eiders favour swim responses over flight or dive responses) and that the likelihood of eider flying away from passing ferries increased strongly in rougher sea states (Jarrett *et al.*, 2018). In Norway, Dehnhard *et al*. (2020) found that boats disturbed moulting eiders resulting in displacement up to 771m; although most flocks returned to pre-disturbance behaviour within 10 mins after the disturbance event, the authors suggested that disturbance from boats increased locomotion costs, displacement from accessible foraging habitat and/or time lost for foraging or resting.

Likely sensitivity to disturbance = Medium/High

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 200-500m

Common eider is assessed to have a medium to high sensitivity to human disturbance.

FID values for eider are wide ranging. The maximum FID value recorded for eider is 70m when approached by a pedestrian during the breeding season and 3.2km when approached by a large commercial fishing boat during the nonbreeding season. For motorised watercraft in nearshore waters, a maximum FID of 400m has been recorded during the nonbreeding season. A buffer zone of 200m has been reported to protect breeding eider from watercraft disturbance.

In the UK, eider has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. A buffer zone of 100-200m is suggested to protect nesting eider and a buffer zone of 200-500m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance as well as disturbance from watercraft in nearshore waters.

Knowledge gaps

More studies required to record AD/FID during the breeding season and for pedestrian activity on the beach during the nonbreeding season.

Common scoter, *Melanitta nigra*

Conservation Status

UK; Red List; Schedule 1

European: Least Concern

UK status

Resident/Migrant Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 52 breeding pairs in Scotland, 135,000 individuals in winter (Woodward *et al*., 2020); Scottish winter population = 25,000-30,000 individuals (Forrester *et al*., 2012). Scottish breeding population has declined since Forrester *et al*. (2012) estimated 95 breeding pairs.

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (-22%) over 25 years.

Breeding numbers have decreased in Scotland and Ireland since 1995/1999. The breeding population in Northern Ireland became extinct in 1993 (Balmer *et al*., 2013). The winter range expanded by 39% in Britain and Ireland between 1981/84 and 2007/11.

AD/FID

Quantitative disturbance distances

FID update (Schwemmer *et al*., 2011) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Scotland: Min/Max FID (incubating female) =c.2 to 20m (Dr L. Griffin, pers. obs.).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 40 to 310m (n = 2); Min/Max AD (80% opinion range) = <10 to 500m; Min/Max AD (90% opinion range) = 300 to 500m.

Range of median FID = 5 to 125m (n = 3); Min/Max FID (80% opinion range) = <10 to 300m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Motorised watercraft (large commercial ship) in the German North Sea: Median FID = 804m (n = 210), Maximum FID = 3200m (Schwemmer *et al*., 2011).

Motorised watercraft (high speed ferry service route) in the southern Kattegat Sea, Denmark: Min/Max FID = 0 to 1000m (Larsen and Laubek, 2005).

MAD and/or

Buffer zone

Quantitative distances

No buffer zone update published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 300 to 800m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative disturbance responses

The majority of common scoters breed in tundra habitats near freshwater bodies (Snow and Perrins, 1998). In the UK, this species only breeds in Scotland, where it is restricted to the Flow Country of Caithness and Sutherland, larger lochs in Inverness-shire and Perthshire, and to a few scattered loughs in western Ireland (Balmer *et al*., 2013). Most breeding sites are in remote moorlands where birds nest on the ground in long heather at least 10m from the water's edge, but at Loch Lomond and on Islay this species breeds on wooded islands (Snow and Perrins, 1998; Thom, 1986). The diet of common scoter is mainly molluscs which are obtained by diving, but in fresh water habitats this species will also feed on aquatic insects and fish eggs as well as occasionally small fish and seeds (Snow and Perrins, 1998).

Due to the low numbers of breeding common scoters in Scotland and the remote habitats in which they are found, the potential for disturbance from human recreational activities during the breeding season is limited, however, connectivity of breeding sites for human access (by tracks and roads) and forestry activity around breeding lochs will increase the potential disturbance risk for this species. Common scoters are known to be strongly site faithful and may continue to attempt breeding at historical sites despite an increased risk of human disturbance (Robson, 2017).

Common scoters are considered to be sensitive to human disturbance during the breeding season, but the level of sensitivity of individual birds likely depends on the stage of the breeding cycle as well as exposure to and ability to cope with human presence; birds nesting in more remote areas may be more sensitive to disturbance. In breeding lochs in Scotland (west Inverness-shire, Perthshire and Islay), it has been noted that incubating female common scoters will mostly sit tight when approached by a surveyor (moving slowly and quietly) to a distance of c.2-5m, although females incubating at nests on islands or mainland heaths are sometimes more "jumpy” and will leave the nest when approached to within c.10-20m (L. Griffin, pers. comm.). Some individuals appear to be highly tolerant of human disturbance; in Islay, a common scoter has been noted to remain at the nest within 20-40m of noisy fishing and pedestrian activity (e.g. talking loudly, getting in and out of boats and picnicking activity), the same bird even allowed a surveyor to fit a camera at the nest and instead of flushing, pecked the surveyor on the hand (L. Griffin, pers. comm.).

The distance at which female common scoter will return to a nest also varies between individual birds. Generally, females will not return until people are at least c.100-200m distant from a nest, but this distance is greater if the nest is in a remote location. In areas where birds may be habituated to people, female common scoter will return to nests at shorter distances; for example, on an island in Loch Garry that is near a regular fishing/camping location and a fish farm jetty, females have been noted to return to nests within 50-70m, although they often access the island on the side away from the sight of people (L. Griffin, pers. comm.). Human activity taking place between foraging areas and nest sites may prolong common scoter returning to their nests. At Loch Gorm on Islay, it has been noted that boats present on the loch or people fishing from the shore may delay foraging common scoter on the loch from returning to their nest on the heathland. Birds disturbed in this way have been observed to fly over their nests but not land, or they may carry on feeding for longer until the source of disturbance has gone. However, the severity of this kind of disturbance is difficult to judge, as common scoter may forage for between one and six hours, and birds may not resettle on their nests even when there is no apparent source of disturbance (L. Griffin, pers. comm.).

Foraging and resting common scoter present on freshwater lochs have been noted to be relatively tolerant of human presence and tend to flush only if a boat approaches rapidly and straight at the birds or makes a sudden appearance from behind an island etc. Common scoters have been observed to continue foraging within c.50-300m of boats and anglers on the bank, but this distance depends on how loud the agents of disturbance are and whether or not the disturbance is from one or multiple directions (L. Griffin, pers. comm.). Common scoter further away may be inquisitive and are known to approach slow moving boats, but if bird watchers with scopes for example approach to within <100m, common scoters tend to gently move a bit further away by "swim-feeding" (L. Griffin, pers. comm.).

Outside the breeding season, common scoter is rarely seen on land. Although this species may use freshwater lakes on migration, the majority of birds moult and overwinter at sea. They are present around much of the UK coastline, although patchily distributed in western Scotland and northwest Ireland (Balmer *et al*., 2013). The highest wintering concentrations are recorded in the Moray Firth, the coast from Angus south to County Durham, off Norfolk, Carmarthen Bay and the Irish Sea and off the South West coast of Ireland (Balmer *et al*., 2013). During the winter, common scoters roost communally at sea; they also periodically loaf on water during the day and, rarely, on islets or sandbanks (Cramp and Simmons, 1977).

Due to their distance from land during the nonbreeding season, the potential for human recreation disturbance is limited. However, common scoter is known to be particularly sensitive to human activities in marine areas including through the disturbance effects of ship and helicopter traffic (Garthe and Hüppop, 2004; Schwemmer *et al.*, 2011; Furness *et al*., 2013; Furness and Wade, 2012; Bradbury *et al.,* 2014; Kaiser *et al*., 2006). Common scoter may flush from boats that are over 3km away (Schwemmer *et al.*, 2011) and this species is likely to be at risk of disturbance or displaced from habitats as a result of offshore wind turbines (Furness *et al*., 2013). Dierschke *et al*. (2016) reviewed all available evidence from operational offshore wind farms on the extent of displacement or attraction of seabirds in relation to these structures; a weak avoidance of offshore wind farms was noted for common scoter and velvet scoter (*Melanitta fusca*).

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 300-500m

Common scoter is assessed to have a high sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for common scoter, but the maximum FID value recorded for this species is 3.2km when approached by commercial shipping during the nonbreeding season. Although there are no official AD/FID values recorded for breeding common scoter, Dr Larry Griffin has personally noted that incubating female common scoter will flush from a nest when approached by a surveyor at a maximum approximate distance of 20m and that foraging birds on freshwater lochs will keep a maximum distance of 300m away from quiet boats and pedestrians. Ruddock and Whitfield (2007) recommended that a buffer zone of 300 to 500m would be required to prevent flushing from the nest during the breeding season.

Buffer zone to protect common scoter from forestry operations in the UK range from 300 to 800m during the breeding season.

In the UK, common scoter has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-500m is suggested to protect nesting common scoter during the breeding season from pedestrian and boating (on breeding lochs) disturbance. For activities with a high potential for visual and audial disturbance (e.g. forestry operations), a buffer zone ≤800m may be necessary. In marine areas during the nonbreeding season, a large buffer zone between 1 to 4km may be necessary to protect foraging and roosting birds from shipping disturbance.

Knowledge gaps

Lack of studies recording AD/FID during the breeding season.

Common goldeneye, *Bucephala clangula*

Conservation Status

UK: Red List; Schedule 1–Part II

European: Least Concern

UK status

Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 200 breeding pairs, 21,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 150 breeding pairs, 10,000-12,000 in winter (Forrester *et al*., 2012).

UK long-term trend

UK breeding numbers increased from 13 to 38 between 1988/91 – 2007/11 and included colonisation of Perthshire and Aberdeenshire (Balmer *et al*., 2013). Wintering numbers have remained relatively stable between 1981/84–2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021; Laursen *et al*., 2017; Borgmann, 2012; Liley *et al*., 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Norway: FID = 18m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Norway: Mean FID = 10.4m (n = 5); Min/Max FID = 6 to 22m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Finland: FID = 40m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Finland: FID = 4m (n = 1) (Díaz *et al*., 2021).

Surveyor walking up to a nest box in Canada: Min/Max FID = 0.1 to <16m (Mallory *et al*., 1998).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 5 to 125m (n = 4 to 5); Min/Max AD (80% opinion range) = <10 to 300m; Min/Max AD (90% opinion range) = 150 to 300m.

Range of median FID = 5 to 75m (n = 5 to 8); Min/Max FID (80% opinion range) = <10 to 150m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Pedestrian (general) along the shoreline in England: Min/Max AD = 75 to 100m (n = 3); Min/Max FID = 75 to 150m (n = 4) (Liley *et al*., 2010).

Pedestrian walking/running on Cannock Reservoir, England: Min/Max FID = 100 to 200m (Hume, 1976).

Non-motorised watercraft (sailing boat) on Cannock Reservoir, England: Min/Max FID = 350 to 400m (Hume, 1976).

Non-motorised watercraft (Sailing dinghy) on Brent Reservoir, England: Min/Max FID = 300 to 400m (Batten, 1977).

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Mean FID = 37m (Borgmann, 2012).

Non-motorised watercraft (sailing dinghy) in nearshore waters off Denmark: Min/Max FID = 300 to 400m

Non-motorised watercraft (rowing boat) in nearshore waters off Denmark: Mean FID = 360m

Non-motorised watercraft (sailing boat) in nearshore waters off Denmark: Mean FID = 360m

Non-motorised watercraft (kite surfer) in nearshore waters off Denmark: Mean FID = 740m

Motorised watercraft (motorboat) in nearshore waters off Denmark: Mean FID =640m

Motorised watercraft (jet-ski) in nearshore waters off Denmark: Mean FID = 765m, Min/Max FID = 700 to 830m

(Laursen *et al*., 2017).

Motorised watercraft (motorboat) on Cannock Reservoir, England: Min/Max FID = 550 to 700m (Hume, 1976).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Borgmann, 2012) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian (general): Buffer zone around active nests = 100-150m (Ruddock and Whitfield, 2007).

Forestry operations in the UK: Safe working distance = 150 to 300m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Nonbreeding:

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Buffer zone = 163m (Borgmann, 2012).

Ecology and non-quantitative disturbance responses

In Scotland, confirmed goldeneye breeding records are concentrated in Strathspey, Great Glen, River Dee and around Loch Tay; in England, confirmed breeding has been recorded in Northumberland and Avon (Balmer *et al*., 2013).

Goldeneye is a cavity nesting species with a preference for habitats around freshwater lakes, pools, rivers and deep marshes; this species will readily breed in nest boxes (Snow and Perrins, 1998; Dennis and Dow, 1984; Mallory and Weatherhead, 1993; Mallory *et al*., 1998). This species feeds during the daytime primarily on molluscs, crustaceans and insect larvae depending upon locality and season (Snow and Perrins, 1998). During the breeding season goldeneyes exhibit relatively low to moderate flushing distances in response to human disturbance, likely in part due to the lack of visual stimuli inside cavities (Ruddock and Whitfield, 2007; Mallory and Weatherhead, 1993; Mallory *et al*., 1998). In a study in Canada investigating female goldeneye nest defence, Mallory *et al*. (1998) found that 43% of female goldeneyes waited until the observer was on the tree before flushing and that this species flushed at closer distances as incubation proceeded. In Europe, Díaz *et al*. (2021) recorded low flushing distances (4 to 40m) in response to disturbance from a surveyor walking in the breeding season.

In the nonbreeding season, resident breeding goldeneye are joined by overwintering birds from Fennoscandia and Russian breeding grounds; they have a preference for coastal areas and a wide variety of freshwater habitats (Balmer *et al*., 2013). This species is widely distributed throughout Scotland and northern England with the exception of some upland areas; further south, winter distribution is patchy and focussed on suitable coastal areas, river valleys and wetland habitats (Balmer *et al*., 2013), they may also be found in the vicinity of sewage outfalls (Campbell and Milne, 1977). Goldeneye can be a gregarious flocking species, congregating at communal roost sites overnight (Snow and Perrins, 1998). Separate to their feeding grounds, goldeneyes roost on open water at the coast, on standing water or on rivers (Duncan and Marquiss, 1993). In some foraging and roosting areas goldeneye may be susceptible to human disturbance, especially from water-based leisure activities such as fishing and boating (e.g. Laursen *et al*., 2017; Tuite *et al*., 1984; Holloway, 1997; Hume, 1976; Campbell and Milne, 1977); disturbance from motorised watercraft can cause goldeneyes to flush over 800m away (Laursen *et al*., 2017). Goldeneye can also be sensitive to hunting pressures particularly during the winter when food may be scarce; in Ireland Evans and Day (2002) recorded that goldeneye moved away from the disturbed shorelines of Lough Neagh where hunting took place to central, relatively less disturbed areas of the Lough. In the Netherlands, Platteeuw and Henkins, 1997 considered goldeneye to be a particularly shy species, although goldeneye are generally not found in areas with high densities of recreation. However, not all wintering grounds are disturbed by human activity; in Orkney, goldeneye is largely present in very sheltered areas and inland lochs where marine activity is unlikely and therefore this species rarely comes into contact with marine activity in Orkney (Jarrett *et al*., 2018).

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Medium evidence

Breeding season buffer zone = 100-150m

Nonbreeding season buffer zone = 150-800m

Common goldeneye is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for goldeneye when approached by a pedestrian is 40m during the breeding season and 200m during the nonbreeding season. For non-motorised watercraft mean FID values ranging between 37 to 740m have been recorded and mean FID values between 640 to 765m (max FID = 830m) have been recorded for motorised watercraft.

There are few suggested buffer zones for goldeneye. Ruddock and Whitfield (2007) suggested that a buffer zone of 100 to 150m would be required to prevent flushing from the nest during the breeding season. In the nonbreeding season, Borgmann, (2012) suggested a buffer zone of 163m to protect birds from non-motorised watercraft disturbance, but a larger buffer zone may be required for noisy activities in heavily disturbed areas.

In the UK, goldeneye has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; as a hole nesting species, goldeneye may be less likely to be disturbed when on the nest. A buffer zone of 100-150m is suggested to protect nesting goldeneye and a buffer zone of 150-800m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian and boating disturbance.

Knowledge gaps

More studies required to record AD/FID during the breeding season and for pedestrian activity on the beach during the nonbreeding season.

Species: Grouse

Capercaillie, *Tetrao urogallus*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern, Annex 1

UK status

Re-introduced Breeder

UK and Scottish population estimate

Scottish population only = 1,100 individuals in winter (Woodward *et al*., 2020); Forrester *et al*. (2012) suggest 300 lekking males in early 2000s, and a winter population of 1,300 to 2,800 individuals.

UK long-term trend

Eaton *et al*. (2021) state a strong decrease in breeding birds (-49%) over 22 years.

There was a 55% decrease in the number of occupied 10 km squares between 1981-84 and 2008-11 (Balmer *et al*., 2013). The population declined from about 20,000 birds in the 1970s, but declines have been partially mitigated in some areas by predator control and removal of fences on which collisions were occurring (Forrester *et al*., 2012).

AD/FID

Quantitative disturbance distances

FID update (Jiang and Møller, 2017; Thiel *et al*., 2007; Catt *et al*., 1998) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: FID 77.5m (n = 1) (Jiang and Møller, 2017).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD for nesting females = 75m (n = 15); Min/Max AD (80% opinion range) = <10 to 150m; Min/Max AD (90% opinion range) = 100 to 150m.

Range of median FID for nesting females = 5 to 30m (n = 16); Min/Max FID (80% opinion range) = <10 to 100m.

Median AD for lekking males = 125m (n = 9); Min/Max AD (80% opinion range) = 100 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Median FID for lekking males = 75m (n = 7); Min/Max FID (80% opinion range) = 50 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Pedestrian (general) in a forest habitat in Europe: Mean FID = 27m (n = 752); Min/Max FID = 1 to 104m (Thiel *et al*., 2007).

Surveyor walking in a forest habitat in Scotland: Mean FID for males = 46m (n = 39)

Surveyor walking in a forest habitat in Scotland: Mean FID for females = 30m (n = 35)

(Catt *et al*., 1998).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Coppes *et al*., 2017; Thiel *et al*., 2007) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian leisure activity in forest land in Germany: Buffer zone = 800m (Coppes *et al*., 2017).

Forestry operations and recreational activities in Scotland:

Buffer zone for nests and broods = 100m

Forestry operations and recreational activities in Scotland:

Buffer zone for leks = 1000m

Buffer zone around leks for stalkers = 500 to 1000m (Kortland, 2006).

Forestry operations in the UK: Safe working distance = 200 to 800m (Currie and Elliot, 1997).

Forestry operations in Scotland: Safe working distance = 200 to 1000m (Forestry Commission Scotland, 2006).

Nonbreeding season:

Pedestrian (general) in a forest habitat in Europe: Buffer zone = 100m (Thiel *et al*., 2007).

Pedestrian leisure activity in forest land in Germany: Buffer zone = 800m (Coppes *et al*., 2017).

Ecology and non-quantitative disturbance responses

Capercaillie is a resident upland woodland species confined to pine forests in the north of Scotland (Balmer *et al*., 2013; Forrester *et al*., 2012). The main areas for this species include Easter Ross, Strathspey and Aberdeenshire, with only a few occupied sites outside of these areas; birds are largely sedentary, breeding and nonbreeding distribution ranges are similar (Balmer *et al*., 2013). Individual capercaillie normally use the same areas of summer and winter habitat in the same forest each year (Kortland, 2006). Mature conifer forests are typically used, especially Scots pine, open enough to support ground vegetation rich in dwarf shrubs (Forrester *et al*., 2012). Capercaillie is generally a ground nesting species, feeding on the ground in summer and mainly in the crowns of trees during winter (Snow and Perrins, 1998). Adults feed on plants including leaves, needles, stems, berries, mosses and rushes depending on the season; young chicks feed mostly on insects and spiders (Snow and Perrins, 1998). In winter, capercaillie live mostly in trees and eat conifer needles (Kortland, 2006).

Capercaillie populations in Scotland have declined significantly in the last 40 years. Reasons for the decline include loss of suitable habitat, unfavourable woodland management, climate change, predation, collisions with deer fences as well as disturbance (Kortland, 2006).

There is an increasing body of research that indicates that capercaillie stay away from areas where there is human activity. For example, in a study in the Spey valley in Scotland, Moss *et al*. (2014) investigated the impacts of human disturbance on capercaillie through the distribution of their droppings in relation to woodland tracks and entrances; droppings were found to be sparser within 300 to 800m of entrances and 70 to 235m of tracks, depending on track use and habitat. Moss *et al*. (2014) estimated that disturbance along the tracks deterred capercaillie from a belt of ground at least 140m wide and up to 470m long where people and dogs strayed off tracks. In another study by Summers *et al*. (2007) in the Cairngorms National Park, capercaillie avoided areas within 61 to 108m of public access tracks, the range being dependent on the level of pedestrian activity along the track. Capercaillie consistently disturbed away from foraging grounds may have fat reserves to survive only nine days (Hissa *et al*. (2003)). Kortland (2006) states that capercaillie can become habituated to predictable disturbance and will use habitat within 100m of tracks provided there is abundant screening and if walkers remain on the tracks; Kortland (2006) also states that if people or their dogs wander off tracks, capercaillie will stop using the areas where this happens.

The Capercaillie Biodiversity Action Plan Group (CBAPG) is responsible for implementing the Species Action Plan for Capercaillie on behalf of the UK Biodiversity Partnership. The current forest management for capercaillie builds on the Capercaillie Life project, which ran from 2002-2007 (Kortland, 2006). As recommended in Ruddock and Whitfield (2007), the guidance and management plans provided by the CBAPG should be followed in the UK. For survey work, NatureScot’s guidance on capercaillie survey methods should be followed (NatureScot, 2013).

Likely sensitivity to disturbance = Medium/High

Quantitative information = Medium agreement & Medium evidence

Breeding season (Nesting females) buffer zone = 100m

Breeding season (Lekking males) buffer zone = 500-1000m

Nonbreeding season buffer zone = 100m

Capercaillie is assessed to have a medium to high sensitivity to human disturbance.

The maximum FID value recorded for capercaillie when approached by a pedestrian is a mean of 77.5m during the breeding season and a mean of 46m (max FID = 104m) during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for capercaillie during the breeding season is 100-150m for nesting females and 500-750m for lekking males. Buffer zones to protect capercaillie during the breeding season from pedestrian activity and forestry operations range from 800 to 1000m; during the nonbreeding season, buffer zones range from 100 to 800m.

The data presented in this report are broadly consistent with the buffer recommendations detailed in the forest management guide for capercaillie issued by the CBAPG. The CBAPG recommends that forestry operations and known recreational activities etc should be avoided within 1km of lek sites between 1 March and 15 May. Deer control work is acceptable within 1km of leks between 1 March and 15 May, however, stalkers must stay at least 500m from lek sites between 4am and 9am. An exclusion zone of 100m must be used to prevent disturbance to nests and broods. Pedestrian disturbance must be avoided within 100m from tracks when passing though capercaillie habitat.

In the UK, capercaillie has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season. The CBAPG recommends that a buffer zone of 500-1000m is used to protect leks and a buffer zone of 100m is used to protect nesting females to avoid pedestrian disturbance during the breeding season. Pedestrians should stick to paths when walking though capercaillie habitat at all times of the year and it is suggested that capercaillie habitat should not be disturbed within 100m.

Knowledge gaps

Lack of studies measuring AD/FID for pedestrian activity during the nonbreeding season.

Black grouse, *Tetrao tetrix*

Conservation Status

UK: Red List

European: Least Concern

UK status

Resident Breeder

UK and Scottish population estimate

UK population = 4,850 lekking males (Woodward *et al*., 2020); Scottish winter population = 7,500-19,000 individuals (Forrester *et al*., 2012). Forrester *et al*. (2012) estimated the Scottish population to be between 3,550-5,750 lekking males in the early 2000s, but population may have declined since that publication.

UK long-term trend

Declining in recent decades, especially latter part of 20th century, and range contracting; a 29% contraction in breeding range occurred between 1968/72 – 2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021; Jiang and Møller, 2017; Schranz, 2009) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in the Ukraine: Mean FID = 24.3m (n = 6);

Min/Max FID = 20 to 28m (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID 24.3m (n = 6) (Jiang and Møller, 2017).

Surveyor walking over moorland in England: Range of mean FID = 74 to 86m (n = 44); Min/Max FID = 62 to 101m (Baines and Richardson, 2007).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD for nesting females = 5 to 75m (n = 8 to 11); Min/Max AD (80% opinion range) = <10 to 150m; Min/Max AD (90% opinion range) = 100 to 150m.

Range of median FID for nesting females = 5 to 30m (n = 8 to 11); Min/Max FID (80% opinion range) = <10 to 100m.

Median AD for lekking males = 225m (n = 17); Min/Max AD (80% opinion range) = 100 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Median FID for lekking males = 225m (n = 17); Min/Max FID (80% opinion range) = 50 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Surveyor walking over moorland in England: Range of mean FID = 17 to 88m (n = 107); Min/Max FID = 7 to 106m (Baines and Richardson, 2007).

Surveyor skiing in an alpine habitat in Switzerland:

Range of mean FID for males= 11.5 to 12m (n = 171); Min/Max FID = 1 to 80m

Range of mean FID for females= 8.1 to 11.3m (n = 77); Min/Max FID = 1 to 60m

(Schranz, 2009).

Pedestrian leisure activity (skiing and snow ploughs) in an alpine habitat in Bavaria:

Range of FID for black grouse under cover = <10 to 30m.

Range of FID for black grouse in the open = >30 to 100m.

(Zeitler, 2000)

MAD and/or

Buffer zone

Quantitative distances

Buffer zone updates (Arlettaz *et al*., 2013; Schranz, 2009) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 300 to 1000m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Nonbreeding season:

Pedestrian leisure (winter sports) in alpine habitats in Switzerland: Buffer zone = 120m (Arlettaz *et al*., 2013; Schranz, 2009).

Ecology and non-quantitative disturbance responses

Black grouse is a resident species in upland areas of Britain where it shows a preference for young plantations on moorlands, marginal farmland and woodland edges; as plantations mature, this habitat becomes less suitable and this may result in losses (Balmer *et al*., 2013). The highest abundance of this species has been recorded in upland areas of northern and central Scotland, the Southern Uplands, the Pennines and North Wales; birds are largely sedentary, and breeding and nonbreeding distribution ranges are similar (Balmer *et al*., 2013). Black grouse is generally a ground nesting species which feeds predominantly on plants; the main foods include buds, needles, pinecones, dwarf shrubs, grasses and berries, depending upon location and season (Snow and Perrins, 1998).

Disturbance caused by human recreational activities are considered to be a serious threat to grouse in central Europe (Storch, 2000). Disturbance in black grouse habitats can cause behavioural changes in the short-term and longer-term changes, in habitat use, spatial distribution and extinction of local populations (Storch, 2000; Zeitler 2000).

There is a growing body of evidence to show that recreational winter sports in the Alps causes disturbance to black grouse (Arlettaz *et al*., 2013; Schranz, 2009; Zeitler, 2000; Laiolo and Rolando, 2005; Baltic, 2005, Baltic *et al*., 2005). Zeitler found that black grouse kept distances of at least 150m away from new sources of disturbance such as newly operating snow generators and ski runs active outside the normal operational period. Under the cover of spruce or dwarf pines, Zeilter (2000) also found that this species can tolerate disturbances that occur within normal spatial and temporal patterns, but outside in the open, birds are more easily disturbed. Arlettaz *et al*. (2013) found that even moderate levels of disturbance, such as that caused by off-piste skiing activity, are enough to elicit a chronic stress response in black grouse. Compared with capercaillie, black grouse is a smaller species and may be more vulnerable to the risk of starvation if continually disturbed in foraging areas (Baltic *et al*., 2005; Hissa *et al*., 2003). Baines and Richardson (2007) highlight that access restrictions to wintering grounds where large numbers of birds regularly concentrate should be considered.

Flushing distance to disturbance varies depending on the time of year (Baines and Richardson, 2007). In the breeding season, lekking males are more vulnerable to disturbance compared with females on nests (Ruddock and Whitfield 2007; Storch, 2000). Because of the greater risk of disturbance at lek sites and the negative consequences for reproduction, ecotourism at grouse leks needs to be carefully managed (Storch, 2000). Baines and Richardson (2007) recommend that at black grouse breeding areas dogs should be kept on leads from April to August and viewing facilities should be provided for birdwatchers at leks.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season (Nesting females) buffer zone = 100-150m

Breeding season (Lekking males) buffer zone = 500-750m

Nonbreeding season buffer zone = 100-150m

Black grouse is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for black grouse when approached by a pedestrian is 101m during the breeding season and up to 100m during the nonbreeding season; FID values up to 100m have been recorded for disturbance from skiers and snow ploughs during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for black grouse during the breeding season is 100-150m for nesting females and 500-750m for lekking males.

Buffer zones to protect black grouse from forestry operations in the UK range from 300 to1000m during the breeding season. A buffer zone of 120m has been recommended to protect black grouse from pedestrian disturbance in Switzerland during the nonbreeding season.

In the UK, black grouse has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season.

Depending on the level of habituation to disturbance, buffer zones of 100-150m for nesting females and 500-750m for lekking males (considered to be the upper disturbance limits estimated by expert opinion (Ruddock and Whitfield, 2007)) are suggested to protect breeding birds from pedestrian disturbance. For forestry activities, buffer zones up to 1000m may be necessary during the breeding season. Buffer zones required to protect nonbreeding birds may be lower, a buffer zone of 100-150m is suggested to protect nonbreeding birds from pedestrian disturbance. For survey work, the monitoring methods presented in Gilbert *et al*. (1998) should be followed.

Knowledge gaps

Lack of studies measuring AD/FID for pedestrian leisure activity during the breeding season.

Species: Divers and grebes

Red-throated diver, *Gavia stellata*

Conservation Status

UK: Green List; Schedule 1

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,250 (1,000-1,550) breeding pairs, 21,500 individuals in winter (Woodward *et al*., 2020); Scottish population = 935-1,500 pairs, over 2,270 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a weak increase in breeding birds (+38%) over 12 years.

Winter range expanded by 32% between 1981/84 – 2007/11. Breeding numbers in Scotland increased by 38% between 1994 – 2006. Breeding range increased by 11% between 1968/72 – 2007/11, although a 9% range contraction was recorded between 1968/72 – 2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID updates (Díaz *et al*., 2021; Laursen *et al*., 2017; Jiang and Møller, 2017) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: FID = 110m (n = 3); Min/Max FID = 100 to 120m (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID = 110m (n = 3) (Jiang and Møller, 2017).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 225m (n = 12 to 13); Min/Max AD (80% opinion range) = 150 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Median FID = 125m (n = 14 to 15); Min/Max FID (80% opinion range) = 10 to 750m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Motorised watercraft (motorboat) in nearshore waters off Denmark: Mean FID = 1200m (Laursen *et al*., 2017).

Non-motorised watercraft (kite surfer) in nearshore waters off Denmark: Mean FID = 1400m (Laursen *et al*., 2017).

MAD and/or

Buffer zone

Quantitative distances

No buffer zone update published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 300 to 900m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative disturbance responses

In the UK, red-throated divers breed only in North and West Scotland and Co. Donegal in Ireland, on freshwater lochs or bog pools in open moorland, blanket bogs or open and wet peatland habitats (Balmer *et al*., 2013; Snow and Perrins, 1998). The highest breeding densities in Scotland are found in Shetland, parts of Orkney, Caithness, the western fringe of the Highlands and the Outer Hebrides (Balmer *et al*., 2013). Red-throated divers feed principally on fish; almost all birds at UK breeding sites commute from their freshwater nesting site to feed at sea in nearby shallow coastal areas, so this species is potentially vulnerable to human disturbance at sea as well as on breeding lochs. Human disturbance on and around waterbodies where red-throated divers breed can deteriorate the quality of diver breeding habitat and reduce their breeding success; the use of artificial nesting rafts has been shown to increase breeding success and help mitigate the effects of human disturbance (Nummi *et al*., 2013; Piper *et al*., 2002).

In the nonbreeding season, red-throated divers are usually to be found in inshore marine waters along sheltered coasts, only rarely occurring inland on freshwater bodies (Snow and Perrins, 1998). In the UK this species overwinters all around the coast of Britain and Ireland, the highest concentrations are found along the North Sea coasts, in South West Scotland and in South West Ireland (Balmer *et al*., 2013). This distribution partly agrees with diver distribution recorded during offshore aerial surveys which have revealed large congregations of wintering red-throated divers off South East England, especially in the Greater Thames (Balmer *et al*., 2013).

Red-throated diver has been assessed as having a very high sensitivity to boat disturbance (Furness *et al*., 2013); in marine areas this species has been identified as being particularly sensitive to human activities (Dierschke *et al.*, 2016), including through the disturbance effects of ship and helicopter traffic (Mendel *et al*. 2019; Garthe and Hüppop, 2004; Schwemmer *et al.,* 2011; Furness and Wade, 2012; Bradbury *et al.,* 2014; Dierschke *et al.,* 2016). Marine activity may also increase the number of red-throated diver flights; relative to the other two diver species, red-throated divers are much more likely to take flight in response to disturbance, but they have also been recorded flying more in the absence of disturbance than the other two diver species (Jarrett *et al*., 2018). Red-throated divers are very likely to take flight in the 200-300m distance band from a passing ferry (Jarrett *et al*., 2018) and other studies have suggested that this species will fly away from approaching vessels at a distance of at least 1km or more (Garthe and Hüppop, 2004; Schwemmer *et al.,* 2011; Topping and Petersen, 2011). In the German North Sea, Schwemmer *et al*. (2011) have shown that red-throated divers avoid active shipping lanes. Dierschke *et al*. (2016) reviewed all available evidence from operational offshore wind farms on the extent of displacement or attraction of seabirds in relation to these structures; a strong avoidance of offshore wind farms was noted for red-throated divers and black-throated divers.

However, as for other diver species, the response to human disturbance may vary between individuals. Within Irish coastal waters during the nonbreeding season, Gittings *et al*. (2015) found that two out of three red-throated divers flushed at distances of approximately 15m and 100m from a motorised boat, while a third was recorded at a distance of 400 to 500m from the boat, although, as noted by the author, the sample size in this study was very small; flushed birds flew a long way (at least 0.5km and over 1km) from the boat.

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 500-750m

Nonbreeding season buffer zone = ≤1000m

Red-throated diver is assessed to have a high sensitivity to human disturbance.

Divers have some of the highest AD/FID/MAD values recorded in the bird disturbance response database. Studies measuring AD/FID are limited for red-throated divers, but the maximum AD/FID value recorded for this species is 120m when approached by a pedestrian during the breeding season and 1400m when approached by non-motorised watercraft during the nonbreeding season. Ruddock and Whitfield (2007) suggested that the upper pedestrian disturbance limit for red-throated diver during the breeding season is 500-750m.

Buffer zones range from 300 to 900m for forestry operations during the breeding season.

In the UK, red-throated diver has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds (particularly by boat traffic) at the coast during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 500-750m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect breeding red-throated diver from pedestrian and boating (on breeding lochs) disturbance. For activities with a high potential for visual and audial disturbance (e.g. forestry operations), a buffer zone ≤900m may be necessary. In marine areas during the nonbreeding season, a large buffer zone ≤1km may be necessary to protect foraging and roosting birds from shipping disturbance.

Knowledge gaps

Lack of studies measuring AD/FID during the nonbreeding season. Current research on time budgets of red-throated divers in the nonbreeding season (using time-depth recorders deployed on leg rings on breeding birds) may indicate the extent to which they experience an energy bottleneck during winter and therefore may be vulnerable to impacts on body condition and overwinter survival.

Black-throated diver, *Gavia arctica*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 215 (190-250) breeding pairs, 560 individuals in winter (Woodward *et al*., 2020); Scottish population = c.200 breeding pairs, 700-800 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (+16%) over 12 years.

Believed to have declined during early 20th century due to persecution by anglers and collectors, but has increased since and recovered breeding range that had been lost (Forrester *et al*., 2012). A 10% breeding range was recorded between 1988/91 – 2007/11 this mirrors national survey results showing an increase from 187 territories in 1994 to 217 territories in 2006 Balmer *et al*. (2013). Winter range expanded by 51% between 1988/91 – 2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: FID = 125m (n = 1) (Díaz *et al*., 2021).

Motorised watercraft (pedestrian leisure) on a lake in Sweden: Range of mean FID = 189 to 278m (n = 6 to 12); range of median FID = 80 to 310m; Min/Max FID = 0 to 750m (Götmark *et al*., 1989).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 310 to 400m (n = 10); Min/Max AD (80% opinion range) = 100 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Median FID = 225m (n = 10 to 11); Min/Max FID (80% opinion range) = 50 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season:

Motorised watercraft (pedestrian leisure) on a lake in Sweden: Buffer zone = >100m around islands where divers are nesting, although an exact figure wasn't stated (Götmark *et al*., 1989).

Forestry operations in the UK: Safe working distance = 300 to 900m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in Massachusetts: Safe working distance = 152m, No-cut zone = 30m (Natural Heritage and Endangered Species Program, 2007).

Ecology and non-quantitative disturbance responses

Black-throated diver has a high sensitivity to human disturbance both during the breeding and nonbreeding seasons.

In the UK, black-throated divers breed mainly in the north and west of Scotland (Sutherland and Wester Ross) and the Outer Hebrides (Balmer *et al*., 2013) in large shallow freshwater lochs or extensive pools with islets and peninsulas (Snow and Perrins, 1998). Loch occupancy is associated with the abundance of small salmonids and complex shorelines (Balmer *et al*., 2013). In these locations, divers may be disturbed by a range of pedestrian leisure activities, especially activities involving boats. In a study investigating disturbance by fishing activities on black-throated divers, Bundy (1979) found that on larger waterbodies, fishing from the bank did not disturb divers and that adults with chicks kept 50m away from boats, however, on small waterbodies of less than 45ha, divers couldn't maintain a safe distance and were often absent. Götmark *et al*. (1989) found that black-throated divers will flush between 189 to 278m from motorised watercraft in areas where they breed. Mudge and Talbot (1993) found that black-throated divers had a high degree of chick mortality in some core areas of their Scottish breeding range between1983-87; almost 80% of nest failure was due to predation and water level changes, but 13% was due to human egg collectors and 5% to desertion following human disturbance. Artificial rafts are increasingly used by black-throated divers to nest upon (Balmer *et al*., 2013). The use of breeding rafts may moderate effects of fluctuating water levels and human disturbance and have been shown to increase productivity of the Scottish population by 44% (Hancock, 2000).

In the nonbreeding season, black-throated divers generally move to salt water locations around sheltered coasts. Concentrations occur in Cornwall and north west Scotland, and other wintering hotspots occur along the east coast of England and the north coast of Scotland (Balmer *et al*., 2013). This species can sometimes be seen at inland reservoirs during the nonbreeding season, occasionally frequenting large inland freshwater bodies (Snow and Perrins, 1998). Black-throated divers at sea have been identified as having a high vulnerability to disturbance by boats (Furness *et al*., 2013) and will often swim or dive in the 200-300m distance band from a passing ferry (Jarrett *et al*., 2018). In the German North Sea, Schwemmer *et al*. (2011) have shown that black-throated divers avoid active shipping lanes. It seems likely that this species may avoid areas where marine activity takes place, making data gathering for this species difficult. Black-throated divers are less likely than the smaller red-throated diver to take flight in response to marine activity, instead this species favours a swim or dive response, similar to great northern diver (Jarrett *et al*., 2018).

Garthe and Hüppop (2004) ranked black-throated diver and red-throated diver as the most sensitive species to offshore wind farm disturbance/displacement impacts. Dierschke *et al*. (2016) have found that black-throated divers show a significant avoidance of offshore wind farms at more than 2km and that this species can completely disappear around offshore wind farms where formally there was a high density.

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 500-750m

Nonbreeding season buffer zone = ≤1000m

Black-throated diver is assessed to have a high sensitivity to human disturbance.

Divers have some of the highest AD/FID/MAD values recorded in the bird disturbance response database, although studies measuring AD/FID are limited for black-throated divers., The maximum FID when approached by watercraft during the breeding season is 750m, although the response varies and FID values recorded in other studies are considerably shorter. Ruddock and Whitfield (2007) suggested that the upper pedestrian disturbance limit for black-throated diver during the breeding season is 500-750m. A quantitative measure of FID during the nonbreeding season is not currently available.

Buffer zones of at least 100m have been recommended to protect breeding birds from watercraft disturbance, but out at sea during the nonbreeding season birds will flush from passing boats at a distance of 200-300m. Buffer zones range from 152 to 900m for forestry operations during the breeding season.

In the UK, black-throated diver has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds (particularly by boat traffic) on the coast during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 500-750m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007))is suggested to protect breeding black-throated diver from pedestrian and boating (on breeding lochs) disturbance, but a better understanding of the impact, if any, of disturbance on body condition and survival of black-throated divers would help to inform such decisions. For activities with a high potential for visual and audial disturbance (e.g. forestry operations), a buffer zone ≤900m may be necessary. In marine areas during the nonbreeding season, a large buffer zone ≤1km may be necessary to protect foraging and roosting birds from shipping disturbance.

Knowledge gaps

Lack of studies measuring AD/FID during the nonbreeding season.

Great northern diver, *Gavia immer*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern, Annex 1

UK status

Extremely Scarce Breeder, Winter Visitor

UK and Scottish population estimate

UK winter population = 4,400 individuals (Woodward *et al*., 2020);

Scottish population = 1 possible breeding record, 1,000-3,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Possibly increasing; distribution increased by 39% between 1981/84 – 2007/11, although apparent gains may be a consequence of improved coverage (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021; Jiang and Møller, 2017; Borgmann, 2012; Liley *et al*., 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: FID 76.8m (n = 1) (Jiang and Møller, 2017).

Motorised watercraft (pedestrian leisure) on an inland waterbody in Montana: Min/Max FID = 64 to 129m (Kelly, 1992).

Motorised watercraft (pedestrian leisure) on inland waterbodies: Range of mean FID = 10 to 200m (Ruddock and Whitfield, 2007).

Non-motorised watercraft (surveyor canoeing) on an inland waterbody in Wisconsin: Mean FID = 27.8m (n = 30), Min/Max FID = 3 to 90m (Titus and VanDruff, 1981).

Nonbreeding:

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Mean FID = 51m (Borgmann, 2012).

Pedestrian (general) along the shoreline in England: FID = 50m (n = 1) (Liley *et al*., 2010).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Borgmann, 2012) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian (Wisconsin Loon Project): MAD = 67m (Ruddock and Whitfield, 2007).

Pedestrian (Wyoming Bird Conservation Plan): Buffer zone = 165m (Ruddock and Whitfield, 2007).

Motorised watercraft (leisure boat) on an inland waterbody in Montana: MAD = 137m (Kelly, 1992).

Motorised watercraft on lakes in Wisconsin: Buffer zone from the shores of lakes or islands = 150m (Ruddock and Whitfield, 2007).

Human development (Damage Assessment, Remediation and Restoration Program in New England): Buffer zone = 165 to 330m (Ruddock and Whitfield, 2007).

Nonbreeding:

Non-motorised watercraft (pedestrian leisure) in a range of habitats and locations: Buffer zone = 218m (Borgmann, 2012).

Ecology and non-quantitative disturbance responses

Great northern divers are winter visitors to the UK; this species migrates south in winter from arctic breeding grounds. The coastal waters around the UK hold an internationally important wintering population of great northern divers and this species is also occasionally recorded on inland wetland areas and some larger reservoirs (Balmer *et al*., 2013; Wernham *et al*., 2002). The largest concentrations of wintering great northern divers are found in the Northern Isles, Outer Hebrides, North West Scotland south to Argyll as well as western and southern Ireland (Balmer *et al*., 2013). In England, this species is abundant off the Cornish coast (Balmer *et al*., 2013). Great northern divers feed primarily on fish up to 28cm, but the diet can also include crustaceans, molluscs, annelids, insects and amphibians, depending upon location and season (Snow and Perrins, 1998).

Great northern divers very rarely breed with black-throated divers. A single hybrid pair was recorded in Scotland for several consecutive seasons up to 2008 (Balmer *et al*., 2013). Birds recorded in the UK during spring are likely to be those migrating north, although small numbers do remain to summer in coastal waters in the north and west (Balmer *et al*., 2013).

During the breeding season in the high arctic, great northern divers can have a relatively high sensitivity to human disturbance, although the response can vary depending on habituation of individuals and the source of disturbance; disturbance limits of this species may be lower compared with those of red-throated or black-throated diver species (Ruddock and Whitfield, 2007). The majority of studies on breeding great northern divers suggest that they will flush when disturbed on their breeding grounds at a distance of 150 - 300m (Ruddock and Whitfield, 2007), which is generally lower than for black-throated and red-throated divers. Heimberger *et al*. (1983) found that great northern diver nesting success was greatest when sources of disturbance were beyond 600m. Breeding success has been shown to increase with the use of artificial breeding rafts (Piper *et al*., 2002).

During the nonbreeding season, great northern divers at sea have been identified as having a high vulnerability to disturbance by boats (Furness *et al*., 2013, Jarrett *et al*., 2018); birds are quite likely to swim or dive in the 200-300m distance band from a passing ferry and may also swim (but very rarely fly) out of the path of ferries up to 4km away (Jarrett *et al*., 2018). In winter, great northern divers spend a high proportion of daylight hours foraging (David C. Jardine, unpublished data) and so it may be difficult to distinguish between behaviours of diving to avoid nearby boats and diving to hunt for food. However, if great northern divers are exposed to an energetic bottleneck in winter, any increase in energy costs caused by disturbance may influence body condition and therefore potentially influence overwinter survival.

FID values vary between individuals. Gittings *et al*. (2015) found that within Irish coastal waters, great northern divers tolerated a medium sized motorised boat travelling at slow to moderate speeds to within 10 to 20m during the nonbreeding season; great northern divers did not fly away from the boat at this distance, but some individuals did show a dive response at 10 to 20m. Great northern divers also respond to other marine activity, particularly slow vessels/craft (including motorised and non-motorised boats for pleasure and commercial activities) by swimming or diving; in Orkney, they are frequently found in areas where regular marine activity takes place, although rarely recorded close to shore (Jarrett *et al*., 2018).

In contrast to red-throated and black-throated divers, which tend to avoid areas of human activity such as piers, harbours and ferry terminals, great northern divers can often be watched foraging under piers or in harbours, close to human activity, which suggests that this species, or at least some individuals, are less sensitive to human disturbance than are the smaller diver species (David C. Jardine, pers. comm.).

Likely sensitivity to disturbance = Medium/High

Quantitative information = Medium agreement & Medium evidence

Nonbreeding season buffer zone = 100-350m

Great northern diver is assessed to have a medium to high sensitivity to human disturbance.

The maximum FID value recorded for great northern diver during the breeding season is a mean of 76.8m when approached by a pedestrian and 200m when approached by motorised watercraft. However, as this species does not breed in the UK, quantitative values recorded during the breeding season may not be relevant to disturbance in the UK. During the nonbreeding season, the maximum FID value recorded is 50m when approached by a pedestrian and a mean of 51m when approached by non-motorised watercraft.

A MAD value of 67m and 137m has been recorded for pedestrian and motorised watercraft disturbance respectively during the breeding season. Buffer zones from 150 to 165m have been reported to protect breeding great northern divers from watercraft and pedestrian disturbance, larger buffers up to 330 may be required for disturbance from human development. A buffer zone of 218m has been reported to protect nonbreeding birds from non-motorised watercraft disturbance.

In the UK, great northern diver has the potential to be disturbed (particularly by boat traffic) on foraging and roosting grounds at the coast during the nonbreeding season. A minimum buffer zone of 100-350m is suggested to protect nonbreeding great northern diver from pedestrian disturbance, but a better understanding of the impact, if any, of disturbance on body condition and survival of great northern divers would help to inform such decisions.

Knowledge gaps

Lack of studies measuring AD/FID for a range of disturbance activities, especially pedestrian activity on the beach during the nonbreeding season.

Slavonian grebe, *Podiceps auritus*

Conservation Status

UK: Red List; Schedule 1

European: Near Threatened, Annex 1

UK status

Resident Breeder, Winter Visitor

UK and Scottish population estimate

UK population = 28 breeding pairs, 995 individuals in winter (Woodward *et al*., 2020); Scottish winter population = 300-500 individuals (Forrester *et al*., 2012). Scottish breeding population has declined since Forrester *et al*. (2012) estimated 30 (30-80) breeding pairs.

UK long-term trend

Eaton *et al*. (2021) state a strong decrease in breeding birds (-61%) over 25 years.

Breeding numbers have decreased since 1993 (Balmer *et al*., 2013). Winter range expanded in Britain and Ireland between 1981/84 – 2007/11; part of this increase may stem from improved survey coverage, increases in Scotland may be in response to an increase in the Icelandic breeding population (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Liley *et al*., 2011) published since Ruddock and Whitfield (2007).

Breeding season (Slavonian grebe):

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 75 to 225 (n = 5); Min/Max AD (80% opinion range) = <10 to 300m; Min/Max AD (90% opinion range) = 150 to 300m.

Range of median FID = 30 to 125m (n = 5); Min/Max FID (80% opinion range) = <10 to 150m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Breeding season (great crested grebe, *Podiceps cristatus*, stand in species for Slavonian grebe):

Surveyor walking in an urban habitat in Finland: FID = 10m (n = 1) (Díaz *et al*., 2021).

Pedestrian walking/running around breeding lochs in Scotland: Min/Max FID = 8 to 30m (Summers *et al*., 1994, cited in Bright *et al*., 2006).

Pedestrian leisure (boats) on breeding lochs in Scotland: Mean FID = 6.4m (n = 7) (Summers *et al*., 1994, cited in Bright *et al*., 2006).

Non-motorised watercraft: Min/Max FID = 0 to 100m (Keller, 1989).

Nonbreeding season (Slavonian grebe):

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median AD = 50m (n = 2), FID = 30 (n = 1) (Liley *et al*., 2011).

Nonbreeding season (great crested grebe):

Non-motorised watercraft (sailing boat) in nearshore waters off Denmark: Mean FID = 90m

Non-motorised watercraft (kite surfer) in nearshore waters off Denmark: Mean FID = 340m (Laursen *et al*., 2017).

Vehicle (bus) near a treatment plant in Australia: FID = 70m (n = 1) (McLeod *et al*., 2013).

Pedestrian (general) along the shoreline in England: Median FID = 100m (n = 3); Min/Max FID = 20 to 100m (Liley *et al*., 2010).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season (Slavonian grebe):

Forestry operations in the UK: Safe working distance = 150 to 300m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative disturbance responses

In the UK, Slavonian grebes breed in Scotland where it is a rare breeding bird at the extreme southern end of the species' Arctic range; breeding is restricted to the eastern Highlands (Balmer *et al*., 2013). A female Slavonian grebe did attempt to breed with a great crested grebe in the East Midlands between 2006 and 2008 but breeding was not successful (Balmer *et al*., 2013). This species breeds on a wide variety of lochs including small, shallow fresh, brackish or slightly alkaline waters between 0.5 and 2m deep and between 1-20ha in area with rich floating, submerged and emergent vegetation (Snow and Perrins, 1998).

Breeding Slavonian grebes can be relatively tolerant of human presence and although they are threatened by predation at nests, by flooding and wave damage, human disturbance of nesting birds is not considered to be a threat (Forrester *et al*., 2007). However, lake selection may be influenced by human disturbance; in particular bank-anglers, whose presence may keep grebes off eggs for extended periods (Thom, 1986; Summers *et al*., 2011). Summers *et al*. (2011) note that Slavonian grebe breeding lochs tend to be located hundreds of metres from roads and houses which they suggest is an indication of human disturbance.

In the nonbreeding season, Slavonian grebes move to sheltered coastal inshore waters up to 10-20m in depth including sheltered bays, lagoons and estuaries, joining immigrants from other Arctic breeding areas (Wernham *et al*., 2002; Snow and Perrins, 1998). Wintering Slavonian grebes occur around most of the Scottish coast; the highest numbers are recorded in the Northern Isles, northwest Scotland, the Moray Firth, the Firth of Forth and Kintyre. In England, this species is also recorded along the coast of Northumberland and from East Anglia to Cornwall (Balmer *et al*., 2013). Nonbreeding Slavonian grebes on the sea do not normally come ashore. They forage in shallow marine habitats where they could potentially be disturbed by people on the shore, but, in areas where Slavonian grebes occur regularly, there can be considerable human activity. For example, in Argyll, Orkney and Shetland, Slavonian grebes overwinter in areas with frequent ferry and fishing vessel traffic, salmon and mussel farming activity (Argyll Bird Reports volumes 12 to 29, Upton *et al*., 2018; Jackson, 2018), and these populations appear to be tolerant of these practices.

However, flushing distances of individual birds depends on the extent of habituation and tolerance of disturbance in different areas (Ruddock and Whitfield, 2007). Slavonian grebe is known to have a very high sensitivity to boat disturbance; this species is very likely to respond to a passing ferry at a distance of 200-300m (the third highest response after black-throated and red-throated divers) by flying away (Jarrett *et al*., 2018). Slavonian grebes can be absent from areas where regular marine activity takes place; in response to marine activity, the evasive flights of Slavonian grebes are longer/further than for other species (Jarrett *et al*., 2018).

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 150-350m

Slavonian grebe is assessed to have a medium sensitivity to human disturbance.

Studies measuring AD/FID are limited for Slavonian grebe, but the maximum AD/FID values estimated by expert opinion are 300m for AD and 150m for FID when approached by a pedestrian during the breeding season. During the nonbreeding season, the maximum FID value recorded is a median value of 50m when approached by a pedestrian. A wider range of FID studies are available for great crested grebe; the maximum FID value recorded for great crested grebe when approached by non-motorised watercraft is 100m during the breeding season and a mean value of 340m during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance limit for Slavonian grebe during the breeding season is 150-300m. Buffer zones range from 150 to 300m for forestry operations during the breeding season.

In the UK, Slavonian grebe has the potential to be disturbed on its breeding grounds, although, due to the scarcity of breeding Slavonian grebes in the UK, human disturbance is more likely on roosting and foraging grounds at the coast during the nonbreeding season. A minimum buffer zone of 150-350m is suggested to protect both breeding and nonbreeding Slavonian grebe from pedestrian disturbance.

Knowledge gaps

Lack of AD/FID studies during the breeding season.

Species: Diurnal raptors

White-tailed eagle, *Haliaeetus albicilla*

Conservation Status

UK: Amber List; Schedule 1, 1A and A1

European: Least Concern, Birds Directive Annex 1

UK status

Re-introduced Resident Breeder, Accidental

UK and Scottish population estimate

Scottish population only = 122 breeding pairs (Woodward *et al*., 2020), in winter the number of adults is same as breeding population (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+1,216%) over 25 years.

White-tailed eagle was once widespread in the UK, but this species was driven to extinction by humans early in the 20th century (Balmer *et al*., 2013). In Scotland there has been a strong increase following re-introductions, starting slowly in the 1970s. There were 30 pairs in 2003 (Forrester *et al*., 2012). Population models suggest that the population will increase considerably in the coming years, as well as spread over much of Scotland; density-independent predictive models suggest that the white-tailed eagle population could continue to grow to over 200 pairs by 2025 (Sansom *et al.,* 2016). Re-introductions are now taking place in England, where numbers are also likely to increase.

AD/FID

Quantitative disturbance distances

No AD/FID updates published since Ruddock and Whitfield (2007).

Breeding season (white-tailed eagle):

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 510m (n = 8); Min/Max AD (80% opinion range) = 150 to 1000m; Min/Max AD (90% opinion range) = 500 to 750m.

Range of median FID = 125 to 225m (n = 10 to 11), Min/Max FID (80% opinion range) = 50 to 1000m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Breeding season (bald eagle, *Haliaeetus leucocephalus*, stand in species for white-tailed eagle):

Pedestrians walking/running and motorised vehicle (general) in the USA:

Mean FID = 200m, Min/Max FID = 50 to 990m

(Fraser *et al*., 1985)

Nonbreeding season (bald eagle):

Pedestrian walking/running in North America: Min/Max FID = 183 to 268m

Motorised watercraft in North America: Range of mean FID = 136 to 276m

Non-motorised watercraft in North America: Min/Max FID = 111 to 202m

Fishing boat in North America: Range of mean FID = 127 to 137m.

Bank angler in North America: Mean FID = 201 to 293m

(Stalmaster and Kaiser, 1997)

Aircraft disturbance in North America: Mean FID = 625 to 800m

(Grubb and King, 1991; Fleischner and Weisberg, 1986).

Unknown season (African fish eagle, *Haliaeetus vocifer*, stand in species for white-tailed eagle):

Surveyor walking in Africa: Mean FID = 68m (n = 2) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Update on buffer zones (SNH, 2015; Kortland *et al*., 2011; Horváth, 2009; Naylor, 2009) published since Ruddock and Whitfield (2007).

Breeding season (white-tailed eagle):

Forestry operations in Scotland: Buffer zone = 250 to 500m (Kortland *et al*., 2011).

Forestry operations in Scotland: Safe working distance = 500m (Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 900 to 1100m (Petty, 1998).

Forestry operations (tree felling) in Hungary: Buffer zone = 300 to 400m (Horváth, 2009).

Forestry operations in Finland: Buffer zone = 50 to 500m

Pedestrian walking/running in forest land in Finland: Buffer zone = 500m

Pedestrian camping in forest land in Finland = 1000m

Motorised vehicles (general) in forest land in Finland: Buffer zone = 1000m. (Koivusaari *et al*., 1988a,b).

Forestry operations in Sweden: Buffer zone = 500m

Industrial development in Sweden: Buffer zone = 2000m

Recommended general buffer zone in Sweden: Buffer zone = 500m

(Ruddock and Whitfield, 2007).

Public viewing platform on the island of Mull in Scotland: Buffer zone = 300m

Public parking area on an island in Scotland: Buffer zone = 600m

(MacLennan and Evans, 2003).

Aircraft disturbance in Scotland: Safe working distance = 500-750m (lateral), 1000m (altitudinal) (SNH, 2015).

Nonbreeding season (white-tailed eagle):

Forestry operations in Scotland: Buffer zone = 0 to 250m (Kortland *et al*., 2011).

Forestry operations (tree felling) in Hungary: Buffer zone = 100m (Horváth, 2009).

Ecology and non-quantitative disturbance responses

White-tailed eagles are resident breeders in the UK. Reintroduced white-tailed eagles now breed in four key breeding areas in the Western Highlands of Scotland: Outer Hebrides, Wester Ross, Skye and the Small Isles and North Argyll centred on Mull (Balmer *et al*., 2013). Further white-tailed eagles have been reintroduced to East and Central Scotland (Balmer *et al*., 2013) and most recently to the Isle of Wight where they are showing some signs of territorial behaviour (Pitches, 2021). These areas are all linked with sea coasts, lochs, rivers and wetlands where fish and other aquatic prey can be caught (Snow and Perrins, 1998). As a predator, scavenger and kleptoparasite, white-tailed eagles have a wide-ranging diet including fish, waterbirds, mammals and carrion (Snow and Perrins, 1998). This species prefers to nest in tall, mature trees, although nesting can take place on cliffs and crags and very occasionally on the ground (Snow and Perrins, 1998). The nest is a large structure, composed of big branches and twigs and often driftwood, juniper and seaweed, which is lined with vegetation; breeding birds are monogamous and often pair for life with pairs reusing the same nest (Snow and Perrins, 1998). Adults generally remain in their territories during the nonbreeding season, whereas immature birds can roam widely; some in Scotland travel inland following highland glens until they reach the east coast (Balmer *et al*., 2013). White-tailed eagles form communal roosts during the nonbreeding season, although territorial pairs may roost singly at or near nest sites (SNH, 2015).

White-tailed eagles are considered to be sensitive to human disturbance, but the level of sensitivity of individual pairs likely depends on the stage of the breeding cycle as well as exposure to and ability to cope with human presence; in remote areas this species may be scarce and unlikely to be encountered by people, which is likely to increase their sensitivity to disturbance. Some studies have shown that white-tailed eagles are much more approachable and more tolerant of human presence than golden eagles, which makes them particularly vulnerable to persecution (Forrester *et al*., 2012). Wallgren (2003) suggested that there has been a decreased fear of humans in Finnish white-tailed eagles although there was little evidence of habituation over three decades (1970s, 80s and 90s). During the nonbreeding season in Scotland, Kortland *et al*. (2011) suggest that forestry operations and activities up to and around white-tailed eagle nests may be carried out with little risk of disturbing white-tailed eagles (unless the eagles are actively nest-building which sometimes happens in December and January), although roost sites should be protected from repeated disturbance. To avoid this, forestry activities or recreational events within 250m of an active roost site should be avoided during the period from two hours before sunset until two hours after sunrise, at any time of year.

However, habituation to disturbance can vary widely across different habitats. In a survey recording white-tailed eagle nests in Croatia, Radović and Mikuska (2009) found that more than 95% of the white-tailed eagle population chose to nest more than 1000m away from the nearest human settlement, regardless of the availability of forests, and that nests were located up to 5,690m away from roads; the busier the road the more likely that some eagles chose to nest a long way from it, although illegal killing, nest robbery and hunting activities which still occur regularly in Croatia are likely to influence white-tailed eagle disturbance distances (Mikuska, 2009). At an onshore wind farm in Norway, Dahl *et al*. (2012) noted that post-construction, white-tailed eagles tended to vacate their territories within 500m from turbine locations and experienced significantly lower breeding success compared with the same territories before construction. Forrester *et al*. (2012) consider that human activities such as over-fishing inshore and clearance of woodland beside streams with the resultant loss of fish stocks from freshwater lochs may also impact white-tailed eagle populations. Ruddock and Whitfield (2007) noted that in Europe, forestry guidelines generally advise ‘no-cut’ zones around white-tailed eagle nests between 50 and 300m wide, whereas most North American no-cut zones around bald eagle nests are 400m, although these may be reduced in some situations.

In the UK, Hardey *et al*. (2013) state that white-tailed eagles should not be disturbed from eyries with eggs or small young unless a licenced surveyor has a specific need to record clutch or brood size; when chicks are eight weeks or more old, disturbance at the nest can cause premature fledging. To minimise the risk of disturbance Hardey *et al*. (2013) recommended that nesting areas are viewed from distances of 500 to 1000m away (Ruddock & Whitfield, 2007; Whitfield *et al*., 2008a). Adults may be secretive before laying, and, if disturbed during incubation, they will generally slip quietly off the nest and return once the disturbance is over, although it is recognised that different pairs or sites may have different sensitivities to disturbance.

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Medium evidence

Breeding season buffer zone = 500-1000m

Nonbreeding season buffer zone = 250-500m

White-tailed eagle is assessed to have a high sensitivity to human disturbance in remote areas, although it is important to note that different pairs or sites may have different sensitivities to disturbance; sensitivity may be lower in areas where eagles are habituated to human presence.

Quantitative studies measuring AD/FID are very limited for white-tailed eagle, but, from studies in the USA, the maximum FID value recorded for bald eagle when approached by a pedestrian is 990m during the breeding season and 268m during the nonbreeding season. The maximum FID value recorded for bald eagle during the nonbreeding season is a mean value of 293m when disturbed by fishing activity on the bank. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for white-tailed eagle during the breeding season is 500 to 1000m, although the authors also state that only one of eight respondents considered disturbance (AD) to occur between 750 to 1000m.

Recommended buffer zones for white-tailed eagle vary widely depending on the source of disturbance. Buffer zones to protect white-tailed eagles from forestry operations in Europe range from 50 to 1100m during the breeding season and 0-250m during the nonbreeding season; the majority of forestry buffer zone recommendations during the breeding season, including those for Scotland, range between 250 and 500m. Buffer zones to protect white-tailed eagles from pedestrian disturbance during the breeding season range from 300 to 1000m and a safe working distance for aircraft in Scotland is considered to be 500-700m (lateral) and 1000m (altitudinal).

In the UK, white-tailed eagle has the potential to be disturbed on breeding grounds as well as at communal roosting areas and foraging grounds during the nonbreeding season; this species is most likely to be disturbed pre- and during egg laying early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 500-1000m is suggested to protect nesting white-tailed eagles and a buffer zone of 250-500m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance. Buffer zones at the lower end of these ranges may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

There are a range of studies providing buffer zones for white-tailed eagle, but studies recording AD/FID are required.

Osprey, *Pandion haliaetus*

Conservation Status

UK: Amber List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 240 breeding pairs (Woodward *et al*., 2020), almost all in Scotland, but reintroduction to Rutland in 1996 has been followed by increase in that area and a spread to Wales (Balmer *et al*., 2013). Scottish population = 230 breeding pairs in 2017 (Challis *et al*., 2020), an increase from 182-200 in 2004 estimated by Forrester *et al*. (2012).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+207%) over 25 years.

Ospreys became virtually extinct as a breeding species in Britain during the 1900s due to human persecution, but since natural recolonisation in the 1950s there has been a steady increase in range and abundance in Scotland and northern England (Balmer *et al*., 2013). A translocation programme at Rutland Water in 1996 is likely to continue to increase numbers (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

No AD/FID updates published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian (general) in the USA: Mean FID = 50m (Carrier and Melquist, 1976).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 225 (n = 12); Min/Max AD (80% opinion range) = 100 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Range of median FID = 175 to 225m (n = 12 to 14); Min/Max FID (80% opinion range) = 50 to 750m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Motorised watercraft (powerboat) in nearshore waters off Florida: Mean FID = 57.91m (n = 58); Min/Max FID = 30 to 140m (Rodgers and Schwikert, 2002).

Motorised watercraft (jet-ski) in nearshore waters off Florida: Mean FID = 49.53m (n = 71); Min/Max FID = 20 to 159m (Rodgers and Schwikert, 2002).

Motorised watercraft (airboat) on a lake in Florida: Mean FID = 103m (n = 18) (Rodgers and Schwikert, 2003).

MAD and/or

Buffer zone

Quantitative distances

Update on buffer zones (SNH, 2015; Naylor, 2009; Craig, 2002; Adams and Scott, 1979) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 350 to 1,000m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 500 to 800m (Petty, 1998).

Forestry operations in Ontario: Buffer zone = 200m (Naylor, 2009).

Forestry operations in Arizona: Buffer zone = 100m (Adams and Scott, 1979).

Forestry operations in Canada: Buffer zone = 100 to 800m

Forestry operations in Canada next to water edge: Buffer zone = 70 to 350m

(Ewins, 1997).

Pedestrian (general buffer zone) from Colorado Wildlife guidance: Buffer zone = c.402m (Craig, 2002).

Pedestrian (general buffer zone) in USA: Buffer zone = 400 to 1500m (Richardson and Miller, 1997).

Pedestrian (general): Buffer zone = 201m

Forestry operations in Washington State: No-cut zone = 40 to 61m

Forestry operations in Washington State: Restricted-cut zone = 201 to 335m

Motorised Vehicles in Washington State: Buffer zone = 201m

Campsites in Washington State: Buffer zone = 1000m

Hiking trails in Washington State: Buffer zone = 91m

(Rodrick and Milner, 1991).

Aircraft disturbance in Scotland: Safe working distance = 500-750m (lateral), 500m (altitudinal) (SNH, 2015).

Nonbreeding season:

Nearshore water habitat off Florida:

Motorised watercraft (powerboat): Buffer zone = 149m

Motorised watercraft (jet-ski): Buffer zone = 142m

Motorised and non-motorised watercraft: Buffer zone = 150m

(Rodgers and Schwikert, 2002).

Motorised watercraft (airboat) on a lake in Florida: Buffer zone = 250m (Rodgers and Schwikert, 2003).

Forestry operations in Canada: Buffer zone year-round restriction = 40 to 200m (Ewins, 1997).

Ecology and non-quantitative disturbance responses

Ospreys are summer visitors to the UK. Since breeding began at Loch Garten (Inverness-shire) in Scotland in the 1950s, the British osprey population has spread over much of north-east Scotland; the straths and lowlands of the eastern and central Highlands remain a stronghold, with a further significant population breeding in Tayside and central Scotland (Balmer *et al*., 2013). The species range expanded over the border into Cumbria and Northumberland between 2001-2010 and, due to a translocation programme, this species now breeds at Rutland Water and in Wales (Balmer *et al*., 2013). In the UK, ospreys are a tree-nesting species breeding near fresh water, often far inland on lochs, pools and rivers (Snow and Perrins, 1998). Ospreys predominately feed on a range of fish species, which are caught in the talons after a shallow dive of no more than 1m (Snow and Perrins, 1998). This species does not spend the winter in the UK, after the breeding season ospreys travel south to overwinter in sub-Saharan Africa (Snow and Perrins, 1998). Ospreys recorded in November and February are late passage birds or birds returning early respectively (Balmer *et al*., 2013).

Ospreys are considered to be sensitive to human disturbance, but the level of sensitivity of individual pairs likely depends on the stage of the breeding cycle as well as exposure to and ability to cope with human presence. Ospreys vary in their ability to habituate to human disturbance, the effect of disturbance on nesting ospreys is influenced by the timing of the disturbance event during the breeding season (Swenson, 1979; Levenson and Koplin, 1984). Swenson, 1979, suggested that if ospreys are habituated to human presence before nesting, their continued presence might not be detrimental to nesting success, whereas Levenson and Koplin (1984) found that forestry logging activity can have significant adverse effects on productivity. In Perthshire, Scotland, a pair of ospreys continued to breed normally in 2015 despite the occurrence of a music festival (T In The Park), which took place in the immediate surrounding area in the summer; mitigation measures put in place to protect the ospreys included: changes to the festival site layout, introduction of buffer zones around the nest (maximum buffer zone of 750m) and restrictions on activities including fireworks and lighting, all of which appeared to be successful in preventing disturbance to the birds (RSPB, 2015). A safe working distance for aircraft in Scotland is considered to be 500-750m (lateral) and 500m (altitudinal) (SNH, 2015), however, it has been noted by Network Rail that ospreys nesting alongside a powerline pylon in northern Scotland will behave normally when filmed from a helicopter at a distance of c.900m away; Network Rail now inform their pilots of this distance and use it to minimise disturbance risks (Andrew Stevenson, pers. Comm.).

Ospreys that are unaccustomed to human activities should be protected from disturbance. Rodrick and Milner (1991) recommend that roads are closed between April 1 and September 15 if they are located within 201m of a sensitive pair; the authors also suggest that in wild areas, people should not camp within 1km of occupied nests and hiking trails should not come within 91m of a nest tree. Rodrick and Milner (1991) have also presented a range of management recommendations for osprey that include forestry management around nest trees (see Ruddock and Whitfield, 2007 for review).

Ospreys have adapted well to nesting on a wide range of artificial platforms. In Canada, Ewins (1997) has reported that in some areas up to 70% of occupied osprey nests now occur on artificial support structures. In Alberta, Canada, it is common to see osprey nests on roadside telegraph poles adjacent to major highways, with the birds showing no reaction to high volumes of road traffic. In the UK, it has also been noted that ospreys will successfully breed on artificial platforms, some platforms are in public places (e.g. busy marinas) suggesting that osprey behaviour in the UK can be similar to that recorded in Canada (Andrew Stevenson, pers. Comm.).

In the UK, Hardey *et al*. (2013) state disturbance around osprey nests should be avoided while breeding birds are displaying, incubating or brooding small young. To minimise the risk of disturbance, Hardey *et al*. (2013) recommend that nests should be viewed from distances of 500–750 m (Ruddock and Whitfield, 2007; Whitfield *et al.*, 2008a).

Likely sensitivity to disturbance = Medium/High

Quantitative information = Low agreement & Medium evidence

Breeding season buffer zone = 350-750m

Osprey is assessed to have a medium to high sensitivity to human disturbance, although different pairs or sites may have a different sensitivity to disturbance; sensitivity may be lower in areas where ospreys are habituated to human presence.

Quantitative studies measuring AD/FID are very limited for osprey, but the highest FID value recorded for this species is a mean of 50m during the breeding season when approached by a pedestrian and a maximum of 159m during the nonbreeding season when approached by a jet-ski. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for osprey during the breeding season is 500 to 750m, although the authors also state that expert opinion of disturbance distances for this species varied widely.

Recommended buffer zones for osprey vary depending on the source of the disturbance. Buffer zones to protect ospreys from forestry operations in the UK range from 350 to 1000m during the breeding season. Buffer zones to protect ospreys from pedestrian disturbance during the breeding season range from 91 to 402m (although campsites may need a wider buffer zone of up to 1000m). A safe working distance for aircraft in Scotland is considered to be between 500 to 900m. In the nonbreeding season, buffer zones between 149 and 250m have been suggested to protect osprey from watercraft disturbance, but as this species does not overwinter in the UK, quantitative values recorded during the nonbreeding season may not be relevant to disturbance in the UK..

In the UK, osprey has the potential to be disturbed at nest sites, especially early on in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 350-750m is suggested to protect ospreys during the breeding season from pedestrian disturbance. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

A wide range of management recommendations exist in the literature suggesting buffer zones for osprey. Empirical studies measuring osprey AD/FID are limited. Further studies, particularly focussing on the AD/FID response to human leisure activities are required for this species.

Golden eagle, *Aquila chrysaetos*

Conservation Status

UK: Green List, Schedule 1, 1A and A1

European: Least Concern, Annex 1

UK status

Resident Breeder

UK and Scottish population estimate

Scottish population only = 510 breeding pairs (Woodward *et al*., 2020); c.1,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (+16%) over 33 years.

Due to human persecution, golden eagles became extinct in England, Wales and Ireland by the middle of the 19th century and the population became increasingly rare and fragmented in Scotland (Forrester *et al*., 2012). Respite from persecution during the two World Wars together with legal since 1954 allowed this species to survive in remoter Scottish hills and glens and eventually begin to recover (Forrester *et al*., 2012). In Scotland, Forrester *et al*. (2012) and Balmer *et al*. (2013) reported that there were 442 pairs in 2003, with numbers remaining stable from 1982 to 2003. However, (Woodward *et al*., 2020) found that the population had increased to 510 breeding pairs in Scotland in 2015.

AD/FID

Quantitative disturbance distances

FID updates (Spaul and Heath, 2017; Grubb *et al*., 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running in a shrub-steppe habitat in the USA: Mean FID = 779m (n = 11); Min/Max FID = 200 to 1300m (Spaul and Heath, 2017).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 400 to 625m (n = 15 to 14); Min/Max AD (80% opinion range) = 100 to 1500m; Min/Max AD (90% opinion range) = 750 to 1000m.

Range of median FID = 225 to 400m (n = 25 to 19); Min/Max FID (80% opinion range) = 10 to 1500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Off-road vehicle in a shrub-steppe habitat in the USA: Mean FID = 414m (n = 121); Min/Max FID = 90 to 1300m (Spaul and Heath, 2017).

Road vehicle in a shrub-steppe habitat in the USA: Mean FID = 553m (n = 107); Min/Max FID = 30 to 1100m (Spaul and Heath, 2017).

Aircraft (helicopter) disturbance across canyonlands in the USA: Mean AD = 400m (n = 8); Mean FID = 200m (n = 8) (Grubb *et al*., 2010).

Nonbreeding season:

Pedestrian walking/running in farmland habitat in Colorado:

Mean FID = 225m (n = 18); Min/Max FID = 105 to 390m (Holmes *et al*.,1993).

Motorised vehicle (general) in farmland habitat in Colorado:

Mean FID = 82m (n = 16); Min/Max = 14 to 190m (Holmes *et al*.,1993).

MAD and/or

Buffer zone

Quantitative distances

Update on buffer zones (SNH, 2015; D'Acunto *et al*., 2018; Grubb *et al*., 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Motorised vehicle and pedestrian walking/running (simulated results from a model) across shrub-steppe in the USA: Buffer zone = 600m (D'Acunto *et al*., 2018).

Pedestrian leisure activity (general) in the USA: Buffer zone = 800m (Ruddock and Whitfield, 2007).

Pedestrian (general) in North America: Buffer zone = 200 to 400m

Noise disturbance in North America: Buffer zone = 800m

Visual/audible disturbance in North America: Buffer zone = 200 to 1600m (Richardson and Miller, 1997).

Forestry operations in the UK: Safe working distance = 750 to 1500m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 900 to 1100m (Petty, 1998).

Forestry operations in Sweden: Buffer zone = 500m (McGrady *et al*., 2004).

Aircraft disturbance in Scotland: Safe working distance = 1000m (lateral), 500m (altitudinal) (SNH, 2015).

Aircraft (helicopter) disturbance across canyonlands in the USA: Buffer zone = 800m (Grubb *et al*., 2010).

Nonbreeding season:

Pedestrian walking/running or motorised vehicle across farmland in the USA: Buffer zone = 300m (Holmes *et al*., 1993).

Ecology and non-quantitative disturbance responses

Golden eagles are scarce resident breeders in the UK. This species is mainly confined to upland areas of the Scottish Highlands north and west of the Highland Boundary Fault and most Hebridean islands throughout the year (Balmer *et al*., 2013); the Uists, parts of Lewis, Harris and Mull support some of the highest densities in Europe (Forrester *et al*., 2012). Smaller numbers of golden eagles inhabit the hills and mountains of central and eastern Scotland as well as the Southern Uplands in the Scottish Borders and Dumfries & Galloway (South of Scotland Golden Eagle Project, 2021; Balmer *et al*., 2013). This species is absent from Orkney and Shetland (Balmer *et al*., 2013). One lone golden eagle was present in the Lake District for some years after its mate died and, in Ireland, a reintroduction project resulted in three breeding pairs in 2010 (Balmer *et al*., 2013). Adult golden eagles are highly sedentary and remain in their territories throughout the year, whereas immature birds roam widely within the uplands, although there is little difference in distribution between breeding and nonbreeding seasons (Balmer *et al*., 2013). Scottish golden eagles show a preference for nesting on cliffs, which may allow greater visibility of their surroundings compared to forest nesting birds in Europe, therefore buffer zones may need to be greater for Scottish breeding golden eagles compared with their European counterparts (McGrady *et al*., 2004; Ruddock and Whitfield, 2007). Territories may have 1–13 (normally 1–6) alternative nests (Hardey *et al*., 2013). Golden eagles feed mainly on mammals and birds, but reptiles, occasionally fish and insects, may also be eaten; taken alive or as carrion (Snow and Perrins, 1998). Golden eagles may roost singly or at the nest for territorial birds (SNH, 2015).

Golden eagle is a shy, scarce species which lives in remote areas of Scotland and is sensitive to human disturbance. However, the level of sensitivity of individual pairs likely depends on the stage of the breeding cycle as well as exposure to and ability to cope with human presence. Golden eagles now don’t appear to be affected by pesticides and other pollutants, although this species has probably been negatively affected by the long-term, extractive human use of moorlands by grazing, burning, hunting and forestry (RSPB, 2021a). Persecution still remains a significant problem in the central and eastern Highlands of Scotland where the land is managed for red grouse (Whitfield *et al*., 2003); in these locations, large areas of suitable golden eagle breeding habitat are unoccupied (Whitfield *et al*., 2007).

The distance at which golden eagles show no reaction to disturbance varies widely depending on the source of disturbance, individual birds, habitats and the time of the year. Caution should be exercised if applying buffer zones to the UK from studies carried out abroad; for example, many of the FID values and buffer zones listed for golden eagle in this report are from studies carried out in the USA where habituation to disturbance may be greater than it is for some golden eagle individuals present in remote locations in Scotland. Reaction to disturbance can be highly variable between individuals; Spaul and Heath (2017) report that during the breeding season in the USA, some golden eagles do not react to people on foot passing by the nest at 200m, whereas other individuals will react at 1300m. When approached by non-motorised vehicles, the lack of reaction between golden eagles has been found to vary between 400 and 1100m (Spaul and Heath, 2017). Grubb *et al*. (2010) found that an Apache helicopter in the USA could pass by a golden eagle on a nest at a distance of 400m, whereas other individuals will react to this disturbance at 3000m. Also in the USA, White and Sherrod (1973) found that golden eagles did not flush when a helicopter was 18m from the nest and Boeker (1970) report that golden eagles did not flush when a fixed-wing aircraft was within 60m of a nest site.

In the UK, Hardey *et al*. (2013) state that golden eagle nests should not be approached in March and early April as this species is particularly sensitive to human disturbance just before and during egg laying. Disturbance behaviour typically involves both adult birds circling together to a great height and often drifting away from the nest; if this behaviour is seen the observer should move away as quickly as possible (Hardey *et al*., 2013). Observer disturbance at nest sites should also be avoided on particularly wet, hot or cold days as the absence of the adults may result in the chilling or overheating of the eggs or young and disturbance may also cause premature fledging (Hardey *et al*., 2013).

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Medium evidence

Breeding season buffer zone = 750-1000m

Nonbreeding season buffer zone = 250-500m

Golden eagle is assessed to have a high sensitivity to human disturbance in remote areas, although this species is scarce and unlikely to be encountered in Scotland. Different pairs or sites may have a different sensitivity to disturbance; sensitivity may be lower in areas where golden eagles have some habituation of human presence.

Quantitative studies measuring AD/FID are very limited for golden eagle in the UK, but the maximum FID value recorded for this species in the USA when approached by a pedestrian is 1300m during the breeding season and 390m during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for golden eagle during the breeding season is 750 to 1000m, although the authors also state that the divergence of opinion on disturbance distance for this species during incubation was greater than that for any other species reviewed.

Recommended buffer zones for golden eagle vary widely depending on the source of disturbance. Buffer zones to protect golden eagles from forestry operations in Europe range from 500 to 1500m during the breeding season. Buffer zones to protect golden eagles from pedestrian disturbance during the breeding season range from 200 to 800m and a safe working distance for aircraft in Scotland is considered to be 1000m (lateral) and 500m (altitudinal).

In the UK, golden eagle has the potential to be disturbed on breeding grounds as well as on roosting and foraging grounds during the nonbreeding season; this species is most likely to be disturbed pre and during egg laying early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 750-1000m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect nesting golden eagles and a buffer zone of 250-500m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance. For activities with a high potential for visual and audial disturbance (e.g. forestry operations), a buffer zone ≥1500m may be necessary.

Knowledge gaps

There is a lack of disturbance distance studies in the UK.

Red kite, *Milvus milvus*

Conservation Status

UK: Green List, Schedule 1A

European: Least Concern, Annex 1

UK status

Resident/Introduced Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 4,400 breeding pairs (Woodward *et al*., 2020);

Scottish population = ≥ 273 breeding pairs in 2015 (Challis *et al*., 2020), 300-350 birds in winter (Forrester *et al*., 2012).

UK long-term trend

Red kites became extinct outside Wales in the late 19th century due to human persecution. Since the reintroduction of red kites outside of Wales in 1989, the range and abundance in England and Scotland has rapidly increased; the range increased sevenfold between 1988/91 and 2007/11 (Balmer *et al*., 2013). Reintroduction into Scotland started with the Black Isle in 1989, numbers in north and central Scotland have been doubling about every five years (Forrester *et al*., 2012).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 125m (n = 9 to 11); Min/Max AD (80% opinion range) = 10 to 300m; Min/Max AD (90% opinion range) = 150 to 300m.

Range of median FID = 30 to 75m (n = 11); Min/Max FID (80% opinion range) = 10 to 300m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Breeding season (Black kite, *Milvus migrans*, stand in species for red kite):

Surveyor walking in a rural habitat in Spain: Mean FID = 37.9m (n = 2); Min/Max FID = 35.5 to 40.3m (Díaz *et al*., 2021).

Unknown season (Black kite):

Surveyor walking in Africa: Mean FID = 26.7m (n = 8) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (SNH, 2015) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 300 to 600m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 400 to 600m (Petty, 1998).

Aircraft disturbance in Scotland: Safe working distance = 300m (lateral), 500m (altitudinal) (SNH, 2015).

Ecology and non-quantitative disturbance responses

Red kites are resident breeders in the UK. The first reintroduction programme in Scotland took place between 1989 and 1993 when 93 red kites of Swedish origin were reintroduced on the Black Isle. Following this, reintroduction programmes in Scotland have established populations in central Scotland (Stirling area) between 1996 to 2001, Dumfries and Galloway (Castle Douglas area) between 2001 to 2004 and in Aberdeenshire between 2007 to 2009 (Forrester *et al*., 2012; RSPB, 2018). In England, red kites were introduced into the Chilterns in 1989, by 2011 this population had increased to over 800 pairs and since this time the population has spread to colonise much of central southern England and satellite populations have spread to Wiltshire, Hampshire and Sussex (Balmer *et al*., 2013). The remnant native Welsh population has also expanded since the early 1990s and now covers most of Wales and parts of Shropshire and Herefordshire (Balmer *et al*., 2013).

Red kites prefer habitats containing open stands of woodland for nesting and communal roosting in winter (Forrester *et al*., 2012). This species builds a nest composed of dead twigs usually in trees (rarely on a cliff ledge or crag), and often old buzzard or raven nests will be reused (Snow and Perrins, 1998); in Scotland, most nests are in Scots pine or oak (Forrester *et al*., 2012). Red kites have a varied diet; they are mainly scavengers although they will also take live prey such as small mammals and birds (Snow and Perrins, 1998). In the UK, red kites are sedentary and do not migrate; in the winter this species may disperse short distances to supplementary feeding grounds, breeding and nonbreeding distributions are similar (Balmer *et al*., 2013).

Red kite is a species that associates closely with humans and in the past this species flourished in areas of human habitation. Red kite was once a common bird seen over London where they would feed in the city waste dumps, much like black kites do in some Indian cities today (N. Goodship pers. obs). In 1544, William Turner recorded red kites taking bread from the hands of children and fish from women; the Greek poet Homer called them ‘snatchers’ as they had a reputation for stealing hats off people’s heads (see Colwell, 2021 for review). There are also other historical records of red kites stealing herring and fish processing waste from workers on the shores of Loch Fyne (Baxter and Rintoul, 1953), and stealing food from the hands of children in the streets of other UK cities (Raye, 2021).

Today, red kites can be seen foraging over farmland, rough grasslands and heath (Snow and Perrins, 1998) where humans are present. In agricultural areas, this species may associate closely with tractors ploughing the ground in order to take earthworms, farmyards where they scavenge for waste, as well as roads where they scavenge for roadkill (Wildman *et al*., 1998). Red kites will come close to people when feeding opportunities are provided. For example, this species feeds on bird tables in hundreds of UK gardens where meat is put out for them (Orros and Fellowes, 2014), including in Scotland (Wildman *et al*., 1998). There are also a number of commercial feeding stations in the UK that encourage large flocks of red kites to come to bait in sites providing public viewing. Katzenberger (2021) concluded that, as the population increased between 1970 and 2020 as a consequence of reduced persecution, red kites in Germany moved closer to human settlements, which suggests a reduction in human avoidance by this species and most likely reflects the change from being persecuted to being protected.

However, despite their apparent tolerance of humans, red kites are still potentially sensitive to disturbance, especially early on during the breeding season when birds are laying and incubating as well as when present at communal roosts. In the UK, Hardey *et al*. (2013) recommend that searches for nests in woodland should not be carried out between mid-March and mid-April (once kites start to display) as disturbance at this stage of breeding may cause a pair to move several kilometres away; if disturbed whilst nest building (such as tree felling in the nesting wood), a breeding pair may stop nest building and start again with a new nest 500-1000m away. To minimise the risk of disturbance Hardey *et al*. (2013) recommended that nests are viewed from distances of 150–300m (Ruddock and Whitfield, 2007; Whitfield *et al.*, 2008a) and that no attempt should be made to locate the roosts of breeding red kites, as this causes excessive disturbance.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 150-300m

Nonbreeding season buffer zone = 150-300m

Red kite is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for red kite, but the maximum FID value recorded for black kite is 40.3m when approached by a pedestrian during the breeding season; there are no records of AD/FID values during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for red kite during the breeding season is 150-300m.

Buffer zones to protect red kites from forestry operations in the UK range from 300 to 600m during the breeding season. A safe working distance for aircraft in Scotland is considered to be 300m (lateral) and 500m (altitudinal).

In the UK, red kite is most likely to be disturbed at nest sites early on in the breeding season as well as at communal roosting areas during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 150 to 300m 500m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect both breeding and nonbreeding red kites from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. For activities with a high potential for visual and audial disturbance (e.g. forestry operations, aircraft), a buffer zone between 300-600m may be necessary. For activities with a high potential for disturbance (e.g onshore wind farms), a buffer zone up to 5km may be necessary.

Knowledge gaps

Lack of AD/FID studies during both the breeding and nonbreeding seasons.

Marsh harrier, *Circus aeruginosus*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern; Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 590-695 breeding pairs (Woodward *et al*., 2020); Scottish population <10 breeding pairs between 2003-2015 (Challis *et al*., 2020), 10-100 birds during spring passage and 10-40 birds during autumn passage (Forrester *et al*., 2012). There were 10-12 occupied home ranges in Scotland in 2019 which fledged 22 young (Marsh Harrier | Scottish Raptor Monitoring Scheme).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+389%) over 25 years.

Marsh harrier temporarily went extinct in the UK at the end of the 19th century, numbers then increased before a crash to just one pair in 1971 (Balmer *et al*., 2013). Since this time abundance and range have shown a large increase; breeding range doubled between 1988/91 and 2007/11 and the number of breeding females increased by 131% between 1995 and 2005 (Balmer *et al*., 2013). Woodward *et al*. (2020) recorded a further increase in UK breeding pairs in 2016.

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Poland: Min/Max FID = 54.6 to 130.1m (n = 2). (Díaz *et al*., 2021).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 215 to 225m (n = 4); Min/Max AD (80% opinion range) = 10 to 500m; Min/Max AD (90% opinion range) = 300 to 500m.

Range of median FID = 30 to 75m (n = 3), Min/Max FID (80% opinion range) = <10 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Unknown season (African marsh harrier, *Circus ranivorus*, stand in species for marsh harrier):

Surveyor walking in Africa: FID = 61m (n = 1) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Ecology and non-quantitative disturbance responses

As the name indicates, marsh harriers breed in wetland areas with shallow, standing, fresh or brackish waters surrounded by aquatic vegetation such as standing reeds and reedmace (Snow and Perrins, 1998), which are habitats often associated away from human habitation and disturbance. However, this species can also be found on irrigated fields, rush grassland, fens and peat bogs. Marsh harriers are mainly concentrated in south-eastern areas of England, although there has been some range expansion into northwest England, the Channel Islands, the Isles of Scilly and a few sites in eastern Scotland (Balmer *et al*., 2013). As a ground nesting species, marsh harriers build a nest in thick marshy vegetation and sometimes in plants growing in shallow water; the nest is composed of a large pile of grass, reeds and small sticks (Snow and Perrins, 1998). This species feeds on a variety of ground and marsh animals, depending on local conditions (Snow and Perrins, 1998).

Marsh harrier is a partial migrant, some British breeders overwinter in Britain while others migrate to southern Europe and northwest Africa or south of the Sahara (Wernham *et al*., 2002). During the winter in the UK, the highest number of marsh harriers is recorded in a broad coastal band along south-eastern England (Balmer *et al*., 2013), where they may forage on grassy plains or agricultural areas (Snow and Perrins, 1998), which can bring them into contact with sources of human disturbance, although this species seems able to tolerate and even benefit from humanised environments, such as rice fields (Alves *et al*., 2014). During the winter, marsh harriers may gather at communal roost sites; gatherings of more than 30 birds have been recorded in north Norfolk, over 20 in Lincolnshire and up to 15 on the Isle of Sheppey in Kent (see Bright *et al*., 2009 for review).

Marsh harrier is an adaptable and opportunistic species (Wernham *et al*., 2002); the response to human disturbance may vary between individuals depending on levels of habituation to disturbance. In a Spanish study investigating wetland occupation during the breeding season, García *et al*. (2015) found that variables affecting occupation included vegetation composition and characteristics, wetland dimensions and distance to other wetlands occupied by marsh harriers; human disturbance (i.e. distance to paths, roads and habitation) was not a factor affecting wetland occupation.

However, other studies have found that marsh harriers are potentially sensitive to human disturbance. Direct persecution, agro-pastoral activities and lead-poisoning may determine wetland occupation in many areas in Europe; human disturbance has been found to affect different aspects of marsh harrier breeding activity such as breeding effort, nest defence or provision of prey for offspring (Fernández and Azkona, 1993; Stanevicius, 2004). Fernández and Azkona (1993) found that a relatively low level of disturbance during the breeding season (such as a quiet pedestrian) can result in reduced parental care and reduced nutrition levels in the young. To minimise the risk of disturbance in the UK, Hardey *et al*. (2013) recommend that nesting areas are viewed from a distance of 300-500 m, although the reedbed nesting habitat may provide a degree of protection in terms of reducing the visible detection of disturbance by marsh harriers (Ruddock and Whitfield, 2007; Whitfield et al., 2008a). Hardey *et al*. (2013) discourage searches for roosting birds during the breeding season due to the disturbance that this can cause.

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 300-500m

Nonbreeding season buffer zone = 300-500m

Marsh harrier is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for marsh harrier, but the maximum FID value recorded for this species is 130m when approached by a pedestrian during the breeding season; there are no records of AD/FID values during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for marsh harrier during the breeding season is 300-500m, although the authors stated that this estimate was cautionary as survey samples for this species were low.

In the UK, marsh harrier is most likely to be disturbed at nest sites early on in the breeding season as well as at communal roosting areas and potentially foraging grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 300 to 500m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect both breeding and nonbreeding marsh harriers from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

Lack of AD/FID studies on marsh harrier, more empirical studies are required.

Hen harrier, *Circus cyaneus*

Conservation Status

UK: Red List, Schedule 1A

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 545 breeding pairs (Woodward *et al*., 2020);

Scottish population = 460 breeding pairs in 2016 (Challis *et al*., 2020), 350-450 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a weak decrease in breeding birds (-29%) over 12 years.

Hen harrier became virtually extinct in mainland Britain by the start of the 20th century, mainly due to persecution by gamekeepers; tiny populations remained on Orkney, the Outer Hebrides and possibly on Kintyre and on Arran (Forrester *et al*., 2012). Respite from persecution during the two World Wars together with legal protection allowed some recovery time for this species. In the UK plus the Isle of Man, numbers increased from 630 pairs in 1988-89 to 806 pairs in 2004; however, numbers fell again to 662 pairs in 2010 (Balmer *et al*., 2013). Woodward *et al*. (2020) reported a further decrease to 545 pairs in 2016. Steep population declines have been reported from Ireland (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Booms *et al*., 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Aircraft (helicopter) in Alaska: Mean FID = 70m (n = 6), Min/Max FID = 30 to 150m (Booms *et al*., 2010).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 225 to 310m (n = 23 to 24); Min/Max AD (80% opinion range) = <10 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Range of median FID = 30 to 225m (n = 27 to 29), Min/Max FID (80% opinion range) = <10 to 750m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (SNH, 2015) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 500 to 1000m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 500 to 600m (Petty, 1998).

Operational onshore wind farm in the UK: Distance to nearest nest = 200 to 300m (Madders and Whitfield, 2006).

Aircraft disturbance in Scotland: Safe working distance = 500-750m (lateral), 500m (altitudinal) (SNH, 2015).

Ecology and non-quantitative disturbance responses

Hen harriers are generally scarce resident breeders in the UK. This species usually breeds in heather moorland, farmland and newly afforested uplands throughout Scotland, Ireland and Wales. The highest concentrations of hen harrier are recorded in Orkney, Outer Hebrides (Uists) and Inner Hebrides, parts of the Highlands and locally in the Southern Uplands; smaller numbers are present in northern England, Wales and the Isle of Man (Balmer *et al*., 2013). Forestry is influencing population trends, but hen harriers usually only inhabit areas with young trees (<15 years); mature tree plantations are not used by this species (Balmer *et al*., 2013). In Scotland, hen harriers nest on the ground, and the nest, which is a low pile of available vegetation (heather, rushes, grass etc), is constructed in amongst thick marshy vegetation, rarely out in the open (Snow and Perrins, 1998). Male hen harriers may perform a ‘sky-dance’ over breeding territories early in the season (Forrester *et al*., 2012). Some female hen harriers, and occasionally males, can be aggressive towards people at the nest, even striking an intruder’s head with feet and claws, Hardey *et al*. (2013) therefore recommend that head protection is used by surveyors approaching a nest site. This species feeds on small birds and rodents, typically by flying low over the ground and pouncing on prey; in the breeding season hen harriers will hunt along transects, following habitat edges (Snow and Perrins, 1998).

The hen harrier is a partial migrant, juveniles especially may disperse in the winter into southern England, Ireland and southwest Europe, but many adults remain in the UK throughout the year (Wernham *et al*., 2002). It is possible that in late autumn there is a small arrival and passage of wintering birds from Scandinavia, although there is no supporting ringing evidence for this (Forrester *et al*., 2012; Wernham *et al*., 2002). The overwintering population, which is probably largely composed of British and Irish breeders, is significantly different from the breeding distribution, with birds wintering in the lowlands, particularly around the coast all around the UK (Balmer *et al*., 2013). During the winter, hen harriers may gather at communal roost sites; exceptionally large roosts can hold up to 90 birds (in the Isle of Man), but more usually smaller numbers of 3-4 birds roost together, usually in wetlands, but sometimes also on heather moorland, lowland heath, conifer plantations and also in long grass (see Bright *et al*., 2009 for review).

Hen harriers are sensitive to human disturbance, and persecution in the form of nest destruction has been suggested to limit breeding attempts on grouse moors (Whitfield *et al*., 2008b). However, some individual hen harriers are able to habituate to human presence; this species can show a wide range of FID responses to different disturbance sources, some seemingly high disturbance activities such as a helicopter or operational wind turbines in the vicinity of nest sites can cause relatively little disturbance, whereas a pedestrian passing by can provoke a response at a relatively large distance (see Ruddock and Whitfield, 2007 for review; Booms *et al*., 2010; Madders and Whitfield, 2006).

Harriers prefer undisturbed grasslands for nesting (Urquhart, 2011). Tapia *et al*. (2004) found that hen harriers avoid areas with high levels of human activity such as roads and tracks. Another study found that northern harrier nests did not occur closer than 188m from the nearest building (see U.S. Fish and Wildlife Service, 1991 for review). Hiking trails have also been found to decrease the abundance of wintering harriers in riparian zones (Fletcher *et al*., 1999). Through habitat modelling, Tapia *et al*. (2004) suggest that the greatest threats to harrier populations are human infrastructure and human activities such as afforestation and wild-fires that change the habitat conditions.

Hen harriers are especially sensitive to disturbance early on during the breeding season when birds are laying as well as when they are present at roost sites. Hardey *et al*. (2013) state that if females are disturbed during the laying period, nests containing one or two eggs may be deserted. To minimise the risk of disturbance in the UK, Hardey *et al*. (2013) recommend that nesting areas are viewed from distances of 500-700m (Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a) and that care should be taken not to disturb nests in cold or wet weather around the time of hatching or when small young are present. Hardey *et al*. (2013) also discourage searches for roosting birds during the breeding season due to the disturbance that this can cause.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 300-750m

Nonbreeding season buffer zone = 300-750m

Hen harrier is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for hen harrier, but the maximum FID value recorded for this species is 150m when approached by a helicopter during the breeding season; there are no records of AD/FID values during the nonbreeding season. A non-quantitative study suggests that hen harrier will stay at least 188m away from human habitation. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for hen harrier during the breeding season is 500-750m. Hen harrier will nest at 200 to 300m from an operational wind turbine (Madders and Whitfield 2006) or closer (Ruddock and Whitfield, 2007).

In the UK, hen harrier is most likely to be disturbed at nest sites early on in the breeding season as well as at communal roosting areas and potentially foraging grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-750m is suggested to protect both breeding and nonbreeding hen harriers from pedestrian and aircraft disturbance, but habituation to disturbance influences the size of the buffer required and further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to disturbance. For activities with a high potential for visual and audial disturbance (e.g. forestry operations), a larger buffer zone between 500-1000m may be necessary during the breeding period.

Knowledge gaps

There are few studies have directly measured AD/FID for hen harriers, further empirical studies are required particularly focussing on sources of disturbance from human leisure activity.

Common buzzard, *Buteo buteo*

Conservation Status

UK: Green List

European: Least Concern

UK status

Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 63,000-87,500 breeding pairs (Woodward *et al*., 2020); Scottish population 15,000-20,000 breeding pairs, 40,000-60,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Reduced by persecution during late 19th and early 20th century, but this species has subsequently increased with legal protection. Increase has been especially strong in England where the species has spread its range dramatically since 1968-72 (Balmer *et al.*, 2013).

AD/FID

Quantitative disturbance distances

Common buzzard was not included in Ruddock and Whitfield (2007).

Breeding season (common buzzard):

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 49.9 to 88.0m (n = 24); Min/Max FID = 15.3 to 100m (Díaz *et al.*, 2021).

Surveyor walking in an urban habitat in Denmark: FID = 55m (n = 1) (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in Spain: Range of mean FID = 41.5 to 191.50m (n = 7); Min/Max FID = 34 to 231.2m (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in Czech Republic: Mean FID = 55.3m (n = 3); Min/Max FID = 40.3 to 70.5m. (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in France: FID = 55m (n = 1) (Díaz *et al.*, 2021).

Surveyor walking in an urban habitat in France: FID = 25m (n = 1) (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in Poland: Mean FID = 95.8m (n = 2); Min/Max FID = 30.5 to 161m. (Díaz *et al.*, 2021).

Surveyor walking in Europe: Mean FID 60.3m (n = 26) (Jiang and Møller, 2017).

Surveyor walking over farmland in Denmark: Min/Max FID = 0 to 200m (n = 213) (Sunde *et al.*, 2009).

Breeding season (rough-legged buzzard, *Buteo lagopus*, stand in species for common buzzard):

Surveyor walking in a rural habitat in Denmark: FID = 20.1m (n = 1) (Díaz *et al.*, 2021).

Surveyor walking in Europe: FID = 20.1m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season (common buzzard):

Surveyor walking in Europe: Mean FID = 54.06m (n = 9) (Møller, 2008a; Møller and Erritzøe, 2010).

Pedestrian (general activity) in Europe: Mean FID = 51.07m (n = 8) (Møller, 2008b).

Nonbreeding season (rough-legged buzzard):

Surveyor walking in Europe: FID = 20.1m (n = 1) (Møller, 2008a).

Pedestrian walking/running in farmland habitat in Colorado: Mean FID = 177m (n = 45); Min/Max FID = 55 to 900m (Holmes *et al*.,1993).

Motorised vehicle (general) in farmland habitat in Colorado: Mean FID = 71m (n = 62); Min/Max = 9 to 170m.

(Holmes *et al*.,1993).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Forestry operations in Scotland: Safe working distance = 200m

(Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 300 to 450m (Petty, 1998).

Ecology and non-quantitative disturbance responses

Although buzzards were persecuted in the 18th, 19th and early 20th centuries and were impacted by myxomatosis and organochlorine pesticides in the 1950s-60s, the population has rapidly increased; they are now widespread across the UK and are amongst the most abundant diurnal raptor species in Central Europe, (Balmer *et al*., 2013; Sunde *et al*., 2009; Thom, 1986). In the UK this species is most abundant in Wales, southwest and northern England, southern Scotland and the low ground of eastern Scotland, although this species has yet to colonise Shetland (Balmer *et al*., 2013). Buzzards forage over low vegetation, preferring unimproved pasture. They have a broad diet but rabbits are a key prey species (Balmer *et al*., 2013). Buzzards rest and nest on trees, rocky crags or cliffs, or rarely on steeply sloping ground. The nest is a substantial structure of branches, twigs, heather and other available material (Snow and Perrins, 1998). This species can occupy a wide variety of habitats that can be relatively undisturbed or densely populated by humans including: forests, woodland edges, agricultural land with isolated trees, hilly slopes, ridges or uplands with some degree of tree cover (Snow and Perrins, 1998; Thom, 1986). Buzzards are largely sedentary in the UK, and breeding and nonbreeding ranges are similar, although the range does expand slightly in the winter owing to the dispersal of immature birds (Balmer *et al*., 2013).

Due the potential of buzzards to live in close proximity with humans, it is not unexpected to find that this species may be disturbed at shorter distances compared with some other raptors. Studies measuring responses of buzzards to a walking pedestrian found that the FID response was generally lower than 100m with an upper limit of 200m (Díaz *et al*., 2021; Jiang and Møller, 2017; Sunde *et al*., 2009; Møller 2008a, b; Møller and Erritzøe, 2010). White and Sherrod (1973) found that rough-legged buzzards did not flush when a helicopter was 18m from the nest, although some caution should be exercised when comparing disturbance distances between common buzzards and rough-legged buzzards, as the latter species is a northerly breeding bird which may be less wary of humans than buzzards in the UK where some persecution still occurs.

Care must be taken to avoid excessive disturbance around buzzard nests during egg laying and early incubation as desertion can occur (Hardey *et al*., 2013). Santangeli *et al*. (2012) found that buffer zones greater than 100m around nests in intensively harvested areas in Finland resulted in higher occupancy than when harvesting occurred less than 100m from nests, suggesting that as wide a retention buffer zone as possible should be considered in each case (e.g., an increase in clear-cut distance from 0 to just 50 m more than doubled the occupancy).

Likely sensitivity to disturbance = Low/Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-200m

Common buzzard is assessed to have a low to medium sensitivity to human disturbance.

The maximum FID value recorded for buzzard when approached by a pedestrian is 231m during the breeding season and at least 54m (a mean value) during the nonbreeding season, however, the majority of recorded FID values are under 100m during the breeding season. MAD/buffer zones range from 200 to 450m to protect common buzzards from forestry operations during the breeding season in the UK.

In the UK, common buzzard has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season; this species is most likely to be disturbed in breeding territories early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect both breeding and nonbreeding common buzzards from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a wider buffer zone up to 450m to avoid disturbance during the breeding period.

Knowledge gaps

A range of FID distances in response to a surveyor walking have been recorded across Europe, but studies investigating other types of human disturbance (e.g. agricultural activities and motorised vehicles) are lacking. Further studies to record AD/FID response to a range of human activities are required, especially during the nonbreeding season.

Honey buzzard, *Pernis apivorus*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern; Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = more than 100 territories and at least 60 confirmed breeding pairs in 2020 (Rare Breeding Birds Panel, 2020b);

Scottish population = 50 territories in Scotland in 2020 (Rare Breeding Birds Panel, 2020b). Challis *et al*. (2020) estimated <10 breeding pairs between 2003-2015. Forrester *et al*. (2012) estimated possibly up to 50 pairs in 2004 and 2-30 individuals during passage.

UK long-term trend

Eaton *et al*. (2021) state a weak increase in breeding birds (+57%) over 25 years.

Honey buzzards have spread into upland forests of northern and western Britain, but as this is a very cryptic species, population estimates shouldn’t be too relied upon and there is some uncertainty about trends (Forrester *et al*., 2007; Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Honey buzzard was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Estonia: FID = 60m (n = 1) (Díaz *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Forestry operations in the UK: Safe working distance = 150 to 600m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 400 to 500m (Petty, 1998).

Ecology and non-quantitative disturbance responses

Honey buzzards are a summer visitor to the UK where they have a patchy distribution during the breeding season. The largest concentrations are along the south coast of England including Dorset through to Kent with other smaller breeding populations in Wales, Norfolk, North Yorkshire and Scotland (northeast, central and southern Scotland) (Balmer *et al*., 2013). Honey buzzards are superficially similar in appearance to common buzzards, but the former species is a more secretive woodland raptor specialising in mature woodlands with clearings to allow foraging (largely on insects, particularly bees and wasps), as well as mixed landscapes of detached woods, copses, meadows and small wetlands (Balmer *et al*., 2013; Snow and Perrins, 1998; Thom, 1986). This species breeds on branches or in forks of large trees, usually 10-20m above the ground in nests composed of twigs and green leaves; old carrion or common buzzard nests may be re-used (Snow and Perrins, 1998). Roosts generally occur near to the nest site during the breeding season (Hardey *et al*., 2013). In Scotland, nest woods can be either plantation forest or an older growth mix of deciduous and conifer trees and usually feature open glades, wooded rides and clear-felled areas (Forrester *et al*., 2012). Honey buzzards do not overwinter in the UK, after the breeding season birds migrate mainly to west and central regions of Equatorial Africa where they spend the winter in wooded areas (Snow and Perrins, 1998).

Honey buzzard is a cryptic species and their secretive habits sometimes allow them to inhabit woodland areas close to human habitation; this species has been considered to be vulnerable to persecution and/or interference with habitat, especially in the breeding season (Snow and Perrins, 1998). It may be difficult to determine how much honey buzzards are disturbed by human presence as, in contrast to other raptor species (sparrowhawks, goshawks and common buzzards), honey buzzards are usually silent when disturbed by humans at the nest site (Selås, 1997). For honey buzzard nests, Santangeli *et al*. (2012) reported that buffer zones greater than 100m around nests in intensively harvested areas in Finland resulted in higher occupancy than when harvesting occurred less than 100m from nests, suggesting that as wide a retention buffer zone as possible should be considered in each case (e.g., an increase in clear-cut distance from 0 to just 50 m more than doubled the occupancy).

However, habituation and tolerance of disturbance varies between individual honey buzzards. Some studies have found that this species is more tolerant of human activity than any other raptor species (see Roberts *et al*., 1999 for review). Roberts *et al*. (1999) did not find honey buzzards to be particularly sensitive in a study recording locations of nests in forests of central and lowland Britain. Roberts *et al*. (1999) found that of 48 honey buzzard nesting attempts, 24 (50%) were in trees adjacent to rides, paths or clearings, and a total of 37 (77%) were within 20m; the farthest nest tree was 150m from an access route and only one nest was believed to have failed as a direct result of human disturbance.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-200m

Honey buzzard is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for honey buzzard, but the maximum FID value recorded for this species is 60m when approached by a pedestrian during the breeding season. Buffer zone range from 150 to 600m to protect honey buzzards from forestry operations during the breeding season in the UK. In England, breeding honey buzzards are considered to have a high sensitivity to disturbance within 3km and medium sensitivity within an additional 2km around onshore wind farms.

In the UK, honey buzzard has the potential to be disturbed at nest sites early in the breeding season during egg laying and incubation. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect breeding honey buzzards from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a wider buffer zone up to 600m to avoid disturbance during the breeding period.

Knowledge gaps

A range of FID distances in response to a surveyor walking have been recorded across Europe, but studies investigating other types of human disturbance (e.g. agricultural activities, wind farms and motorised vehicles) are lacking. Further studies to record AD/FID response to a range of human activities are required, especially during the nonbreeding season.

Northern goshawk, *Accipiter gentilis*

Conservation Status

UK: Green List; Schedule 1

European: Least Concern

UK status

Re-introduced Resident Breeder

UK and Scottish population estimate

UK population = 620+ breeding pairs (Woodward *et al*., 2020);

Scottish population = 165 breeding pairs in 2017 (Challis *et al*., 2020), 350-450 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+206%) over 25 years.

Once widespread in Scotland, but was exterminated in the 1880s as a result of deforestation and persecution (Balmer *et al*., 2013). Since then, escaped falconry birds or deliberately released birds first bred in Scotland in 1972, and numbers have increased since then, though at highly variable rates in different parts of Scotland (Forrester *et al*., 2012). Similar increases after release have occurred in Wales and in England (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

AD/FID updates (Díaz *et al*., 2021; Grubb *et al*., 2013) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in an urban habitat in Poland: FID = 23.1m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Spain: FID = 140m (n = 1) (Díaz *et al*., 2021).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 125 to 175m (n = 10); Min/Max AD (80% opinion range) = 10 to 500m; Min/Max AD (90% opinion range) = 300 to 500m.

Range of median FID = 30 to 70m (n = 10), Min/Max FID (80% opinion range) = <10 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Forestry operations (logging truck noise) in North America:

Min/Max AD = 78 to 167m (Grubb *et al*., 2013).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Anonymous, 2012; Naylor, 2009) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations (blasting) in North America: Buffer zone = 1000m

Forestry operations (vehicle/machine) in North America: Buffer zone = 500m

Forestry operations (helicopter) in North America: Buffer zone = 1000m

(Anonymous, 2012).

Forestry operations in Ontario: Buffer zone = 200m (Naylor, 2009).

Forestry operations in the UK: Safe working distance = 250 to 450m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 375 to 425m (Petty, 1998).

Forestry operations in France/Italy at a disturbed site: 100m (Penteriani and Faivre, 2001).

Pedestrian (general buffer zone) from Colorado Wildlife guidance: Buffer zone = c.800m (Craig, 2002)

Ecology and non-quantitative disturbance responses

Goshawk is a relatively scarce resident species in the UK that is associated with state-owned forests. The highest numbers of breeding birds are present in the Scottish Borders, northeast Scotland and Wales, the latter is a major stronghold of this species, numbers are smaller elsewhere (Balmer *et al*., 2013). Goshawk breed on branches or in the forks of large trees, often conifers, usually 10-20m above the ground; the nest is composed of twigs and is freshly built each year, either as a completely new structure, or on top of an existing nest (Forrester *et al*., 2012; Snow and Perrins, 1998). The nests from different years are often clustered within the same tree (Hardey *et al*., 2013). This species may also occasionally breed in small broad-leaved trees, but they are then more susceptible to disturbance (Wernham *et al*., 2002). Goshawks are predators with a wide-ranging diet, prey items include birds as small as goldcrests and mammals as large as adult brown hares; pigeons, corvids and thrushes form the main part of the diet during the breeding season (Forrester *et al*., 2012; Snow and Perrins, 1998). Adults are sedentary and remain in their territories throughout the year, leading to similar patterns of distribution and abundance between seasons, whereas immature birds roam more widely outside key breeding areas (Balmer *et al*., 2013). Adults recorded outside known breeding areas in the winter may include the occasional continental migrant (Forrester *et al*., 2012).

Northern goshawk is a shy, scarce species and is sensitive to human presence, especially early in the breeding season; this species is considered to have low to moderate thresholds for new human disturbance (Anonymous, 2012). Hardey *et al*. (2013) advises that care must be taken to avoid excessive disturbance around goshawk nests during nest building and early incubation as some pairs are prone to desert at this time. Hardey *et al*. (2013) recommend that surveyors monitor nests from a distance of 300-500 m (Ruddock and Whitfield, 2007; Whitfield et al., 2008a) and the authors state that if disturbed early in the season, breeding goshawks may move up to 2.5 km to another nest site, with some pairs having up to four different nesting areas within their nesting range. In a study in Germany, Saga and Selås (2012) found that when goshawk pairs lost their nests during autumn, winter or early spring by natural causes or human disturbance, the birds often moved 500m or 1km away and constructed new nests elsewhere.

However, disturbance distance for individual goshawks depends on habituation to disturbance. Snow and Perrins (1998) state that this species requires freedom from disturbance but will live close to isolated dwellings or even fringes of towns.

At a disturbed forestry site in Arizona, Grubb *et al*. (2013) observed that goshawks present on the nest with 15-day old chicks did not appear to respond to logging trucks passing by the nest at 78m and they generally did not respond to passing aircraft, although in most cases aircraft were louder than the logging truck, indicating acclimatization to aircraft noise. Goshawks are generally considered to be much more tolerant to disturbance in urban environments compared with rural ones (Díaz *et al*., 2021; see Ruddock and Whitfield, 2007 for review).

The type of forest habitat influences goshawk disturbance; in Norway, Saga and Selås (2012) observed that logging did not reduce the proportion of nests used in the second or third breeding season after logging, but that nest reuse was greater in larger areas of mature forest as well as forests with a higher proportion of Norway spruce, which gives better cover than Scots pine and deciduous trees. Santangeli *et al*. (2012) found that buffer zones greater than 100m around nests in intensively harvested areas in Finland resulted in higher occupancy than when harvesting occurred less than 100m from nests, suggesting that as wide a retention buffer zone as possible should be considered in each case (e.g. an increase in clear-cut distance from 0 to just 50 m more than doubled the occupancy).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 300-500m

Northern goshawk is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are fairly limited for goshawk in the UK, but the maximum FID value recorded for this species is 140m when approached by a pedestrian and 167m when approached by a logging truck during the breeding season; there are no records of AD/FID values during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for goshawk during the breeding season is 300-500m; the authors noted that this range is generally in line with the published UK and international buffers.

Buffer zones range from 250 to 425m to protect goshawks from forestry operations during the breeding season in the UK; in America buffer zones for forestry operations can go up to 1km.

In the UK, goshawk has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season; this species is most likely to be disturbed in breeding territories early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-500m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect both breeding and nonbreeding goshawks from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions, especially during the nonbreeding season. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a wider buffer zone up to 425m to avoid disturbance during the breeding period.

Knowledge gaps

There are a range of studies providing buffer zones for goshawks, but studies recording AD/FID are relatively few. FID empirical studies are required to record habituation levels of individual birds.

Kestrel, *Falco tinnunculus*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 31,000 breeding pairs (Woodward *et al*., 2020);

Scottish population = 2,750-5,500 breeding pairs in 2013 (Challis *et al*., 2020), 15,000-25,000 individuals in winter and 500-1,000 during passage (Forrester *et al*., 2012).

UK long-term trend

Breeding range in the UK declined by 6% between 1968/72 to 2007/11, UK population declined by 32% between 1995 to 2010, part of an overall decline of 44% since 1970 (Balmer *et al*., 2013). The decline in the kestrel population is thought to be stronger in Scotland than in England (Forrester *et al*., 2012), this species declined by 61% in Scotland between 1995-2018 (Harris *et al*., 2020). Losses have occurred in western Scotland, Wales and sparingly through the midlands and north of Ireland (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Kestrel was not included in Ruddock and Whitfield (2007).

Breeding season (kestrel):

Surveyor walking in a rural habitat in Spain: Range of mean FID = 2.8 to 12m (n = 16), Min/Max FID = 9.6 to 151.7m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Spain: Range of mean FID = 11.8 to 31.6m (n = 9), Min/Max FID = 10.9 to 31.6m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 18 to 48m (n = 6), Min/Max FID = 8.5 to 48m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Hungary: Range of mean FID = 25 to 41.5m (n = 5), Min/Max FID = 12.5 to 91.6m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Czech Republic: Range of mean FID = 31 to 61.3m (n = 6), Min/Max FID = 31 to 61.3m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Poland: Range of mean FID = 19.9 to 117.7m (n = 3), Min/Max FID = 19.9 to 120m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Poland: FID = 40.3m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID = 32.6m (n = 10) (Jiang and Møller, 2017).

Breeding season (lesser kestrel, *Falco naumanni*, stand in species for kestrel):

Surveyor walking in Europe: Mean FID = 44.3m (n = 5) (Jiang and Møller, 2017).

Nonbreeding season (kestrel):

Surveyor walking in Europe: Mean FID = 30.08m (n = 6) (Møller, 2008a).

Pedestrian (general activity) in Europe: Mean FID = 18.02m (n = 3) (Møller, 2008b).

Surveyor walking in Europe: Mean FID = 30.94m (n = 9) (Møller and Erritzøe, 2010).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Forestry operations in the UK: Disturbance free zone = 100 to 200m (Petty, 1998).

Ecology and non-quantitative information on disturbance responses

The kestrel is one of the most adaptable, widespread and abundant resident raptor species in the UK. Densities are highest in central and eastern England and southwest Ireland, but this species is scarcer in western Scotland, Wales and southwest England (Balmer *et al*., 2013). Breeding and nonbreeding ranges are very similar in the UK (Balmer *et al*., 2013). Kestrels inhabit a wide range of habitats, both in uplands and lowlands. Rural habitats include moorland, heathland, grassland, wetlands, woodlands and coastal areas; kestrels will also inhabit many areas close to human activity including: parklands, airfields, railways, motorways and other grass-verge highways, canal and river banks, as well as within human settlements including cities with open green spaces (Snow and Perrins, 1998). The nesting locations of this species are highly variable and include cavities or forks in trees and on cliffs, buildings, occasionally pylons, and they will readily take to nest boxes when available (Snow and Perrins, 1998). Kestrels will alarm call if disturbed or if responding to other raptors or corvids entering the nest area, they may also be seen displaying over the nesting territory (Hardey *et al*., 2013). This species is adaptable and opportunistic in its foraging behaviour; the diet is chiefly small mammals (especially voles), although birds, insects and lizards may also be taken depending upon location and season (Snow and Perrins, 1998).

The kestrel is considered a human-tolerant species, they occur in a variety of human-dominated environments including urban, suburban and agricultural habitats and are therefore able to habituate to at least some degree of human presence. However, although recorded FID values are generally lower for kestrel than for some other raptor species (e.g. Díaz *et al*., 2021), some studies have shown that kestrel breeding success can be impacted by human disturbance (Strasser, 2010). In a study on American kestrels, Strasser and Heath (2013) found that birds nesting in areas with higher levels of vehicle traffic were 9.9 times more likely to fail than birds nesting in lesser disturbed areas (the habitat and clutch initiation dates did not explain the reproductive outcome). In addition, proximity to large, busy roads and developed areas was found to negatively affect kestrel reproduction by causing increased stress hormones that promoted nest abandonment. The authors of the study suggested that their results demonstrated that the presence of kestrels in human-dominated areas does not necessarily indicate a tolerance for human presence and that disturbance may cause physiological stress responses that impact survival.

Negro and Hiraldo (1993) found that the breeding success of lesser kestrels in Spain was positively correlated with the height of their nests and it was suggested that birds selected the highest positions to avoid predation and disturbance (by carnivores or humans). However, response to human disturbance may differ between kestrels and lesser kestrels as the former is usually a solitary nesting species, whereas lesser kestrel is colonial breeder, sometimes breeding in colonies up to 500 pairs (Snow and Perrins, 1998).

Hardey *et al*. (2013) advises that care must be taken to avoid excessive disturbance around kestrel nests while pairs are displaying and laying as this may cause the birds to move location. Disturbance at kestrel nests should also be avoided when the chicks are three weeks old or more because they are prone to fledge prematurely from this age (Hardey *et al*., 2013).

The kestrel population is declining in the UK; this may be a consequence of the recovery of the buzzard population (through better protection) which competes with kestrels for small mammalian prey (Forrester *et al*., 2012). In addition, kestrels may be suffering from predation from the increasing UK population of goshawk and peregrine predators (Forrester *et al*., 2012). Concern has been raised by NatureScot over excessive kestrel disturbance at a site in northeast Scotland (NatureScot, 2019); the additional potential for stress caused by excessive human disturbance may increasingly have a detrimental impact upon this species.

Likely sensitivity to disturbance = Low/Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone ≤ 50m

Kestrel is assessed to have a low to medium sensitivity to human disturbance.

The maximum FID value recorded for kestrel when approached by a pedestrian is 152m during the breeding season and at least 31m (a mean value) during the nonbreeding season; the majority of recorded FID values are under 50m during the breeding season. Buffer zones range from 100 to 200m to protect kestrels from forestry operations during the breeding season in the UK.

In the UK, kestrel has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season; this species is most sensitive to disturbance early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect nesting kestrels and a buffer zone of ≤50m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

A range of FID distances in response to a surveyor walking have been recorded across Europe, but studies investigating other types of human disturbance (e.g. agricultural activities and motorised vehicles) are lacking. Further studies to record AD/FID response to a range of human activities are required, especially during the nonbreeding season.

Eurasian hobby, *Falco subbuteo*

Conservation Status

UK: Green List; Schedule 1

European: Least Concern

UK status

Migrant/Resident Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 2,050 breeding pairs (Woodward *et al*., 2020), Challis *et al*. (2020) estimated 632 breeding pairs in UK;

Scottish population is fewer than five breeding pairs, 10-30 individuals during passage (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a weak increase in breeding birds (+48%) over 25 years.

Hobby has undergone a large-scale expansion in range, consolidating their distribution in southern England and spreading north (Balmer *et al*., 2013). The UK population increased by 16% between 1995 and 2010; between 2008-11 this species was found to occupy four times as many 10 km squares as in 1968-72 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Hobby was not included in Ruddock and Whitfield (2007).

No AD/FID distances available for hobby.

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Forestry operations in the UK: Safe working distance = 180 to 450m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative disturbance responses

The hobby is a summer visitor to the UK. Hobbies are a fairly rare breeding species in Scotland, but south of a line from the Humber to the Mersey, this is a widespread breeding species (with the exception of west Wales and Cornwall where they remain scarce) (Balmer *et al*., 2013). Hobbies breed in lowland habitats with open expanses of low vegetation broken up by groups of tall trees or fringed by mature woodlands, warm enough to sustain an abundance of insect prey, principally dragonflies (Balmer *et al*., 2013; Snow and Perrins, 1998), however, as this species has spread north, lowland farmland areas have been increasingly used for breeding (Messenger and Roome. 2007; Sergio and Bogliani 1999). Hobbies nest on trees between 6 and 32m tall, usually in old carrion crow nests (Snow and Perrins, 1998). This species is relatively common in cultivated landscapes in Europe (Fuller *et al*., 1985; Bogliani *et al*., 1994) and they are able to adapt fairly well to intensively managed agroforestry systems (Sergio and Bogliani, 1999; 2000). Hobbies don't overwinter in the UK, after the breeding season they migrate south to warmer latitudes and spend the winter mainly in southern Africa (Wernham *et al*., 2002).

Hobbies show some ability to habituate to human disturbance in farmland areas. Messenger and Roome (2007) observed that in a study of breeding hobbies on lowland farmland in Derbyshire, birds were generally unconcerned by the presence of humans inside vehicles near a nest site, but were usually alarmed by humans on foot close to nest sites; three cases of human related nest failures were thought to be due to unintentional disturbance by farmers or others working outside vehicles for extended periods in the immediate vicinity of the nest. Sergio and Bogliani (1999) documented similar tolerance to human disturbance, in Italy some hobby pairs appear to be extremely tolerant of humans inside tractors, some birds have also been observed to continue incubation whilst the ground just underneath the nest is ploughed. Sergio and Bogliani (1999) also reported that the local hobby population in their Italian study area appeared to have adapted fairly well to the intensively managed agroforestry system, with a recorded density and productivity in the range being similar to that reported for other European hobby populations in less intensively cultivated areas.

However, despite some tolerance shown towards human presence, hobbies are possibly still more likely to choose breeding habitats away from human disturbance if suitable habitat is available. In another study investigating hobby nest site selection in Italy, Sergio and Bogliani (2000) observed that hobbies select nesting areas with a higher extent of mature poplar plantations and further away from potential sources of human disturbance; mean distances of nest sites from roads ranged from 1,004 to 1,255m and mean distance to human habitation ranged from 1,024 to 1,546m. Hardey *et al*. (2013) advises that hobbies are particularly sensitive to disturbance during early incubation and that intensive nest searches are best carried out at a time when young are likely to have hatched.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 200-450m

Eurasian hobby is assessed to have a medium sensitivity to human disturbance, but this is a cautionary assessment due to the lack of available published studies reporting AD/FID values for this species.

Buffer zones range from 180 to 450m to protect hobbies from forestry operations during the breeding season in the UK.

In the UK, hobby has the potential to be disturbed at nest sites early in the breeding season during egg laying and incubation. Depending on the level of habituation to disturbance, a buffer zone of 200-450m is suggested to protect breeding hobbies from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

There is little published on the effects of human disturbance on hobbies. Studies are required to measure a range of human disturbance on the AD/FID for this species.

Peregrine falcon, *Falco peregrinus*

Conservation Status

UK: Green List, Schedule 1

European: Least Concern, Annex 1

UK status

Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,750 breeding pairs (Woodward *et al*., 2020);

Scottish population = 523 (479-592) breeding pairs in 2014 (Challis *et al*. 2020), 2,000-2,500 individuals during winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (+5%) over 22 years.

Although numbers decreased considerably due to organochlorine pesticides in the 1950s-60s, there has been a large increase in numbers after the pesticide ban; a 200% range expansion is reported between 1968-72 to 2008-11 (Balmer *et al*., 2013). However, population trends in different parts of the UK vary and populations in some upland areas have declined; in contrast with England, the population estimates for Scotland suggest an overall decline between 2002 to 2014 (Wilson *et al*.,2018),

AD/FID

Quantitative disturbance distances

No AD/FID updates published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 225 to 310 (n = 24 to 26); Min/Max AD (80% opinion range) = 10 to 750m; Min/Max AD (90% opinion range) = 500 to 750m.

Range of median FID = 125 to 225m (n = 30 to 31); Min/Max FID (80% opinion range) = 10 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season (Prairie falcon, *Falco mexicanus*, stand in species for peregrine falcon):

Pedestrian walking/running in farmland habitat in Colorado: Mean FID = 92m (n = 33); Min/Max FID = 24 to 185m (Holmes *et al*.,1993).

Motorised vehicle (general) in farmland habitat in Colorado: Mean FID = 85m (n = 27); Min/Max = 18 to 200m (Holmes *et al*.,1993).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Slankard *et al*., 2020; SNH, 2015) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian (general buffer zone) from Colorado Wildlife guidance: Buffer zone = c.802m (Craig, 2002).

Pedestrian leisure (climbing) in North America: Buffer zone = 800m

Pedestrian leisure (general) in North America: Buffer zone = 800 to 1500m

Noise disturbance in North America: Buffer zone = 800m

Pedestrian (general) in North America: Buffer zone = 200 to 1600m

(Richardson and Miller, 1997).

Pedestrian leisure (climbing) in the UK: Buffer zone = 200m (Brambilla *et al*., 2004).

Pedestrian leisure (climbing; walking/running) in North America: Buffer zone = 400 to 800m (Ellis, 1982).

Forestry operations in the UK: Safe working distance = 600 to 1000m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 400 to 600m (Petty, 1998).

Forestry operations in Poland: Strict buffer zone = 200m, Seasonal buffer zone = 500m (see Bright *et al*., 2006).

Aircraft disturbance in Scotland: Safe working distance = 500-750m (lateral), 500m (altitudinal) (SNH, 2015).

Aircraft n Europe: Buffer zone = 500m (Fyfe and Olendorff, 1976).

Construction activity at a bridge in the USA: Buffer zone = 46 to 91m (Slankard *et al*., 2020).

Quarrying activities: Buffer zone = 150 to 600m, depending on habituation and tolerance of the individual to human disturbance (British Columbia Ministry of Forests, Lands and Natural Resource Operations, 2013)

Nonbreeding season:

Pedestrian and vehicle disturbance in farmland habitat in Colorado: Buffer zone = 160m (Holmes *et al*.,1993).

Quarrying activities: Buffer zone = 50 to 500m, depending on habituation and tolerance of the individual to human disturbance (British Columbia Ministry of Forests, Lands and Natural Resource Operations, 2013)

Ecology and non-quantitative disturbance responses

The peregrine falcon is a resident species in the UK. Peregrine falcons are adaptable and highly mobile, they breed in a wide range of environments including uplands and coastal areas with suitable precipitous cliffs and crags as well as across much of the lowlands where they can breed in quarries or trees and man-made structures (Balmer *et al*., 2013; Snow and Perrins, 1998). Depending on the location of breeding, the nest can be formed of a slight scrape in earth or old nest debris of nest ledge or a depression on top of an old nest of another species (Snow and Perrins, 1998). Peregrines feed chiefly on birds taken on the wing, usually over open country, but if nesting by the coast, hunting may be carried out almost exclusively over the sea during the breeding season (Snow and Perrins, 1998). Prey recorded in Scotland ranges in size from goldcrest to geese with pigeons and red grouse often eaten (Forrester *et al*., 2012). In the UK, peregrines are non-migratory and breeding and nonbreeding ranges are similar (Balmer *et al*., 2013), though many individuals, especially immature birds may wonder extensively in autumn and winter (Snow and Perrins, 1998).

Peregrines vary in their tolerance to human disturbance. Generally, undisturbed habitats are preferred for breeding, but the use of man-made structures for nesting by some individuals can be very wide and varied including: tall buildings, bridges, electricity pylons, power stations, chimneys, gas towers, church towers, quarry machinery, ruins and windowsills in high-rise buildings (Balmer *et al*., 2013; Forrester *et al*., 2012; Ruddock and Whitfield, 2007 for review). The tolerance level of individual peregrines is likely to depend on the regularity and type of disturbance individuals are exposed to (Ruddock and Whitfield, 2007). Some individual falcons appear to be unaffected by loud disturbance events in close vicinity to the nest, for example, in Alaska, White and Sherrod (1973) found that peregrines did not flush when a helicopter was 18m from the nest and in Australia, Olsen and Olsen (1980) noted that water skiers can regularly pass within 50m of eyries without having any noticeable effect on behaviour. Hardey *et al*. (2013) consider that pairs in remote locations may be more sensitive to human activity whereas birds in urban areas, quarries or frequently visited sites may be more tolerant of disturbance. Hardey *et al*. (2013) also state that if licenced surveyors require to record clutch size, incubating peregrines can be flushed from the eyrie during good weather by loud noises (clapping, shouting), but despite such disturbance, some birds may not leave their eggs until the eyrie is reached. Breeding peregrines have been reported to tolerate large amounts of casual disturbance at high, inaccessible cliffs in the UK (see Bright *et al*., 2006 for review). Moore *et al*. (1997) state that in the absence of interference to eyries or their occupants, breeding peregrines will ignore most human disturbance. Olsen and Allen (1997) noted that peregrines can be very tolerant of quarrying activity in close proximity to nest sites; an incubating female on a nest located 15m high in a quarry in Australia was noted to return to her nest within ten minutes of blasting occurring within 100m of her nest, three young later successfully fledged from the nest.

However, despite the apparent tolerance of humans shown by some individuals, peregrines are still potentially sensitive to disturbance, especially early on during the breeding season when birds are laying and incubating; for some pairs human presence around the nest can prevent breeding (e.g. Olsen and Olsen, 1980). Ratcliffe (1984) suggested that peregrines don’t flush in the presence of humans “until at close range” but that disturbance may cause nest failure. In the UK, Hardey *et al*. (2013) recommend that nesting areas are viewed from distances of 500–750m (Ruddock & Whitfield 2007, Whitfield *et al.,* 2008a) to minimise the risk of disturbance and that visits made to the nest by licenced surveyors to measure and ring chicks should be made before the young are 25 days old because after this disturbance to a nest may cause premature fledging. Ruddock & Whitfield, (2007) state that activities above a nest are more likely to cause disturbance than those below.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 500-750m

Nonbreeding season buffer zone ≤ 200m

Peregrine is generally assessed to have a high sensitivity to human disturbance, although response distances by individual birds can vary widely.

Quantitative studies measuring AD/FID are very limited for peregrine, but the maximum FID value recorded for Prairie falcon in the USA is 185m when approached by a pedestrian and 200m when approached by a motorised vehicle during the nonbreeding season; there are no records of AD/FID values during the breeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for peregrine during the breeding season is 500 to 750m.

Buffer zones to protect peregrines from pedestrian disturbance during the breeding season in North America range from 200m to 1.6km, a 200m buffer zone has been suggested to protect breeding birds from climbing disturbance in the UK. Buffer zones to protect breeding peregrines from forestry operations in the UK range from 200 to 600m. A safe working distance for aircraft in Scotland is considered to be 500-750m (lateral) and 500m (altitudinal).

In the UK, peregrine has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season; this species is most likely to be disturbed in breeding territories early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 500-750m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect nesting peregrines and a buffer zone ≤200m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions, especially during the nonbreeding season. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a wider buffer zone up to 600m to avoid disturbance during the breeding period.

Knowledge gaps

A range of buffer zones exist, but very few studies have measured peregrine AD/FID. Further studies, particularly focussing on the AD/FID response to human leisure activities and quarrying activities in the UK are required for this species.

Merlin, *Falco columbarius*

Conservation Status

UK: Red List, Schedule 1

European: Vulnerable, Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,150 breeding pairs (Woodward *et al*., 2020); Scottish population = 733 breeding pairs in 2008 (Challis *et al*. 2020), 3,000+ individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a weak increase in breeding birds (+94%) over 25 years.

Numbers were thought to be declining slightly up to 1950,and declining faster after 1950. During 1968-72 the population was estimated at 600-800 pairs (of which 280 pairs in Scotland), but surveys in 1983-84 and 1993-94 suggest an increasing population with about 1,100-1,500 pairs (of which 800 pairs in Scotland) (Forrester *et al*., 2012).

AD/FID

Quantitative disturbance distances

No AD/FID updates published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 225 to 400m (n = 19 to 22); Min/Max AD (80% opinion range) = <10 to 500m; Min/Max AD (90% opinion range) = 300 to 500m.

Range of median FID = 30 to 225m (n = 28 to 30); Min/Max FID (80% opinion range) = <10 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Pedestrian walking/running in farmland habitat in Colorado: Mean FID = 76 (n = 14); Min/Max FID = 17 to 180m (Holmes *et al*., 1993).

Motorised vehicle (cars) in farmland habitat in Colorado: Mean FID = 62 (n = 10); Min/Max FID = 44 to 85m (Holmes *et al*., 1993).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Naylor, 2009) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running or motorised vehicles in farmland habitat in Colorado: Buffer zone = 125m (Holmes *et al*., 1993).

Pedestrian activity (general) in North America: Buffer zone = 400m (Becker and Ball, 1983).

Forestry operations in the UK: Safe working distance = 200 to 400m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 200 to 300m (Petty, 1998).

Forestry operations in Ontario: Buffer zone = 200m (Naylor, 2009).

Nonbreeding season:

Pedestrian and vehicle disturbance in farmland habitat in Colorado: Buffer zone = 125m (Holmes *et al*.,1993).

Ecology and non-quantitative disturbance responses

Merlin is a resident breeder in the UK. This species preferentially breeds in upland moorland areas dominated with heather. Scotland holds more than half of the breeding population, the highest densities in the UK are located on Scottish islands, in the northern and eastern Scottish Highlands, the north Pennines and northwest Ireland (Balmer *et al*., 2013). Merlin chiefly feed on small birds caught in open country (Snow and Perrins, 1998). Like other falcons, merlin do not build their own nests but reuse those created by other species, usually corvids, or they lay their eggs in a scrape on the ground (Snow and Perrins, 1998). Tree-nesting merlin are likely to have a greater detection capability compared with birds nesting on the ground, although tree nesting merlin may respond to human disturbance at shorter distances (see Ruddock and Whitfield, 2007 for review). Breeding merlin roost on the ground in deep vegetation, in trees or on crags close to the nest site Hardey *et al*. (2013). In the nonbreeding season, wintering merlin are joined by immigrants from Iceland (Wernham *et al*., 2002). Merlins are much more widespread in the UK during the nonbreeding season, during the winter they tend to avoid uplands and inhabit lower-lying habitats (Balmer *et al*., 2013).

Merlin is a species known to tolerate some human disturbance and there are many individuals which nest in urban environments (Konrad, 2004; Haney and White, 1999) where reproductive output can be higher than in rural populations (see Ruddock and Whitfield, 2007 for review). Holmes *et al*., 1993 discussed that merlin may flush at shorter distances when disturbed on a paved road than when disturbed on gravel roads; the authors discussed that the reason for this may be that merlin perching along paved roads have habituated to the greater traffic volume associated with them, or that individuals with greater tolerance limits to disturbance may be using areas with greater disturbance levels.

However, tolerance of disturbance varies between individuals and merlin are potentially sensitive to disturbance, especially early on during the breeding season when birds are laying and incubating. Newton *et al*. (1981) suggested that increased human recreational disturbance in the Peak District may prevent this species from achieving former breeding numbers in this area. Holmes *et al*. (1993) showed that merlin were more likely to flush when approached by a human on foot than they were when approached by a vehicle. Besides pedestrians, other human activities may impact breeding merlin including camping and picnic areas, shooting and fishing activities (see Konrad, 2004 for review). Becker and Ball (1983) discussed that established breeding merlin populations may decline from increased stress and reduced productivity if human disturbance is persistent.

In the UK, Hardey *et al*. (2013) advise that care must be taken to avoid excessive disturbance around occupied merlin nesting ranges in late March and April, as this may cause the birds to move. To minimise the risk of disturbance Hardey *et al*. (2013) recommended that nesting areas are viewed from distances of 300–500m (Ruddock & Whitfield, 2007; Whitfield *et al.*, 2008a) and that no attempt should be made to locate the roosts of breeding merlin because of the potential for disturbance. Adult merlin flushed from nests may take a long time to return to a nest after disturbance, during which time the eggs are at risk of chilling; small young may also be dislodged (Hardey *et al*., 2013).

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 300-500m

Nonbreeding season buffer zone ≤ 200m

Merlin is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for merlin, but the maximum FID value recorded for this species in the USA is 180m when approached by a pedestrian and 85m when approached by a motorised vehicle during the nonbreeding season; there are no records of AD/FID values during the breeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for merlin during the breeding season is 300 to 500m.

Buffer zones to protect merlin from pedestrian disturbance during the breeding season in North America range from 125 to 400m. Buffer zones to protect breeding merlin from forestry operations in the UK range from 200 to 400m.

In the UK, merlin has the potential to be disturbed on breeding grounds as well as at roosting areas and foraging grounds during the nonbreeding season; this species is most likely to be disturbed in breeding territories early in the breeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-500m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect nesting merlin and a buffer zone ≤200m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions, especially during the nonbreeding season. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

There are only a few published studies measuring merlin AD/FID. Further studies, particularly focussing on the AD/FID response to human leisure activities are required for this species.

Species: Waders

Eurasian oystercatcher, *Haematopus ostralegus*

Conservation Status

UK: Amber List

European: Vulnerable

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 95,500 breeding pairs, 305,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 84,500-116,500 breeding pairs, 80,000-120,000 in winter (Forrester *et al*., 2012).

UK long-term trend

Relatively stable, population declined by 29% in Scotland (causes are unclear) contrasting with a 48% increase in England, gains in Britain are almost exclusively at inland sites, though there are some gains along the south coast of England (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Oystercatcher was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Scotland: Mean FID = 20.2m (n = 9); Min/Max FID = 16 to 22m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Scotland: Mean FID = 24.5m (n = 2); Min/Max FID = 24 to 25m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 35 to 45.1m (n = 9); Min/Max FID = 18 to 40m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Denmark: FID = 28m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Norway: Range of mean FID = 18.6 to 24m (n = 14); Min/Max FID = 15 to 35m (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in Norway: Mean FID = 28m (n = 3); Min/Max FID = 28 to 28m (Díaz *et al*., 2021).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 43m (n = 62); Min/Max FID = 15 to 105m (Scarton, 2018a).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Mean FID = 58.1m (n = 63); Min/Max FID = 31 to 92m (Scarton, 2018a).

Nonbreeding season:

Surveyor walking along shoreline in Scotland: Mean FID of foraging birds = 43.81m (n = 165), Min/Max AD = 18 to 68m; FID was less in areas with more human activity (Azaki and Cresswell, 2021).

Surveyor walking over mudflats in Scotland: Mean FID = 137.61m (n = 22) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 97.3m (n = 147); Min/Max FID = 30 to 228m (Collop *et al*., 2016).

Surveyor walking in an estuary in England: Mean FID = 41m (n = 48) (Brett, 2012).

Surveyor walking along a shoreline in England: Mean FID = 39m (Carless, 2005).

Surveyor walking on mussel bed in England: Mean FID = 123 (n = 27); Min/Max FID = 90 to 140m (Stillman and Goss-Custard, 2002).

Surveyor walking on mussel bed in England: Range of mean FID = 26 to 48m (n = 83) (Urfi *et al*., 1996).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 76.7m (n = 17); Min/Max FID = 50 to 122m (Scarton, 2018b).

Surveyor walking in mudflats in Denmark: Mean FID = 119m (n = 172), Min/Max FID = 20 to 400m (Laursen *et al*., 2005).

Pedestrian walking/running along a shoreline in Northern Ireland: Mean FID = 29m (n = 53) (Fitzpatrick and Bouchez, 1998).

Pedestrian walking/running on grasslands in the Netherlands/Germany: Mean FID = 82m (Smit and Visser, 1993).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Range of mean FID = 85 to 136m; Min/Max FID = 25 to 300m (Smit and Visser, 1993).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median AD = 40m (n = 19), Min/Max AD = 20 to 80m; Range of median FID = 32.5 to 50m (n = 118); Min/Max FID = 0 to 200m (Liley *et al*., 2011).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 25 to 150m; Median FID = 46m (n = 129); Min/Max FID = 10 to 200m (Liley *et al*., 2010).

Pedestrian egg collector in the Netherlands /Germany: Mean FID = 46m (Smit and Visser, 1993).

Cattle disturbance in the Netherlands /Germany: Mean FID = 10m (Smit and Visser, 1993).

Agricultural activities in the Netherlands /Germany: Mean FID = 60m (Smit and Visser, 1993).

Aircraft (fixed-winged aeroplane) in the Netherlands /Germany: Mean FID = 500m (Smit and Visser, 1993).

Motorised vehicle (cars) in the Netherlands /Germany: Mean FID = 106m (Smit and Visser, 1993).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Mean FID = 74m (n = 10); Min/Max FID = 32 to 115m (Scarton, 2018b).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 60m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 160m (Laursen *et al*., 2017).

Non-motorised watercraft (kite surfer) in nearshore waters off Denmark: Mean FID = 130m (Laursen *et al*., 2017).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 82m. Conservative buffer zone of 100m is proposed (Scarton, 2018a).

Motorised watercraft in a coastal lagoon habitat in Italy: Buffer zone = 85m. Conservative buffer zone of 100m is proposed (Scarton, 2018a).

Nonbreeding season:

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 121m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Motorised watercraft in a coastal lagoon habitat in Italy: Buffer zone = 124m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Ecology and non-quantitative disturbance responses

Oystercatcher is a widespread species and breeds on almost all UK coasts (Balmer *et al*., 2013). High densities of breeding birds are associated with the upland margins in eastern Scotland and northern England, as well as with the Northern Isles (Balmer *et al*., 2013). This species breeds in a wide range of habitats where there may be contact with humans including coastal saltmarshes, sand and shingle beaches, dunes, cliff-tops with short grass and occasionally rocky shores, as well as inland along the shores of lakes, reservoirs and rivers or on agricultural grass and cereal fields, often some distance from water (Snow and Perrins, 1998), As this species share habitats that are often attractive to humans, oystercatchers are often exposed to human disturbance, including trampling on nests and pursuit of chicks and adults by dogs (Tratalos *et al*., 2021). Tolerance of human disturbance varies between individual oystercatchers Tjørve and Tjørve, 2010); there are a number of studies showing that human recreational disturbance reduces breeding success (e.g. Stillman and Goss-Custard 2002, Verhulst *et al*., 2001) and that population density is lower in areas where there are high numbers of people (Tratalos *et al*., 2021). Virzi (2010) found that human disturbance influenced territory choice in American oystercatchers *Haematopus palliates*. However, there are cases of oystercatchers nesting in suburban areas (Forrester *et al*., 2007), for example on flat roofs of buildings, in car parks, and on roundabouts. On the other hand, several studies suggest that oystercatcher is less sensitive to disturbance than other wader species, allowing a closer approach and showing habituation to recreational activity and construction work (see literature review in Woodward *et al*., 2015); Davidson and Rothwell (1993) consider oystercatcher to be less nervous than other wader species. Oystercatchers can show some behavioural plasticity in the choice of foraging areas (van Dijk, 2014; van de Pol *et al*., 2009; Safriel 1985) and nest site locations (Briggs, 1984; Heppleston 1972) which may allow some adaption to human presence.

In the nonbreeding season, oystercatcher is chiefly a coastal species, frequenting rocky and estuarine shores with the largest concentrations forming on the major estuaries (Balmer *et al*., 2013); the presence of humans along the shoreline may impact foraging success (Coleman *et al*., 2003) although Collop (2016) suggested that oystercatcher may be able to cope with a 10% reduction in time spent feeding caused by daily disturbance events on the Wash. Oystercatchers usually roost on the coast at high tide, although they can also roost communally inland (Goss-Custard, 1981). Disturbance from human activity may disrupt sleep patterns and ultimately have fitness implications for this species (McBlain *et al*., 2020), although for some roosting flocks, disturbance may only marginally affect daily energy expenditure (Linssen *et al*., 2019). However, the response of roosting birds to human disturbance is likely to depend on the source of disturbance. In a study in North Wales, McBlain *et al*. (2020) found that human disturbance (particularly pedestrians exercising dogs) at daytime roost sites led to increased vigilance and reduced sleeping time, while increased boat activity (leisure watercraft and commercial boats) resulted in a reduced duration of vigilance but increased “peek” (eye-blinking) frequency, possibly because boat locations were a more predictable source of disturbance than pedestrians. Burton *et al*. (1996) suggest that after redevelopment at Hartlepool West Harbour, Cleveland, the numbers of roosting oystercatcher declined, despite the creation of a new island roost, likely because of increased disturbance, particularly from people and boats due to the increased access to the marina.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Robust evidence

Breeding season buffer zone = 50-100m

Nonbreeding season buffer zone = 150-300m

Oystercatcher is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for oystercatcher when approached by a pedestrian is 105m during the breeding season and 400m during the nonbreeding season. For motorised watercraft, mean FID values of 58m and 74m have been recorded during the breeding and nonbreeding seasons respectively; during the nonbreeding season, a range of mean FID values between 60-160m have been recorded for non-motorised watercraft. The highest FID value of 500m was recorded for oystercatcher when approached by an aircraft in the nonbreeding season.

During the breeding season, buffer zones of 82m and 85m have been proposed to protect oystercatchers against pedestrian and motorised watercraft disturbance respectively; a conservative buffer zone of 100m has been suggested. During the nonbreeding season, buffer zones of 121m and 124m have proposed for pedestrian and motorised watercraft disturbance respectively, but for flocks of mixed waders containing more sensitive species (e.g. curlew), a buffer zone of 270m is suggested to protect winter roosts.

In the UK, oystercatcher has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower during the nonbreeding season. A buffer zone of 50-100m is suggested to protect nesting oystercatcher and a buffer zone of 150-300m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian and watercraft disturbance.

Knowledge gaps

More studies to specify habituation to disturbance when recording AD/FID for pedestrian activity on the beach and in watercraft, especially during the breeding season.

Ringed plover, *Charadrius hiaticula*

Conservation Status

UK: Red List

European: Least Concern

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 5,450 (5,250-5,600) breeding pairs, 42,500 individuals in winter (Woodward *et al*., 2020); Scottish population = 4,900-6,700 breeding pairs, 23,000-25,000 in winter (Forrester *et al*., 2012).

UK long-term trend

There has been a 23% range contraction in Ireland and a 5% expansion in Britain since 1968-72; the British breeding population declined by c.37% between 1984-2007 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Ringed plover was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 9.0 to 28.5m (n = 38); Min/Max FID = 9 to 40m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Finland: Mean FID = 20.4m (n = 5); Min/Max FID = 10 to 30m (Díaz *et al*., 2021).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max FID = 17 to c.100m (Liley and Sutherland 2007).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: FID = 31.91m (n = 1) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 41.1m (n = 30); Min/Max FID = 20 to 74m (Collop *et al*., 2016).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 47.7m (n = 18); Min/Max FID = 25 to 76m (Scarton, 2018b).

Surveyor walking in mudflats in Denmark: Mean FID = 42m (n = 59), Min/Max FID = 18 to 100m (Laursen *et al*., 2005).

Surveyor walking along a shoreline in Africa: Mean FID = 16.1m (n = 16.1), Min/Max FID = 10 to 29m (Mikula *et al*., 2018).

Surveyor walking in Europe: Mean FID = 22.50m (n = 10) (Møller, 2008a).

Surveyor walking along an inland waterbody in Africa: Range of mean FID = 15.7 to 30.5m (n = 63), Min/Max FID = 9 to 36m (Mikula *et al*., 2018).

Surveyor walking along a river delta in Africa: Mean FID = 24.0m (n = 6),

Min/Max FID = 13 to 40m (Mikula *et al*., 2018).

Surveyor walking in Africa: Mean FID = 7.8m (n = 12) (Weston *et al*., 2021).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Mean FID = 121m; Min/Max FID = 80 to 162m (Smit and Visser, 1993).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Min/Max FID = 30 to 100 (n = 3) (Liley *et al*., 2011).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 50 to 125m; Min/Max FID = 30 to 100m (Liley *et al*., 2010).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 77m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Ecology and non-quantitative disturbance responses

Ringed plover has a patchy but widespread and mainly coastal distribution in the UK; breeding birds are notably absent from coastal regions of southwest England, Yorkshire and southwest Wales (Balmer *et al*., 2013), which is due to the lack of suitable nesting beaches in these areas (Wernham *et al*., 2002). This species tends to be most numerous and concentrated on wide sandy or shingle tidal beaches, with access to suitable resting or nesting places above the highwater mark (Snow and Perrins, 1998). Inland breeding also occurs in some wetland habitats including along rivers, beside lochs and gravel pits, in the midlands of Ireland and in harvested peat bogs (Balmer *et al*., 2013). Ringed plover is a ground nesting species, usually in the open, but sometimes sheltered by vegetation, never far from water; the nest is a shallow scrape lined with pebbles and vegetation etc. (Snow and Perrins, 1998).

During the winter, ringed plovers are again mainly restricted to coastal areas around the UK where they inhabit muddy, sandy or pebbly coasts (Balmer *et al*., 2013). Resident breeders are joined by East Atlantic Flyway populations, some resident birds may remain on their breeding grounds during the winter while others move to new coastal areas; some southern and eastern England birds may also migrate to Ireland and Brittany (Wernham *et al*., 2002). Ringed plovers feed mainly on terrestrial and coastal invertebrates during the breeding season and principally on marine polychaete worms, crustaceans and molluscs during the nonbreeding season (Snow and Perrins, 1998). This species roosts communally, close to feeding sites along the shoreline, on sandbanks or bare arable fields, and in low vegetation (JNCC, 2012).

Ringed plovers are considered to be sensitive to disturbance particularly during the breeding season (see Conway *et al*., 2008 for review). As ringed plovers predominately breed on sand and shingle beaches which are also attractive to people, they are often exposed to human disturbance, including trampling on nests and pursuit of chicks and adults by dogs (Tratalos *et al*., 2021). Like other species of plover, if disturbed, ringed plovers will perform a distraction display to lure attention away from chicks or a nest site by running along the ground in a huddled “crouch-run” position, flicking wings, displaying one side of the body and giving an impression of an “exhausted bird” (Williamson, 1947). As this species will often creep along that ground from a disturbance source in this manner, rather than fly away, the estimation of FID for this species can be problematic.

Previous studies have shown that, particularly on the coast, recreational disturbance may affect the distribution, numbers and breeding success of this species (Tratalos *et al*., 2021, Liley and Sutherland 2007; Tratalos *et al*., 2005, Brown and Grice, 2005; Pienkowski, 1984). On the eastern shore of the Wash (Norfolk), Liley and Sutherland (2007) found that ringed plovers avoided areas of high disturbance caused by human recreational activity on the beach; a population model suggested that if nests were protected from humans (e.g. by fencing) the ringed plover size would increase by 8% and a complete absence of human disturbance would cause a population increase of 85%. Prater (1976) assessed that disturbance may have altered the habitat choice of ringed plovers in southeast England and on Lindisfarne, Pienkowski, (1984) found that ringed plovers abandoned territories without nesting by mid-May, which appeared to be associated with an increase in the use of the shore by humans at that time of year.

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-300m

Ringed plover is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for ringed plover when approached by a pedestrian is 100m during the breeding season and 162m during the nonbreeding season. However, as this species runs rather than flies away when disturbed, FID values are difficult to estimate. During the nonbreeding season, a buffer zone of 77m has been proposed to protect ringed plover against pedestrian disturbance, but for flocks of mixed waders containing more sensitive species (e.g. curlew), a buffer zone of 270m is suggested to protect winter roosts.

In the UK, ringed plover has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower during the nonbreeding season. A buffer zone of 100-200m is suggested to protect nesting ringed plover and a buffer zone of 100-300m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Lack of studies recording AD/FID during the breeding season. More studies to specify habituation to disturbance when recording AD/FID for pedestrian activity on the beach and in watercraft, especially during the breeding season.

Grey plover, *Pluvialis squatarola*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Passage/Winter Visitor

UK and Scottish population estimate

UK winter population = 33,500 individuals (Woodward *et al*., 2020); Scottish population = 1,700-2,800 individuals in winter, 500-2,000 individuals in Spring passage, 5,000-10,000 individuals in Autumn passage (Forrester *et al*., 2012).

UK long-term trend

Wintering numbers have gradually declined since the mid-1990s, they were 15% lower in 2008-09 compared with 1988-89 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Grey plover was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Min/Max FID = 36 to 66m (n = 2) (Díaz *et al*., 2021).

Nonbreeding season:

Surveyor walking along a shoreline in England: Mean FID = 132.3m (n = 55); Min/Max FID = 35 to 251m (Collop *et al*., 2016).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 77.1m (n = 24); Min/Max FID = 43 to 205m (Scarton, 2018b).

Surveyor walking in a shorebird habitat in Australia: FID = 44m (n = 1) (Glover *et al*., 2011).

Surveyor walking along a shoreline in Africa: FID = 37m (n = 1) (Mikula *et al*., 2018).

Surveyor walking along a river delta in Africa: Mean FID = 41.1m (n = 8),

Min/Max FID = 32 to 53m (Mikula *et al*., 2018).

Surveyor walking in Africa: Mean FID = 38.2m (n = 7) (Weston *et al*., 2021).

Surveyor walking in Sir Lanka: FID = 33 (n = 1) (Gnanapragasam *et al*., 2021).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 75 to 125m; Median FID = 75m (n = 10); Min/Max FID = 30 to 125m (Liley *et al*., 2010).

Surveyor walking in mudflats in Denmark: Mean FID = 132m (n = 80), Min/Max FID = 42 to 400m (Laursen *et al*., 2005).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Mean FID = 124m; Min/Max FID = 106 to 142m (Smit and Visser, 1993).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Mean FID = 75.8m (n = 16); Min/Max FID = 46 to 167m (Scarton, 2018b).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Surveyor walking along a shoreline in Africa: Mean MAD = 47m (n = 9) (Boer and Longamane, 1996).

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 148m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Buffer zone = 139m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Ecology and non-quantitative disturbance responses

Grey plovers are winter visitors and passage migrants to the UK; this species breeds in Russia and the Canadian high Arctic. Wintering and passage birds are restricted to coastal areas all around the around the UK coastline mostly on areas with intertidal mud and sandflats (Balmer *et al*., 2013). In Scotland, some of the largest numbers are to be found on the Eden Estuary, Firth of Forth, Solway, Orkney, Outer Hebrides, Tay and Tyninghame estuaries. During migration this species may also be found inland on lakes, pools or grasslands. Grey plover is usually a solitary species or occurs in small flocks while foraging; food is chiefly marine polychaete worms, molluscs and crustaceans during the nonbreeding season (Snow and Perrins, 1998) and like most plovers, grey plovers tend to run and then suddenly stop to feed. Grey plovers form large flocks at communal roosts, often with other waders in sandy areas, such as on unvegetated sandbanks or sand-spits on sheltered beaches or other sheltered environments such as estuaries or lagoons (Snow and Perrins, 1998), therefore there is the potential to disturb this species on foraging and roosting grounds.

Grey plover was among the species noted to be most sensitive to disturbance by walkers and dogs on the Welsh Dee Estuary (see Woodward *et al*., 2015 for review). Kirby *et al*. (1993) noted that once grey plover had been disturbed (particularly by walkers and dogs), they were most likely to leave the estuary altogether. Similarly, Ross and Liley (2014) found that grey plovers in the Humber estuary were also among the wader species exhibiting the highest proportion of major flight responses to human recreational disturbance. However, Collop (2016) suggested that, along with curlew, oystercatcher and bar-tailed godwit, grey plover may be able to cope with a 10% reduction in time spent feeding caused by daily disturbance events on the Wash.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Nonbreeding season buffer zone = 150-300m

Grey plover is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for grey plover when approached by a pedestrian is 66m during the breeding season and 400m during the nonbreeding season. However, as some plovers tend to run rather than fly initially, FID values may be difficult to estimate. As grey plover does not breed in the UK, quantitative values recorded during the breeding season may not be relevant to disturbance in the UK. During the nonbreeding season, buffer zones of 148m and 139m have been proposed to protect grey plover against pedestrian and motorised watercraft disturbance respectively, but for flocks of mixed waders containing more sensitive species (e.g. curlew), a buffer zone of 270m is suggested to protect winter roosts.

In the UK, grey plover has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 150-300m is suggested to protect nonbreeding grey plover from pedestrian and watercraft disturbance.

Knowledge gaps

More studies to specify habituation to disturbance when recording AD/FID for pedestrian activity on the beach and in watercraft during the nonbreeding season.

Golden plover, *Pluvialis apricaria*

Conservation Status

UK: Green List

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 32,500-50,500 breeding pairs, 410,00 individuals in winter (Woodward *et al.*, 2020); Scottish population = 15,000 breeding pairs, 10,000-30,000 individuals in spring passage, 20,000-60,000 in autumn passage, 25,000-35,000 individuals in winter (Forrester *et al.*, 2012).

UK long-term trend

Decrease. Half of the Irish range and one fifth of the British range have been lost over the last 40 years, mirroring the 13% UK population decline (Balmer *et al.*, 2013).

AD/FID

Quantitative disturbance distances

Golden plover was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: FID = 47m (n = 1) (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in Finland: Range of mean FID = 18.0 to 43.3m (n = 7); Min/Max FID = 18 to 48m (Díaz *et al.*, 2021).

Surveyor walking in moorland habitat in England: Range of median FID = 191 to 227m (Finney *et al*., 2005).

Surveyor walking over moorland in Norway: Min/Max FID = 0 to >100m (n = 46) (Byrkjedal, 1987).

Pedestrian walking/running on moorland in England: Min/Max FID = 1 to 200m (n = 96) (Yalden and Yalden, 1990).

Pedestrian walking/running on moorland in England: Mean AD = 187m (n = 333); Min/Max AD = 38 to 491m (Yalden and Yalden, 1989).

Surveyor walking in Scotland: Min/Max AD = 100-300m; Min/Max FID = 50-150m (Andy Douse, pers. obs.).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 280.9m (n = 2) (Dwyer, 2010).

Surveyor walking in mudflats in Denmark: Mean FID = 143m (n = 38), Min/Max FID = 45 to 450m (Laursen *et al*., 2005).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Surveyor walking in moorland habitat in England: Mean MAD = 50 to 200m (Finney *et al*., 2005; Pearce-Higgins *et al*., 2007).

Pedestrian walking/running on moorland in England: MAD = 200m (Yalden and Yalden, 1990; Yalden and Yalden, 1989).

Ecology and non-quantitative disturbance responses

Golden plover breeds in highland areas and upland bogs, moors and swampy heaths with high abundances of Sphagnum moss and heather. In Scotland, the highest breeding densities occur on the Outer Hebrides, Shetland, the Flow Country of Caithness and Sutherland and in England. High breeding densities occur in the Pennines; breeding densities are low in Ireland and Wales (Balmer *et al*., 2013). During the breeding season golden plover is a strongly territorial species around the nest site and males perform display flights particularly during early pair formation (Snow and Perrins, 1998; Ratchliffe, 1976), but this behaviour declines during egg laying and individuals can be secretive during the early breeding phase and may not respond to human intrusion (Yalden and Yalden, 1989). Golden plover is a ground nesting species; the nest is a shallow scrape in amongst short vegetation or between stones and is lined with vegetation (Snow and Perrins, 1998).

During the nonbreeding season, golden plover has a widespread distribution around the UK's lowland fields (Balmer *et al*., 2013), often in the company of lapwings (Gillings and Fuller, 1999). Resident golden plover in the UK tend to move short distances to their wintering grounds, the majority remain in the UK and are joined by migrants mainly from Iceland (Wernham *et al*., 2002). Golden plovers are omnivorous, feeding mainly on terrestrial invertebrates (principally beetles and earthworms) but will also feed on some plant material including berries, seeds and grasses (Snow and Perrins, 1998). This species prefers to roost on ploughed arable land and damp grassland, but will use tidal flats, rocky shores and saltmarshes in intertidal areas (JNCC, 2012; Forrester *et al*., 2012).

Golden plovers are sensitive to human disturbance and numbers are known to be lower in areas of high disturbance (Finney *et al*., 2005; Pearce-Higgins *et al*., 2007; Yalden and Yalden, 1989). Some golden plovers will run from their eggs if disturbed, but flight is much more usual (Ratchliffe, 1976). During the breeding season, response to disturbance varies between individual golden plovers depending on a number of factors, including habituation to disturbance, alertness, the vulnerability of the chicks, how conspicuous the disturbance is (e.g. a walker appearing against a skyline may cause more disturbance than a walker hidden in a valley) and the predictability of the source of disturbance (Finney *et al*., 2005; Yalden and Yalden, 1989). As well as the nature of the breeding grounds, response to human disturbance also depends on whether nesting plovers tend to be "sitters" or "fliers" at the nest; the majority of individuals will fly direct from their nests as a human comes within sight, however, in certain areas or under certain conditions or at certain times, nearly all the birds sit close and flush only if the intruder chances to walk within about 3-10 m of the nest (Ratchliffe, 1976).

Yalden and Yalden (1989; 1990) found that breeding golden plovers are most likely to be disturbed by people walking across moorland if they are within 200m of a nest. Finney *et al*. (2005) also found that golden plovers avoided pedestrian disturbance across the Pennine Way, however, when this source of disturbance was made more predictable through the resurfacing of the public footpath, golden plovers reduced their avoidance distance of the footpath from 200 to 50m. Pearce-Higgins *et al*. (2007) discussed that high levels of disturbance can impact golden plover habitat usage, but only in limited circumstances where visitor pressure is very high (greater than at least 30 visitors per weekend day); with the provision of well-surfaced paths, the authors considered that access to large numbers of visitors can be permitted without reducing breeding success. Ratchliffe (1976) suggested that recreational pressures were unlikely to have much effect on breeding golden plover unless the source of disturbance was intense.

Pearce-Higgins *et al*. (2009) recorded a reduced occurrence of golden plovers within 200m of turbines across 12 upland wind farms. However, Fielding and Haworth (2010) and Douglas *et al*. (2011) suggest that under some circumstances, golden plovers may be more tolerant of wind farm infrastructure. At Farr wind farm, Fielding and Haworth (2010) showed that the median distance of 16 golden plover nests to the nearest turbine was 168.8m, with nine nests being less than 200m and three less than 100 m from the nearest turbine. At Beinn Tharsuinn wind farm, Douglas *et al*. (2011) found that the distribution of breeding golden plovers appeared to be unaffected by proximity to turbines or tracks, with no evidence for this lack of association changing through time.

Disturbance studies on golden plover are more limited during the nonbreeding season although flocks can be disturbed on foraging and roosting grounds; Ross and Liley (2014) reported high flush rates for golden plover around the Humber estuary during the winter. Furness (1973) noted that roosting golden plovers and bar-tailed godwits at Musselburgh lagoons were much more likely to be disturbed by people than were other waders.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 200-500m

Nonbreeding season buffer zone = 200-500m

Golden plover is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for golden plover when approached by a pedestrian is median of 227m (maximum AD is 491m) during the breeding season and a maximum of 450m during the nonbreeding season. MAD values up to 200m have been suggested to protect golden plover from pedestrian disturbance during the breeding season.

In the UK, golden plover has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; for some individuals, tolerance of human disturbance may be lower during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 200-500m is suggested to protect nesting golden plover as well as foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

AD/FID studies are required during the nonbreeding season.

Dunlin, *Calidris alpina*

Conservation Status

UK: Red List

European: Declining

UK status

Migrant Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 8,600-10,500 breeding pairs, 350,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 8,000-10,000 breeding pairs (*schinzii* subspecies), 37,000-58,000 individuals in winter (*alpina* subspecies) (Forrester *et al*., 2012).

UK long-term trend

Decline. Breeding population declined in the Outer Hebrides by 65% between 1983-2007, there were also losses in marginal upland areas, particularly in western Ireland, northern England and southern Scotland between 1968-72 to 2007-11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Dunlin was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking over moorland in Norway: Range of mean FID = 13.1 to 81.3m (n = 20) (Byrkjedal, 1987).

Pedestrian walking/running on moorland in England: Mean AD = 30m (n = 30); Min/Max AD = 8 to 83m (Yalden and Yalden, 1989).

Surveyor walking in Scotland: Min/Max FID = 50-100m (Andy Douse, pers. obs.).

Nonbreeding season:

Surveyor walking along a shoreline in England: Mean FID = 43.9m (n = 117); Min/Max FID = 9 to 194m (Collop *et al*., 2016).

Surveyor walking over mudflats in Scotland: Mean FID = 163.9m (n = 4) (Dwyer, 2010).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 39m (n = 40); Min/Max FID = 5 to 81m (Scarton, 2018b).

Surveyor walking along mudflats in Denmark: Mean FID = 70m (n = 317), Min/Max FID = 15 to 450m (Laursen *et al*., 2005).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median AD = 8m (n = 11); Range of median FID = 30 to 55m (n = 23); Min/Max FID = 8 to 100m (Liley *et al*., 2011).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 50 to 100m; Median FID = 75m (n = 19); Min/Max FID = 25 to 300m (Liley *et al*., 2010).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Range of mean FID = 71 to 163m; Min/Max FID = 57 to 300m (Smit and Visser, 1993).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Mean FID = 52.3m (n = 23); Min/Max FID = 9 to 175m (Scarton, 2018b).

MAD and/or

Buffer zone

Quantitative distances

Breeding:

Pedestrian walking/running in moorland habitat in England: Mean MAD = 50 to 200m (Pearce-Higgins *et al*., 2007).

Nonbreeding season:

Surveyor walking along a shoreline in North America: Buffer zone = 89m (Koch and Paton, 2014).

Pedestrian walking/running along footpaths or the presence of railways close to intertidal areas in England: Buffer zone = 25 to 75m, although a buffer zone of 200m may be needed to protect a mix of intertidal species (Burton *et al*., 2002a).

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 82m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Buffer zone = 124m, but this buffer zone would increase to 270m to protect mixed species winter roosts (Scarton, 2018b).

Ecology and non-quantitative disturbance responses

One of three subspecies of dunlin breeds in the UK (*schinzii* ssp.) in the upland areas of Scotland, Wales and northern England (Pennines) (Balmer *et al*., 2013). During the breeding season, *schinzii* ssp. are found on wet upland and montane heath, especially where pool systems occur, but also on the machairs of the Outer Hebrides and rarely on coastal saltmarsh (Snow and Perrins, 1998). In Scotland the highest breeding densities occur on the Northern Isles, Outer Hebrides and the Flow Country of Caithness and Sutherland; in England, high breeding densities occur in the Pennines (Balmer *et al*., 2013). Dunlins breed on the ground concealed in vegetation, the nest is a shallow scrape lined with grass and leaves (Snow and Perrins, 1998).

Wintering dunlins are widely distributed throughout the coastlines of Britain and Ireland, the largest concentrations are on estuaries (Balmer *et al*., 2013). The *alpina* ssp. which breeds in Fennoscandia and northwest Russia, winters in western Europe, including the UK; both *schinzii* and *arctica* subspecies winter mainly in northwest Africa (Wernham *et al*., 2002; Snow and Perrins, 1998). Dunlins mainly spend the winter on the coast, but they can also frequent a wide variety of coastal and inland waterbodies including lagoons, muddy freshwater shores, tidal rivers, flooded fields, sewage farms, saltworks, sandy coasts, lakes and dams (BirdLife International, 2021b). Dunlins feed mainly on invertebrates; insects may chiefly be eaten during the breeding season and marine invertebrates during the nonbreeding season (Snow and Perrins, 1998). Similar to other waders, dunlins roost during high tides and at night, but this species prefers large fields of naturally fertilised short pasture or soil-based crops with few vertical structures that could be used by predators (Shepherd and Lank, 2004).

Dunlins are potentially sensitive to human disturbance during the breeding season. As a ground nesting species, dunlin is vulnerable to predator disturbance; Jackson (2001) showed that hatching success can be increased by excluding ground predators with fences around nesting areas. This species can be disturbed by human recreational activity taking place over their breeding grounds, although in the Peak District, Pearce-Higgins *et al*. (2007) found that, like golden plover, the provision of well-surfaced paths in breeding areas that receive at least 30 visitors a day can reduce the impact of human disturbance on the breeding success of this species. Yalden and Yalden (1989) suggest that dunlins are less sensitive to human intruders on their territories compared with golden plovers. Dunlins are relatively small birds and, like many other wader species, have cryptic plumage colour (Ferns, 2003) that can make them difficult to see on the ground, especially in amongst vegetation. For this reason, dunlins are more often detected in flight or when calling and estimating AD for this species is difficult.

During the nonbreeding season, reports of disturbance on dunlins are mixed. Kirby *et al*. (1993) found dunlin to be one of the more commonly disturbed species at roost sites on the Welsh Dee Estuary and tended to leave it altogether when disturbed by dogs and walkers. Davidson and Rothwell (1993) did not include it among the more nervous species (compared with redshank, bar-tailed godwit and curlew), and Burton *et al*. (2002a) recorded that it was the last species to fly when disturbed by walkers, although counts were still significantly lower at sites close to footpaths (see literature review in Woodward et al., 2015). Burton *et al.* (2002b) also noted that dunlin is threatened by disturbance on intertidal mudflats from construction work in the UK. Furness (1973) noted that roosting dunlins at Musselburgh lagoons were much less likely to be disturbed by people or aircraft than were bar-tailed godwits or golden plovers.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 150-300m

Dunlin is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for dunlin when approached by a pedestrian is 100m (maximum AD is 83m) during the breeding season and 450m during the nonbreeding season. For motorised watercraft, a range of mean FID values between 9-175m have been recorded during the nonbreeding season.

MAD values up to 200m have been suggested to protect dunlin from pedestrian disturbance during the breeding season. During the non-breeding season, buffer zones ranging between 25 to 89m have been proposed to protect dunlin against pedestrian disturbance, but for mixed winter flocks, it has been suggested that buffer zones should be larger between 200 to 270m. To protect against motorised watercraft disturbance, a 124m buffer has been proposed to protect dunlin during the nonbreeding season, but for flocks of mixed waders containing more sensitive species (e.g. curlew), a buffer zone of 270m is suggested to protect winter roosts.

In the UK, dunlin has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect nesting dunlin and a buffer zone of 150-450m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Current studies provide a good range of FID values. Future studies should specify habituation to disturbance when recording AD/FID.

Red knot, *Calidris canutus*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Passage/Winter Visitor

UK and Scottish population estimate

UK winter population = 265,000 individuals (Woodward *et al*., 2020); Scottish winter population = 20,400-25,800 individuals (Forrester *et al*., 2012).

UK long-term trend

Slight increase. Wintering range increased by 27% in Britain and 58% in Ireland between 1981/84 to 2007/11, the population has increased by 15% between 1983/84 and 2008/09 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Red knot was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: FID = 26m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in Europe: FID 26m (n = 1) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: FID = 60.01m (n = 1) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 71.8m (n = 78); Min/Max FID = 20 to 240m (Collop *et al*., 2016).

Surveyor walking in a range of habitats in Australia: Mean FID = 21.3m (n = 8) (Weston *et al*., 2012).

Pedestrian (general) along a shoreline in Australia: Mean FID = 74.4m (Lilleyman *et al*., 2016).

Pedestrian leisure (unspecified) along the shoreline in England: FID = 51m (n = 1) (Liley *et al*., 2010).

Non-motorised watercraft (rowing boat) in nearshore waters off Denmark: Mean FID = 260m (Laursen *et al*., 2017).

Motorised watercraft (motorboat) in nearshore waters off Denmark: Mean FID = 200m (Laursen *et al*., 2017).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Pedestrian (general) along a shoreline in Australia: Buffer zone = 100m (Lilleyman *et al*., 2016).

Pedestrian walking/running along footpaths close to intertidal areas in England: Buffer zone = 150m, although a buffer zone of 200m may be needed to protect a mix of intertidal species (Burton *et al*., 2002a).

Ecology and non-quantitative disturbance responses

Red knot are winter visitors and passage migrants to the UK; this species breeds in the high Arctic in Greenland and Canada (Balmer *et al*., 2013). During the nonbreeding season, birds migrate to northwest Europe; over 65% of the population overwinters in the UK where it is strictly a coastal species (Balmer *et al*., 2013). The distribution of knot is widespread around most of the UK, the highest concentrations are found on muddy and sandy shores, especially in estuaries (the Wash is an internationally important site), but this species is generally absent from northern and western Scotland (Balmer *et al*., 2013). In Scotland birds can be found throughout the year due to birds on passage and failed breeders returning to wintering grounds early (Snow and Perrins, 1998). Outside the breeding season, red knot feed mainly on intertidal invertebrates, chiefly molluscs (Snow and Perrins, 1998).

Among shore birds, red knot has long been known to be highly vulnerable to human disturbance, particularly at their roost sites (Woodward *et al*., 2015; Furness, 1973; Mitchell *et al*., 1988). Like other members of the Scolopacidae family, knot roost together at high tide on undisturbed rocks, sandy spits or offshore islets (Snow and Perrins, 1998). Furness (1973) found that red knot on the Forth Estuary will fly to another roost approximately 10 miles away if disturbance is high enough. Mitchell *et al*., (1988) showed that numbers of knot fell by 79% at roosts on the Welsh Dee Estuary between 1979/80 to 1985/86 and that birds moved to disturbance-free sites on the Alt Estuary; for some knots disturbance (particularly from dogs, horse-riders and walkers) at their roost could result in an extra round trip of approximately 25 miles which may account for 14% of their daily energy expenditure. Kirby *et al*. (1993) also note that knot tended to leave the Dee Estuary altogether when disturbed by dogs and walkers. Burton *et al*. (1996) suggested that after redevelopment at Hartlepool West Harbour, Cleveland, the numbers of wintering knot declined despite the creation of a new island roost, likely because of increased disturbance, particularly from people and boats due to the increased access to the marina. Pfister *et al*. (1992) suggested that the severity of the impact of human disturbance on knot at Plymouth Beach is probably most evident in their long-term decline in abundance at that site.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Nonbreeding season buffer zone = 100-300m

Red knot is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for knot is 240m when approached by a pedestrian and a mean of 260m when approached by a non-motorised watercraft during the nonbreeding season; the majority of mean FID values are under 100m when approached by a pedestrian. The maximum FID value recorded for knot when approached by a pedestrian during the breeding season is 26m, but as this species does not breed in the UK, quantitative values recorded during the breeding season may not be relevant to disturbance in the UK. A buffer zone up to 150m has been suggested to protect knot from pedestrian disturbance during the nonbreeding season, but in flocks of mixed waders during the nonbreeding season containing more sensitive species, a larger buffer zone up to at least 200m may be required to protect against disturbance.

In the UK, red knot has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower at roost sites. A buffer zone of 100-300m is suggested to protect nonbreeding knot from pedestrian disturbance.

Knowledge gaps

Lack of studies specifying AD/FID at roost sites during the nonbreeding season.

Purple sandpiper, *Calidris maritima*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern

UK status

Scarce Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1 breeding pair in Scotland, 9,900 individuals in winter (Woodward *et al*., 2020); Scottish winter population = 16,000 individuals (Forrester *et al*., 2012). Scottish breeding population may have decreased since Forrester *et al*. (2012) estimated 1-5 pairs.

UK long-term trend

Eaton *et al*. (2021) state a strong decrease in breeding birds (-67%) over 25 years.

Determining trends for this species is difficult due to difficulties with data comparison (Balmer *et al*., 2013). However, the UK wintering population recorded at the open-coast decreased by 27% between 1984/85 - 2006/07; Irish population declined by 33% between 1987/88 - 1997/98 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Purple sandpiper was not included in Ruddock and Whitfield (2007).

No AD/FID distances available for purple sandpiper.

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for purple sandpiper.

Ecology and non-quantitative information on disturbance responses

Purple sandpiper is a very rare breeding species in the UK, confined to two breeding sites in the Cairngorms National Park, Scotland, where it breeds at the southernmost edge of the species' Arctic range (Balmer *et al*., 2013; Forrester *et al*., 2012). In these locations, very small numbers of purple sandpiper breed on mountains above 1,000m; adults and young occupy habitat beside the wet margins of streams, flushes and pools (Forrester *et al*., 2012). Like many other waders, purple sandpiper is an open ground nesting species, the nest is a small cup part filled with leaves (Snow and Perrins, 1998).

Purple sandpiper is primarily a winter visitor to the UK, it is found on all coasts where there is suitable habitat, but it prefers exposed, shallow rocky coastlines (Balmer *et al*., 2013; Wernham *et al*., 2002). In the UK, this species is the most northerly of wintering waders, density is highest along the coasts of the northern North Sea, Northern Isles and Outer Hebrides as well as exposed headlands in Ireland; southern England and Wales hold small populations and relatively few birds use estuaries (Balmer *et al*., 2013). Three separate breeding populations winter around the coasts of the UK, the majority of the northern and western birds breed in Canada whilst those wintering in eastern Britain originate from breeding populations in Scandinavia and Svalbard (Balmer *et al*., 2013). Purple sandpipers feed both during the day and at night in the littoral zone, the winter diet of this species is largely composed of small winkles and blue mussels, kelp flies are also hunted for amongst seaweed (Forrester *et al.*, 2012).

Dierschke (1994) found that purple sandpipers spend only about half as long foraging during winter as do other wader species, it has been noted that this species will not forage during rising tides, also high tides during daylight hours restricts the foraging period (Simon Cohen, pers. comm.). Burton and Evans (1997) concluded that the predictable food supply on rocky shores allows purple sandpipers to achieve higher survival rates than estuarine waders. These features suggest that purple sandpipers are likely to be much less vulnerable to adverse effects from human disturbance. In addition, purple sandpipers are less prone to being disturbed by human presence than are most wader species, possibly because of their crypsis and the greater opportunity to remain undetected in rocky shore habitat compared with waders that frequent open mud or sand. Indeed, purple sandpipers tend to crouch on the rocks as a pedestrian approaches, only flying off if the person comes very close (perhaps within about 5 to 8 m). Cramp and Simmons (1982) describe purple sandpiper as "noted for tameness throughout the year". Baxter and Rintoul (1953) state "the purple sandpiper is one of the tamest of the waders, it will sit drowsily by the side of the sea until one is within a few feet of it".

Although this review has been unable to find FID data for purple sandpiper, the literature indicates that this will be smaller than for most estuarine waders.

Likely sensitivity to disturbance = Low/Medium

Quantitative information = No evidence

Breeding season buffer zone <300m

Nonbreeding season buffer zone <300m

Purple sandpiper is assessed to have a low to medium sensitivity to human disturbance.

There are a lack of disturbance studies and recommended buffer zones for purple sandpiper. Due to the scarcity and remote locations of breeding purple sandpipers in the UK, this species is unlikely to be encountered on breeding grounds by humans. Non-quantitative studies suggest that buffer zones required to protect purple sandpiper during the nonbreeding season may be lower than those for estuarine waders.

In the UK, purple sandpiper mainly has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season. From studies on other wader species, a buffer zone <300m is suggested to protect breeding and nonbreeding purple sandpiper from pedestrian disturbance.

Knowledge gaps

Lack of studies providing AD/FID values during the nonbreeding season.

Wood sandpiper, *Tringa glareola*

Conservation Status

UK: Amber List, Schedule 1

European: Least Concern, Annex 1

UK status

Scarce Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 30 breeding pairs in Scotland (Woodward *et al*., 2020); Scottish passage population = 10-50 individuals during spring and 20-50 individuals during autumn (Forrester *et al*., 2012). Scottish population estimate has increased since Forrester *et al*. (2012) estimated a breeding population of 18-21 pairs.

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+528%) over 25 years.

The small breeding population in northern Scotland has increased in range and size since 1988/91 when the population was six pairs (Balmer *et al*., 2013). A total of 27 breeding pairs were recorded in 2010 (Balmer *et al*., 2013), this has increased to 30 pairs in 2013-17 (Woodward *et al*., 2020).

AD/FID

Quantitative disturbance distances

FID updates (Díaz *et al*., 2021; Gnanapragasam *et al*., 2021; Mosvi *et al*., 2019; Jiang and Møller, 2017; Whitfield and Rae, 2014) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Mean FID = 20.3m (n = 3), Min/Max FID = 16 to 23m (Díaz *et al*., 2021).

Surveyor walking in Europe: FID = 20.3m (n = 3) (Jiang and Møller, 2017).

Surveyor walking in Norway:

Mean FID of “guard” parents = 59m (n = 27), Min/Max FID = 15 to 100m;

Mean FID of “non-guard” parents = 38m (n = 14), Min/Max FID = 21 to 60m

(Whitfield and Rae, 2014)

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 225m (n = 5); Min/Max AD (80% opinion range) = <10 to 300m; Min/Max AD (90% opinion range) = 150 to 300m.

Range of median FID = 5 to 125m (n = 8); Min/Max FID (80% opinion range) = <10 to 300m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season:

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 33m (n = 15); Min/Max FID = 10 to 57m (Gnanapragasam *et al*., 2021).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 33m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Whitfield and Rae, 2014) published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 200 to 600m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Pedestrian (general activity) in Norway: Buffer zone = 160m (Whitfield and Rae, 2014).

Ecology and non-quantitative information on disturbance responses

In the UK, wood sandpiper is a rare breeding species confined to boggy habitats in Scotland; highest densities are recorded in Sutherland and Caithness, but other breeding sites have been recorded in Inverness-shire, Wester Ross and the Outer Hebrides (Balmer *et al*., 2013). Wood sandpipers breed mainly in marshes and swamps, usually close to lochs (Forrester *et al*., 2012). This species nests on the ground in amongst dense vegetation or in old tree nests of other birds (Svensson *et al*., 2009; Snow and Perrins, 1998). Both male and female wood sandpiper parents typically care for young chicks with a division in roles between a “guard” bird which maintains an alert posture at a “look-out” location with a clear view of the surrounding area, and a “non-guard” bird which broods and stays close to chicks (Whitfield and Rae, 2014). The diet of wood sandpiper is most likely composed of terrestrial and freshwater insects, although little is known about the diet of this species in Scotland (Forrester *et al*., 2012).

Wood sandpipers do not generally overwinter in the UK, after the breeding season this species migrates south to winter in Africa (Wernham *et al*., 2002). Wood sandpipers are recorded in Britain during passage (Balmer *et al*., 2013), many migrants are likely to be from the Scandinavian breeding population (Wernham *et al*., 2002). In Scotland, wood sandpipers recorded outside the breeding season are mostly located at inland sites beside freshwater burns and lochs; more rarely they may be recorded along the coast (Forrester *et al*., 2012).

Wood sandpipers are potentially susceptible to human disturbance (Kalejta-Summers and Chisholm, 2009) and this species has been described as a “wary and nervous bird” (e.g. Oiseaux-Birds, 2021; Australian Government, 2021) particularly in flocks, although solitary birds will sometimes tolerate close approach (Australian Government, 2021). Beaman and Madge, (1998) state that wood sandpipers are considered to flush easily. During the breeding season the distance at which parents with young chicks react to an approaching pedestrian depends on whether or not the birds are on guard duty. In a study in Norway, Whitfield and Rae (2014) observed that birds on guard duty reacted sooner to a surveyor approaching the nest (alarm called at a mean distance of 72m, Mean FID = 59m) than a parent not on guard duty on the nest (alarm called at a mean distance of 44m, Mean FID = 38m). Whitfield and Rae (2014) also noted that the wood sandpipers in their study area (which was not subject to any human disturbance, other than research activities) did not react to human presence between 150–200m.

Likely sensitivity to disturbance = Medium

Quantitative information = High agreement & Limited evidence

Breeding season buffer zone = 150-300m

Wood sandpiper is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for wood sandpiper is 100m when approached by a pedestrian during the breeding season. Ruddock and Whitfield (2007) suggested that the upper pedestrian disturbance limit for wood sandpiper during the breeding season is 150 to 300m. Buffer zones for wood sandpipers range from 200 to 600m for forestry operations and 160m for pedestrian disturbance during the breeding season. The maximum FID value recorded for wood sandpiper when approached by a pedestrian during the nonbreeding season is 57m, but as this species does not generally overwinter in the UK, quantitative values recorded during the nonbreeding season may not be relevant to disturbance in the UK.

In the UK, wood sandpiper has the potential to be disturbed on breeding grounds.

A precautionary buffer zone of 150-300m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect nesting wood sandpiper from pedestrian disturbance.

Knowledge gaps

Further AD/FID studies required during the breeding season investigating a range of disturbance sources.

Common redshank, *Tringa totanus*

Conservation Status

UK: Amber List

European: Declining

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 22,000 breeding pairs, 100,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 11,700-17,500 breeding pairs, 4,000-25,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Strong Decline. There has been a 44% contraction of breeding range across the UK between 1968-72 to 2007-11, losses in range and abundance reflect a 39% population decline in the UK between 1995-2010 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Redshank was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Scotland: FID = 21 (n = 1) (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 19 to 41.3m (n = 16); Min/Max FID = 12 to 57m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Spain: FID = 18m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 39m (n = 20); Min/Max FID = 21 to 55m (Scarton, 2018a).

Surveyor walking in Europe: Mean FID 27.8m (n = 19) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 149.9m (n = 43) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 79.8m (n = 53); Min/Max FID = 28 to 187m (Collop *et al*., 2016).

Surveyor walking along mudflats in Denmark: Mean FID = 137m (n = 73), Min/Max FID = 40 to 450m (Laursen *et al*., 2005).

Surveyor walking around inland waterbodies in Africa: Range of mean FID = 24 to 38.7m (n = 5), Min/Max FID = 22 to 41m (Mikula *et al*., 2018).

Surveyor walking in Europe: Mean FID = 4.74m (n = 2) (Møller and Erritzøe, 2010).

Surveyor walking in Europe: Mean FID = 29.71m (n = 7) (Møller, 2008a).

Pedestrian leisure (bait digging) along tidal flats in England: FID = 22m (n = 1) (Fearnley *et al*., 2013).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Median AD = 60m (n = 15); Range of median FID = 30 to 70m (n = 51); Min/Max FID = 10 to 130m (Liley *et al*., 2011).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 20 to 125m; Median FID = 44.5m (n = 78); Min/Max FID = 10 to 150m (Liley *et al*., 2010).

Pedestrian walking/running along a shoreline in Ireland: Mean FID = 37m (n = 29) (Fitzpatrick and Bouchez, 1998).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 33 (n = 26); Min/Max FID = 15 to 55m (Gnanapragasam *et al*., 2021).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 175m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 260m (Laursen *et al*., 2017).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 37m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 55m. Conservative buffer zone of 100m is proposed (Scarton, 2018a).

Pedestrian walking/running along footpaths close to intertidal areas in England: Buffer zone = 50m, although a buffer zone of 200m may be needed to protect a mix of intertidal species (Burton *et al*., 2002a).

Ecology and non-quantitative disturbance responses

Redshank has a patchy breeding distribution in Scotland, England and Northern Ireland. The species breeds in a variety of damp habitats including coastal marshes, lowland wet grasslands and rough pasture on moorland fringes (Balmer *et al*., 2013). In Scotland the highest breeding densities occur on the Northern Isles, Outer Hebrides and in Caithness; in England, high breeding densities occur in the Pennines, Lancashire and on the coastal marshes of southeast England (Balmer *et al*., 2013). Redshank is a ground nesting species, the nest is a shallow scrape in amongst short vegetation and/or tussocks and is lined with vegetation (Snow and Perrins, 1998).

Wintering redshanks are widely distributed throughout the coastlines of Britain and Ireland, the largest concentrations are on estuaries and the Northern Isles (Balmer *et al*., 2013). Redshanks can feed on a wide range of prey species, but the majority of the diet is made up of crustaceans, molluscs and polychaete worms on estuaries and earthworms and cranefly larvae inland (Snow and Perrins, 1998).

In common with other waders, redshank may be frequently disturbed by human activities on more urbanised wintering sites. The flight distance when disturbed by humans may be lower for redshank compared with some other wader species, especially if redshank are habituated to activities that might cause disturbance (Fitzpatrick and Bouchez, 1998). However, redshanks are considered to be susceptible to disturbance from construction and other activities and this species often feeds closer to shore than other waders (see literature review in Woodward *et al*., 2015). Disturbance from construction work around Cardiff Bay was found to significantly reduce the densities and feeding activity of redshank on adjacent intertidal mudflats (Burton *et al*., 2002b). Work by West *et al*. (2002) and Goss-Custard *et al*. (2006) has aimed to quantify the impacts of disturbance on the wader mortality rates. In the UK, populations of redshank breeding on saltmarshes declined by >50% between 1985 and 2011 which has been linked to nest trampling disturbance by grazing cattle (Sharps *et al*., 2017).

Redshanks, as with all waders, usually roost on the coast at high tide (BirdLife International, 2021b), but this species is also known to roost communally at inland sites including disturbed sites at a sport centre and an oil terminal complex (CAWOS, 2019). Response to disturbance at roost sites varies between individuals, Davidson and Rothwell (1993) report that redshanks roosting in narrow tidal creeks with frequent passers-by on the shore may tolerate people within 20m, yet this species on some large estuaries will take flight when a person is still over 100m away (Smit and Visser, 1993). Davidson and Rothwell (1993) considered that redshanks are one of the more nervous species of wader (in addition to bar-tailed godwit and curlew), compared with oystercatcher, turnstone and dunlin.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Robust evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 200-300m

Common redshank is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for redshank when approached by a pedestrian is 57m during the breeding season and 450m during the nonbreeding season. When approached by non-motorised watercraft during the nonbreeding season, the maximum FID recorded for redshank is a mean of 260m. In the UK, a buffer zone of 50m has been proposed to protect redshank against pedestrian disturbance during the nonbreeding season, but this buffer zone may need to be increased to 200m to protect a mix of intertidal species. A buffer zone of 100m has been suggested to protect redshank from pedestrian disturbance during the breeding season in Italy.

In the UK, redshank has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower at roost sites. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect nesting redshank and a buffer zone of 200-300m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Further studies recording AD/FID from a range of disturbance sources during the breeding season are required.

Greenshank, *Tringa nebularia*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,100 breeding pairs in Scotland, 920 individuals in winter (Woodward *et al*., 2020); Scottish winter population = 50-90 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Increasing. According to Balmer *et al*. (2013), greenshank breeding range has expanded by 2% since 1968-72 and 2007-11; the range of nonbreeding birds has expanded by 48% in Britain and 13% in Ireland since 1981-84 and 2007-11. Gains are most evident in Scotland and eastern England and related to increased abundance, probably as a result of milder climatic conditions (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Greenshank was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 30 to 45.5m (n = 4); Min/Max FID = 20 to 53m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Norway: FID = 30m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Finland: FID = 84m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in Europe: Mean FID 36.2m (n = 5) (Jiang and Møller, 2017).

Surveyor walking in Scotland: Min/Max AD = 200-500m; Min/Max FID = 100-300m (Andy Douse, pers. obs.).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: FID = 494.17m (n = 1) (Dwyer, 2010).

Surveyor walking in Europe: Mean FID = 30m (n = 2) (Møller and Erritzøe, 2010).

Surveyor walking along mudflats in Denmark: Mean FID = 94m (n = 35), Min/Max FID = 38 to 250m (Laursen *et al*., 2005).

Surveyor walking in a wetland habitat in Denmark: Mean FID = 78m (n = 32) (Bregnballe *et al*., 2009).

Surveyor walking in Africa: Mean FID = 51.3m (n = 27) (Weston *et al*., 2021).

Surveyor walking in a shorebird habitat in Australia: Mean FID = 55.41m (n = 17); Min/Max FID = 25 to 145m (Glover *et al*., 2011).

Surveyor walking in a range of habitats in Australia: Mean FID = 47.60m (n = 7) (Weston *et al*., 2012).

Surveyor walking in a variety of habitats: Mean AD = 55.1m (n = 7) (Blumstein *et al*., 2004).

Surveyor walking in a variety of habitats in Australia: Mean FID = 70.0m (n = 3) (Paton *et al*., 2000).

Pedestrian walking/running near inland waterbodies in Australia: Mean AD = 95m; Mean FIS = 75m (Taylor, 2006).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 29.4 (n = 8); Min/Max FID = 21 to 36m (Gnanapragasam *et al*., 2021).

Pedestrian leisure (unspecified) along the shoreline in England: FID = 40m (n = 2) (Liley *et al*., 2010).

Animal (dogs) disturbance in Australia: Mean FID = 80.3m (n = 2) (Paton *et al*., 2000).

Watercraft (surveyor in an unspecified boat) in Australia: Mean FID = 60.7m (n = 3) (Paton *et al*., 2000).

Non-motorised watercraft (surveyor canoeing) in Australia: Mean FID = 51.5m (n = 2) (Paton *et al*., 2000).

Drone (surveyor operating a drone) in France: Min/Max AD = 4 to 10m (n = 5); Min/Max FID = 4 to 10m (n = 2) (Vas *et al.,* 2015).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 35m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Surveyor walking along a shoreline in Africa: Mean MAD = 40m (n = 7) (Boer and Longamane, 1996).

Pedestrian walking/running near inland waterbodies in Australia: MAD = 75 to 95m (Taylor, 2006).

Ecology and non-quantitative disturbance responses

Common greenshank is an uncommon breeding species in Scotland which is on the western edge of the world breeding range of this species (Balmer *et al*., 2013; Wernham *et al*., 2002). In Scotland, greenshanks are largely restricted to the bogs and moors of the northwest Highlands and Hebridean islands; the highest densities are in Sutherland, Wester Ross, Lewis, Harris and North Uist (Balmer *et al*., 2013). Greenshank is a ground nesting species; the nest is a shallow scrape made between rocks/tussocks/dead tree stumps and is located in the open, within and on the edge of native and non-native coniferous forests (Forrester *et al*., 2012; Snow and Perrins, 1998). Breeding greenshanks are highly site-faithful and may even use the same nest scrape in consecutive years (Wernham *et al*., 2002). Males are highly territorial and perform song flights high into the sky over the breeding site (Forrester *et al*., 2012).

Common greenshank is a migratory species; birds breeding in Palaearctic regions migrate south during the nonbreeding season (Wernham *et al*., 2002).

Although the movements of nonbreeding Scottish birds are not well understood (Wernham *et al*., 2002), most greenshanks move to coastal areas near breeding regions during the nonbreeding season (Forrester *et al*., 2012). Passage birds are more widespread in the UK, found in all coastal regions as well as inland, but wintering birds are more concentrated to the south and west (Balmer *et al*. 2013; Forrester *et al*., 2012). The highest concentrations of wintering greenshank are found on key estuaries throughout the UK especially in Ireland and parts of western Scotland, where birds are more widely distributed; recent gains have been recorded in eastern England and Ireland (Balmer *et al*., 2013). Nonbreeding greenshanks feed mainly on invertebrates and small fish (Snow and Perrins, 1998).

Greenshanks are regarded as potentially vulnerable to human disturbance, particularly when disturbance coincides with areas of habitat change. This species has probably been negatively affected by the long-term, extractive human use of moorlands by grazing, burning, hunting and forestry (RSPB, 2021a). Mason *et al*. (2021) suggest that moorland species in Britain such as common greenshank have probably been negatively affected by the long-term, extractive human use of moorlands by grazing, burning, hunting and forestry. Reduction of suitable moorland breeding habitat has occurred in the Flow County of Caithness and Sutherland through commercial afforestation (Forrester *et al*., 2012). Greenshank is threatened by the degradation and loss of wetland habitats through environmental pollution, reduced river flows and human disturbance in the Yellow Sea; in Europe greenshank may be affected by habitat degradation caused by off-road vehicles or dry conditions (BirdLife International, 2021b).

Breeding greenshanks are considered to be shy and to have highly cryptic behaviour, presumably in response to predation risk (Nethersole-Thompson 1951). Similar to golden plover, the distance at which greenshank are likely to fly away from human disturbance may depend on how conspicuous the disturbance is (e.g. a walker appearing against a skyline may cause more disturbance than a walker hidden in a valley) and the predictability of the source of disturbance. Gilbert *et al*. (1998) recommended to keep disturbance to a minimum for survey work and suggest that there is no need to search for nests or to get close to adults; adults with young chicks are likely to be disturbed when pool systems and lochs are checked in June.

Likely sensitivity to disturbance = Medium/High

Quantitative information = High agreement & Robust evidence

Breeding season buffer zone = 300-500m

Nonbreeding season buffer zone = 300-500m

Greenshank is assessed to have a medium to high sensitivity to human disturbance.

AD and FID values recorded for greenshank are wide ranging. The maximum AD value when approached by a pedestrian is 500m during the breeding season. The maximum FID value when approached by a pedestrian is 300m during the breeding season and 494m during the nonbreeding season. The majority of recorded FID values are lower than these maximum values which likely relate to differences in habitat. During the nonbreeding season, mean FID values between 51.5 to 60.7m have been recorded for watercraft disturbance and a maximum FID of 10m has been recorded for a drone.

MAD between 40 (mean value) and 95m (maximum value) have been suggested in Africa and Australia respectively for greenshank during the nonbreeding season, although no studies have yet recommended buffer zones for this species in the UK.

In the UK, greenshank has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-500m is suggested to protect nesting greenshanks as well as foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

More AD/FID studies are required during the breeding season. Future studies should specify habituation to disturbance when recording AD/FID

Black-tailed godwit, *Limosa limosa*

Conservation Status

UK: Red List, Schedule 1

European: Near Threatened

UK status

Migrant Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 53 breeding pairs (mainly *limosa* subspecies), 41,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 5-11 breeding pairs (*islandica* subspecies), 300-600 individuals in winter, 1,000+ individuals during spring and autumn passage (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (+9%) over 25 years.

Winter range of the *islandica* subspecies has expanded by 177% and 55% in Britain and Ireland respectively between 1981/84 - 2007/11, this is linked to a sustained breeding population increase in Iceland; expansion may be linked to climatic and habitat changes on breeding and wintering grounds (Balmer *et al*., 2013). In contrast, the subspecies *limosa* which breeds in England has decreased and fluctuated since the 1970s (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Black-tailed godwit was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: FID = 46.5m (n = 1) (Jiang and Møller, 2017).

Surveyor walking around a lagoon in Denmark: Mean FID = 72 to 95m (n = 203) (Holm and Laursen, 2009).

Nonbreeding season:

Surveyor walking in a range of habitats in Australia: Mean FID = 21m (n = 6) (Weston *et al*., 2012).

Surveyor walking in a shorebird habitat in Australia: Mean FID = 31.25m (n = 4); Min/Max FID = 27 to 35m (Glover *et al*., 2011).

Pedestrian (general) along the shoreline in England: AD = 125 (n = 1); Min/Max FID = 30 to 150m (n = 3) (Liley *et al*., 2010).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 36.9 (n = 7); Min/Max FID = 18 to 46m (Gnanapragasam *et al*., 2021).

Unknown season:

Surveyor walking around a lake in Pakistan: Mean FID = 36m (Mosvi *et al*., 2019).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Pedestrian walking/running along footpaths or the presence of railways close to intertidal areas in England: Buffer zone = 50 to 75m, although a buffer zone of 200m may be needed to protect a mix of intertidal species (Burton *et al*., 2002a)

Ecology and non-quantitative information on disturbance responses

Small numbers of black-tailed godwit breed in the UK. In England, the nominate subspecies *limosa* is associated with increasingly modified agricultural areas, breeding in lowland wet grasslands and flood meadows (Forrester *et al*., 2012); the main breeding areas are located in East Anglia, but confirmed breeding records of this subspecies have also been recorded in Lancashire, Yorkshire and Kent (Balmer *et al*., 2013). Very small numbers of the *islandica* subspecies mainly breed in Orkney and Shetland on moorland with a preference for wet marshland and mesic grasslands (Balmer *et al*., 2013; Forrester *et al*., 2012). Black-tailed godwit is a ground nesting species, nests are a shallow scrape lined with stems and leaves located in short vegetation (Snow and Perrins, 1998).

In the nonbreeding season, resident black-tailed godwits are joined by large numbers of the Iceland breeding *islandica* subspecies (Balmer *et al*., 2013). Overwintering birds are scattered around the UK, the highest densities are found in coastal areas around East Anglia, the Thames Basin, North Wales, northwest England, the east and south Irish coasts and the Shannon Estuary; this species is generally absent on the west coast of mainland Scotland (Balmer *et al*., 2013). Most of the overwintering population is composed of the *islandica* subspecies which has a preference for coastal estuaries (although they may also inhabit inland sites); the resident *limosa* subspecies prefers to winter at inland freshwater sites (Balmer *et al*., 2013; Forrester *et al*., 2012). Black-tailed godwits feed chiefly on invertebrates during the winter and migration periods, plant material may also be consumed (Snow and Perrins, 1998).

Black-tailed godwits appear to be able to habituate to some types of human presence and may have a relatively high level of tolerance towards human disturbance, particularly during the nonbreeding season. Burton *et al*. (2002a) considered overwintering black-tailed godwit to be one of the most tolerant species to walkers along footpaths in estuaries in England at low tide, although numbers were still significantly lower at sites close to a footpath. In a similar study on English east coast estuary sites, Gill *et al*. (2001) found no evidence that human presence reduced the number of black-tailed godwits; the authors also found that the presence of marinas or footpaths did not impact the number of godwits supported on the adjacent mudflats. A study investigating human disturbance on black-tailed godwit, curlew and teal in Co. Cork, Ireland, found that out of the three species, black-tailed godwits were the least affected by disturbance events and were likely to move <50m from their original position when a disturbance event occurred (Sexton, 2017). Birds at high tide roosts are considered to be susceptible to disturbance (Davidson and Rothwell 1993), but Percival (2011) found that roosting black-tailed godwits in the Humber appear to be tolerant of a relatively high disturbance environment. Percival (2011) found that black-tailed godwits roost at high tide on the North Killingholme Haven Pits which are located in an area adjacent to the Humber Sea Terminal and to car import compounds; there was no evidence found in this study that industrialisation had reduced the ability of the pits to support the godwit population.

However, black-tailed godwit may be sensitive to disturbance during the breeding season (e.g. Frikke, 1991). In a study in the Netherlands, Reijnen *et al*. (1996) found that >10% of the breeding black-tailed population was lost beyond 100m of a road with 5000 cars per day. In another study in Denmark on breeding black-tailed godwits, Holm and Laursen (2009) found that one person walking the same route seven times per day in March–June reduced black-tailed godwit territory density within 300–500 m. In a management plan for black-tailed godwit (2007-2009), the European Commission suggested that this species is especially sensitive to disturbance in breeding areas, and there is a need to assess the effects of increasing disturbance on breeding success in agricultural environments (European Commission 2007b).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 100-200m

Nonbreeding season buffer zone = 100-200m

Black-tailed godwit is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for black-tailed godwit when approached by a pedestrian is a mean of 95m during the breeding season and 150m during the nonbreeding season. A buffer zone from 50 to 75m has been suggested to protect black-tailed godwit from pedestrian disturbance during the nonbreeding season, although in flocks of mixed waders during the nonbreeding season containing more sensitive species, a 200m buffer zone may be required to protect against disturbance.

In the UK, black-tailed godwit has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 100-200m is suggested to protect both breeding and nonbreeding black-tailed godwit from pedestrian disturbance.

Knowledge gaps

More AD/FID studies are required during the breeding season and wider range of studies are required for different disturbance sources.

Bar-tailed godwit, *Limosa lapponica*

Conservation Status

UK: Amber List

European: Secure, Annex 1

UK status

Passage/Winter Visitor

UK and Scottish population estimate

UK winter population = 53,500 individuals (Woodward *et al*., 2020); Scottish winter population = 10,000-14,000 individuals (Forrester *et al*., 2012).

UK long-term trend

Stable. The UK wintering population has remained largely stable between 1981-84 to 2007-11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Bar-tailed godwit was not included in Ruddock and Whitfield (2007).

Breeding:

Surveyor walking in Europe: Mean FID 33.3m (n = 5) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 96.91m (n = 3) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 84.4m (n = 92); Min/Max FID = 32 to 225m (Collop *et al*., 2016).

Surveyor walking in an estuary in England: Mean FID = 39m (n = 23) (Brett, 2012).

Surveyor walking along mudflats in Denmark: Mean FID = 156m (n = 120), Min/Max FID = 40 to 450m (Laursen *et al*., 2005).

Surveyor walking in a variety of habitats in Australia: Mean FID = 22.1m (n = 196) (Blumstein, 2003).

Surveyor walking in a variety of habitats in Australia: Mean FID = 22.1m (n = 177); Min/Max FID = 2.1 to 102.2m (Blumstein *et al*., 2003).

Surveyor walking in a variety of habitats in Australia: Mean FID = 48.6m (n = 2) (Paton *et al*., 2000).

Surveyor walking in a shorebird habitat in Australia: Mean FID = 59.50m (n = 4); Min/Max FID = 45 to 69m (Glover *et al*., 2011).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 34 (n = 2); Min/Max FID = 18 to 50m (Gnanapragasam *et al*., 2021).

Pedestrian leisure (walking and watercraft) along the shoreline in England: AD = 30m (n = 1); FID = 25m (n = 1) (Liley *et al*., 2011).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Range of mean FID = 107 to 219m; Min/Max FID = 88 to 225m (Smit and Visser, 1993).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 200m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 230m (Laursen *et al*., 2017).

Watercraft (surveyor in an unspecified boat) in Australia: Mean FID = 53.5m (n = 2) (Paton *et al*., 2000).

Non-motorised watercraft (surveyor canoeing) in Australia: Mean FID = 41.9m (n = 2) (Paton *et al*., 2000).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for bar-tailed godwit.

Ecology and non-quantitative disturbance responses

The European bar-tailed godwit population (*Limosa lapponica lapponica*) breeds in the Arctic in Northern Scandinavia and around the White Sea (Balmer *et al*., 2013; Engelmoer, 2008). This species does not breed in the UK, although in Scotland, small numbers of immature birds remain on the coastline throughout the summer. The European population winters in Western Europe, mainly in the UK and the Western part of the Wadden Sea (Versluijs, 2011). During the nonbreeding season, bar-tailed godwit is chiefly a coastal species around the UK on low-lying shores, the largest numbers occur on major estuaries (Balmer *et al*., 2013). This species is largely absent from much of northern and western Scotland and elsewhere where there are sections of steep cliff coastline (Balmer *et al*., 2013). Bar-tailed godwits feed chiefly on invertebrates, especially on insects, molluscs, crustaceans and annelid worms (Snow and Perrins, 1998).

Bar-tailed Godwits join mixed wader roosts at high tide where they can be disturbed by human activity. This species has been described as relatively sensitive to disturbance compared to other wader species (see literature review in Woodward *et al*., 2015). On a high tide roost in a cultivated grassland area near the Dutch Wadden Sea, Smit and Visser (1993) showed that bar-tailed godwits were disturbed 64% of the time by human activity whereas 18% had a natural cause. Davidson and Rothwell (1993) considered that in addition to curlew and redshank, bar-tailed godwits are a more nervous wader species compared with oystercatcher, turnstone and dunlin. Kirby *et al*. (1993) found that like other sensitive wader species including grey plover, knot and dunlin, bar-tailed godwit tended to leave the Welsh Dee Estuary when disturbed by dogs and walkers. Collop (2016) showed that in comparison to other wader species present at Poole Harbour, bar-tailed godwit had the greatest vulnerability to the impacts of disturbance, although it was also stated that over-winter survival for this species at this site was predicted to be below 100% and the same author suggested that bar-tailed godwits on the Wash may be able to cope with a 10% reduction in time spent feeding caused by daily disturbance events. Furness (1973) noted that roosting bar-tailed godwits at Musselburgh lagoons were much more likely to be disturbed by people and aircraft than were other waders.

However, in a study on inland coastal meadows around the Dutch Wadden Sea, Versluijs (2011) suggested that wintering bar-tailed godwits may tolerate some human activity. The authors of the study found that human activity caused 29% of total disturbance whereas birds flew up earlier more often (37%) to natural causes (e.g. predators). Of the birds that reacted to human disturbance, most of the flocks were present near roads and bicycle paths; often when a tractor or truck passed by the birds they flew up and they were also regularly disturbed by stopping cars and cyclists (Versluijs, 2011).

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Medium evidence

Nonbreeding season buffer zone = 200-300m

Bar-tailed godwit is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for bar-tailed godwit is 450m when approached by a pedestrian; the majority of FID values are less than a mean of 200m when approached by a pedestrian. For non-motorised watercraft, a range of mean FID values between 42 to 230m have been recorded during the nonbreeding season. The maximum FID value recorded for bar-tailed godwit when approached by a pedestrian during the breeding season is a mean of 33.3m, but as this species does not breed in the UK, quantitative values recorded during the breeding season may not be relevant to disturbance in the UK.

In the UK, bar-tailed godwit has the potential to be disturbed on foraging and roosting grounds during the nonbreeding season. There are no published buffer zones for bar-tailed godwit, but from studies on other waders, a minimum buffer zone of 200-300m is suggested to protect foraging and roosting bar-tailed godwit during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Current studies provide a good range of FID values. Future studies should specify habituation to disturbance when recording AD/FID.

Eurasian curlew, *Numenius arquata*

Conservation Status

UK: Red List

European: Vulnerable

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 58,500 breeding pairs, 125,000 individuals in winter (Woodward *et al*., 2020); Scottish population = 58,800 breeding pairs, 85,700 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Strong Decline. Breeding range contracted by 78% in Ireland and 17% in Britain over the last 40 years, there has been a 44% population decline in the UK between 1995 – 2010 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Curlew was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 40 to 65m (n = 12) (Díaz *et al.*, 2021).

Surveyor walking in a rural habitat in Finland: Range of mean FID = 34.5 to 44.6m (n = 16) (Díaz *et al.*, 2021).

Surveyor walking in Europe: Mean FID 57.6m (n = 10) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking over mudflats in Scotland: Mean FID = 235.16m (n = 36) (Dwyer, 2010).

Surveyor walking along a shoreline in England: Mean FID = 340.3m (n = 39); Min/Max FID = 88 to 570m (Collop *et al.*, 2016).

Surveyor walking in an estuary in England: Mean FID = 88m (n = 24) (Brett, 2012).

Surveyor walking in a coastal lagoon habitat in Italy: Mean FID = 140.5m (n = 11); Min/Max FID = 59 to 305m (Scarton, 2018b).

Surveyor walking along mudflats in Denmark: Mean FID = 298m (n = 110), Min/Max FID = 58 to 650m (Laursen *et al.*, 2005).

Surveyor walking around inland waterbodies in Africa: Range of mean FID = 50m (n = 2), Min/Max FID = 46 to 54m (Mikula *et al.*, 2018).

Surveyor walking in Europe: Mean FID = 62.75m (n = 4) (Møller and Erritzøe, 2010).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 44.3 (n = 8); Min/Max FID = 21 to 113m (Gnanapragasam *et al.*, 2021).

Pedestrian leisure (bait digging) along tidal flats in England: AD = 45m (n = 1) (Fearnley *et al.*, 2013).

Pedestrian leisure (walking and watercraft) along the shoreline in England: Range of median FID = 22.5 to 50m (n = 22); Min/Max FID = 15 to 100m (Liley *et al.*, 2011).

Pedestrian leisure (unspecified) along the shoreline in England: Min/Max AD = 25 to 200m; Median FID = 75m (n = 37); Min/Max FID = 30 to 150m (Liley *et al.*, 2010).

Pedestrian walking/running along a shoreline in Ireland: Mean FID = 38m (n = 41) (Fitzpatrick and Bouchez, 1998).

Pedestrian walking/running on grasslands in the Netherlands/Germany: Mean FID = 213 (Smit and Visser, 1993).

Pedestrian walking/running on tidal flats in the Netherlands /Germany: Range of mean FID = 211 to 339m; Min/Max FID = 124 to 550m (Smit and Visser, 1993).

Pedestrian egg collector in the Netherlands/Germany: Mean FID = 140m (Smit and Visser, 1993).

Agricultural activities in the Netherlands/Germany: Mean FID = 129m (Smit and Visser, 1993).

Aircraft (helicopter) in the Netherlands/Germany: Mean FID = 200m (Smit and Visser, 1993).

Animals (dogs) in the Netherlands/Germany: Mean FID = 90m (Smit and Visser, 1993).

Motorised vehicle (cars) in the Netherlands/Germany: Mean FID = 188m (Smit and Visser, 1993).

Non-motorised watercraft (kayak) in nearshore waters off Denmark: Mean FID = 220m (Laursen *et al*., 2017).

Non-motorised watercraft (wind surfer) in nearshore waters off Denmark: Mean FID = 400m (Laursen *et al*., 2017).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Mean FID = 140.3m (n = 19); Min/Max FID = 70 to 205m (Scarton, 2018b).

MAD and/or

Buffer zone

Quantitative distances

Nonbreeding season:

Surveyor walking in a coastal lagoon habitat in Italy: Buffer zone = 267m, buffer zone of 270m is recommended to protect mixed species winter roosts (Scarton, 2018b).

Pedestrian walking/running along footpaths close to intertidal areas in England: Buffer zone = 200m (Burton *et al*., 2002a).

Motorised watercraft (motorboat) in a coastal lagoon habitat in Italy: Buffer zone = 219m, buffer zone of 270m is recommended to protect mixed species winter roosts (Scarton, 2018b).

Pedestrian walking/running on grasslands in the Netherlands/Germany: Mean MAD = 100m (Smit and Visser, 1993).

Pedestrian walking/running on salt marsh in the Netherlands/Germany: Mean MAD = 200m (Smit and Visser, 1993).

Ecology and non-quantitative disturbance responses

With the recent loss of breeding curlews from most of Ireland and parts of western Britain over the past 40 years, the distribution of breeding curlews has become patchy with losses in western Scotland, Wales and southwest England and some gains in eastern and southeast England (Balmer *et al*., 2013). This species breeds in upland areas, the highest concentrations are now in northern England, especially the Pennines, eastern Scotland and the Northern Isles (Balmer *et al*., 2013). Curlew is a ground nesting species; the nest is a large depression lined with dried grass and feathers on tussocks or low hummocks (Snow and Perrins, 1998). Curlews are site faithful and will return to the same breeding grounds each year (Wernham *et al*., 2002).

Curlews are present around the UK coastline throughout the year, but coastal distribution is much more widespread outside the breeding season. During the winter, resident curlews leave their upland breeding areas and most spend the winter on or near the coast as well as adjacent farmland, the highest densities are on the major estuaries (e.g. the Wash, Morecambe Bay and the Solway), in the Northern Isles and in western Ireland (Balmer *et al*., 2013). Curlews are also site faithful in the winter and birds seldom move between estuaries (Wernham *et al*., 2002). Resident birds are joined by migrant birds from continental Europe during the nonbreeding season (Wernham *et al*., 2002). Curlews are omnivorous, intertidal invertebrates form the main part of the diet during the nonbreeding season (Snow and Perrins, 1998).

Changes in land-use, agricultural practices and drainage of wetland areas are considered to be the causes responsible for the decline in curlew numbers in the UK (Balmer *et al*., 2013). Human disturbance on breeding and wintering areas (including shooting that takes place in France) is believed to be of secondary importance (European Commission, 2007c). However, studies have shown that curlews are threatened by disturbance on intertidal mudflats (BirdLife International, 2021b), walkers (Burton *et al*., 2002a) and the flooding of mudflats and saltmarshes for tidal barrage construction (Burton, 2006), probably through indirect mechanisms associated to reductions of food resources or access/ displacement from wintering grounds (see literature review in Woodward *et al*., 2015). Curlew may also be at risk from improvements to water quality which has been found to cause reductions in benthic invertebrate densities at sites close to sewage outfalls (Burton *et al*., 2002b).

Curlews often roost on the coast at high tide with other waders (BirdLife International, 2021b), although large numbers of curlew will also roost on fields and marshland. A study by Scarton (2018b), identified Eurasian curlew to be the most sensitive species to human approach compared with other species of roosting waders. Davidson and Rothwell (1993) considered that curlew is one of the more nervous species of wader (in addition to bar-tailed godwit and redshank), compared with oystercatcher, turnstone and dunlin; although Collop (2016) suggested that large waders such as curlew may be able to cope with a 10% reduction in time spent feeding caused by daily disturbance events on the Wash. Furness (1973) noted that roosting curlews and bar-tailed godwits at Musselburgh lagoons were much more likely to be disturbed by aircraft than were other waders. A study investigating human disturbance on curlew, black-tailed godwit and teal in Co. Cork, Ireland, found that out of the three species, curlews were more susceptible to being greatly disturbed by human presence and activity; curlews predominantly left the study area when disturbed by anthropogenic causes (Sexton, 2017).

Likely sensitivity to disturbance = High

Quantitative information = Medium agreement & Robust evidence

Breeding season buffer zone = 200-300m

Nonbreeding season buffer zone = 200-650m

Curlew is assessed to have a high sensitivity to human disturbance.

The maximum FID value recorded for curlew when approached by a pedestrian is a mean of 65m during the breeding season and a mean of 340m (maximum FID of 650m) during the nonbreeding season. Also during the nonbreeding season, mean FID values have been recorded for curlew disturbed by aircraft (200m), motorised vehicles (188m), motorised watercraft (205m) and non-motorised watercraft (220 to 400m).

During the nonbreeding season, mean MAD values between 100 to 200m have been suggested to protect curlew from pedestrian disturbance. Buffer zones of 200 and 267 have been proposed for pedestrian disturbance and a buffer zone of 219m has been proposed for motorised watercraft disturbance; a buffer zone of 270m is suggested to protect winter roosts.

In the UK, curlew has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; tolerance of human disturbance may be lower at roost sites during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 200-300m is suggested to protect nesting curlew and a buffer zone of 200-650m is suggested to protect foraging and roosting birds during the nonbreeding season from pedestrian disturbance.

Knowledge gaps

Current studies provide a good range of FID values during the nonbreeding season, additional studies required for the breeding season.

Whimbrel, *Numenius phaeopus*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 310 breeding pairs in Scotland only (Woodward *et al*., 2020). Scottish population estimate has decreased since Forrester *et al*. (2012) who estimated a population of 400-500 breeding pairs.

UK long-term trend

Overall breeding range contracted by 29% between 1968/72 - 2007/11, although there was a mixture of gains and losses in northern Scotland; the breeding population fell from 410-470 pairs in the 1980s to c.290 pairs in 2009 (Balmer *et al*., 2013). However, winter migrant records increased by 212% between 1981/84 to 2007/11, probably as a result of milder winters (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Whimbrel was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Finland: Mean FID = 56.7m (n = 3), Min/Max FID = 25 to 90m (Díaz *et al*., 2021).

Surveyor walking in Europe: FID = 37.7m (n = 2) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking in a range of habitats: Mean FID = 37.7m (n = 28) (Blumstein, 2006).

Surveyor walking in a shorebird habitat in Australia: FID = 90m (n = 1) (Glover *et al*., 2011).

Surveyor walking in Africa: Mean FID = 57.2m (n = 21) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for whimbrel.

Ecology and non-quantitative information on disturbance responses

In the UK, whimbrel breed in Scotland and most of the confirmed records are in Shetland which covers 76% of the range; breeding has also been confirmed in Orkney and probable breeding was recorded in the Outer Hebrides and Caithness between 2007 and 11 (Balmer *et al*., 2013). In Scotland, this species breeds on heathlands, blanket bog and grazed acid grassland with little heather (Forrester *et al*., 2012). Whimbrel is a ground nesting species, the nest is a shallow depression lined with vegetation which may be on bare ground or in short vegetation (Snow and Perrins, 1998). This species forages on invertebrates and plant material, the proportion of each depends upon location and season (Forrester *et al*., 2012; Snow and Perrins, 1998).

Whimbrels do not overwinter in the UK, after the breeding season, this species migrates south to winter mainly along the western and southern coasts of Africa and on the islands and coasts of the western Indian Ocean (Wernham *et al*., 2002). Migrating whimbrels are regularly recorded around the coast of the UK (although there is a notable absence of passage birds in northeast Scotland), passing to and from breeding grounds in Greenland, Iceland, Fennoscandia and Russia to nonbreeding grounds; migrant birds are recorded in coastal areas as well as at inland sites (the latter particularly in England) (Balmer *et al*., 2013).

Whimbrels are regarded as potentially vulnerable to human disturbance, although it is possibly a minor factor compared to other threats faced by this species (BirdLife International, 2021b; Forrester *et al*., 2012; Wilke and Johnston-González, 2010). The main threats to whimbrel in Scotland are habitat degradation and climate change (Forrester *et al*., 2012). However, during shorebird migration and on the wintering grounds, excessive disturbance can reduce foraging and resting time, increase energy expenditure, decrease the level of use of available habitat and perhaps indirectly increase mortality (Watts *et al*., 2021; Wilke and Johnston-González, 2010). In a study on migrating shorebirds in America, Forgues (2010) found that off-road vehicles driving along beaches caused a significant decline in whimbrel numbers in the study area; birds maintained a distance of at least 75m from approaching vehicles. Peters and Otis (2007) found that nonbreeding whimbrel selecting a roost site in South Carolina showed a general trend towards avoidance of boat activity within 1000m.

In a study in Columbia, Johnston-Gonzalez and Abril (2019) suggested that whimbrel roost site selection was best explained by a combination of access to feeding territories and isolation from potential sources of mainland predators, but not by avoidance of human disturbance. Watts *et al*. (2021) did not find that human disturbance was a widespread threat to whimbrel night roosts in north America. In an anecdotal observation in Mozambique, Allport (2016) observed that a feeding flock of 40 whimbrel responded rapidly to a drone at c.20m above the ground; the authors noted that this response was consistent with the reaction of whimbrels to threats by predators rather than normal human disturbances, which generally did not cause a significant reaction in the study area.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-300m

Nonbreeding season buffer zone = 100-300m

Whimbrel is assessed to have a medium sensitivity to human disturbance.

The maximum FID value recorded for whimbrel when approached by a pedestrian is 90m during both the breeding and nonbreeding seasons, although quantitative studies are limited for this species.

In the UK, whimbrel has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during migration. There are no published buffer zones for whimbrel, but from studies on other waders, a minimum buffer zone of 100-300m is suggested to protect both breeding and nonbreeding whimbrel from pedestrian disturbance.

Knowledge gaps

More AD/FID studies are required during the breeding season and wider range of studies are required for different disturbance sources.

Red-necked phalarope, *Phalaropus lobatus*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 64 territorial breeding males (Woodward *et al*., 2020); Scottish population = 13-48 breeding pairs, 0-15 individuals during passage (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+267%) over 25 years.

The population of breeding red-necked phalarope in the UK seriously declined in the 19th century, this was followed by a temporary recovery in the early 20th century followed by a further decline since the 1930s (Forrester *et al*., 2012). The current relic breeding population has fluctuated considerably in range and size; the current range is larger compared with 1988/91, but smaller than in 1968/72 (Balmer *et al*., 2013). The number of breeding males ranged from 15-30 between 1978 to 2005 and 19-27 in 2010 (Balmer *et al*., 2013). Woodward *et al*. (2020) records the UK population at 64 breeding males in 2013-17. Breeding records in Ireland were not confirmed between 2007-11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Red-necked phalarope was not included in Ruddock and Whitfield (2007).

No AD/FID distances available for red-necked phalarope.

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for red-necked phalarope.

Ecology and non-quantitative information on disturbance responses

In the UK, red-necked phalarope breeds only in Scotland where it is a rare breeding bird at the southernmost edge of the species' circumpolar range (Balmer *et al*., 2013; Wernham *et al*., 2002). The main breeding areas are located in Shetland with other breeding sites in the Outer and Inner Hebrides and one in northeast Scotland (Balmer *et al*., 2013). This species breeds in areas of open water surrounded by vegetation, in Scotland they favour pools with rich nutrient content and low acidity (Forrester *et al*., 2012). Red-necked phalarope is a ground nesting species, the nest is a cup-shaped depression lined with leaves and stems (Snow and Perrins, 1998). This species forages whilst swimming, wading and walking, chiefly feeding on invertebrates (Snow and Perrins, 1998).

Red-necked phalarope do not overwinter in the UK, after the breeding season this species winters pelagically, favouring upwelling areas with abundant planktonic food (Wernham *et al*., 2002). A small number of migrant birds are recorded each spring, mostly in central and eastern England, whilst on their way to breeding grounds in the north (Balmer *et al.*, 2013).

The red-necked phalarope is well known to be one of the most tolerant of wild birds to human presence. Adults have been recorded brooding chicks in a human's hand, and during migration phalaropes allow close approach by people without disturbance (Cramp and Simmons 1982). Hildén and Vuolanto (1972) state: "Observation of phalaropes is very easy due to their tameness. A stationary observer can watch birds without disturbing them at a distance of only a few meters; egg laying, for instance, has been observed at close range without the use of a hide." According to Congreve and Freme (1930) "The remarkable tameness of this species when breeding is well known; however, one male phalarope that F met with was so ridiculously tame that it actually fed its captured youngsters as he held them in his hand". Michael (1938) described how red-necked phalaropes on migration would feed within 1 to 2 m of people at the edge of a lake.

Jørgensen *et al.* (2007) showed that red-necked phalaropes that nest in association with Arctic terns *Sterna paradisaea* often, but not always, respond to tern 'dreads' caused by predators or human disturbance long before the predator or human disturbance is close enough to cause the phalaropes to flee. They considered this to indicate the important role that colonies of terns can play in providing warning and defence for breeding phalaropes against threats from predators. In most cases, the behavioural response of phalaropes to tern dreads was simply to look up to identify the cause of the tern activity.

Everett (1971) suggested that the main threats to the very small breeding population of red-necked phalaropes in Scotland were drainage of pools, flooding of nest sites, damage to pool edges by cattle, and disturbance to nesting phalaropes by birdwatchers and photographers. The rarity of the red-necked phalarope, combined with its exceptional tolerance of humans, can result in breeding birds being seriously disturbed by people who spend too long too close to birds on breeding sites. Forrester *et al*., (2012) update that assessment to point out that conservation management can improve pools for phalaropes, but that egg collecting and deliberate human disturbance can still be significant factors. The impact of human disturbance is, paradoxically, because these birds are both rare and exceptionally tame, and a few irresponsible birdwatchers or photographers may deliberately disturb these rare birds on nesting sites.

Likely sensitivity to disturbance = Low

Quantitative information = No evidence

Breeding season buffer zone <50m

Red-necked phalarope is assessed to have a low sensitivity to human disturbance.

There are a lack of disturbance studies recording AD/FID values for red-necked phalarope. However, non-quantitative studies suggest that buffer zones required to protect red-necked phalarope during the breeding season may be much lower than those required for other waders.

In the UK, red-necked phalarope has limited potential to be disturbed on breeding grounds. From non-quantitative studies, a buffer zone <50m is suggested to protect breeding red-necked phalarope from pedestrian disturbance.

Knowledge gaps

Lack of studies providing AD/FID values during the breeding season.

Species: Terns

Little tern, *Sternula albifrons*

Conservation Status

UK: Amber List; Schedule 1

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 1,450 breeding pairs (Woodward *et al*., 2020); Scottish population = 331 Apparently Occupied Nests (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (-14%) over 15 years.

Range loss perhaps indicates there has been a shift into fewer, larger colonies (Balmer *et al*., 2013). Approximately stable in Scotland, though apparently declined by about 25% in England, Wales and Ireland (Forrester *et al*., 2012).

AD/FID

Quantitative disturbance distances

Little tern was not included in Ruddock and Whitfield (2007).

Nonbreeding season (little tern):

Surveyor walking: Mean FID = 21.5m (n = 18) (Blumstein, 2006).

Breeding season (least tern, *Sterna antillarum*, stand in species for little tern):

Surveyor walking towards nesting site along a shoreline in Florida: Mean FID = 59m (n = 17) (Rodgers and Smith,1995).

Surveyor walking towards nesting site in the USA: FID = 64m (n = 1) (Erwin, 1989).

MAD and/or

Buffer zone

Quantitative distances

Breeding season (least tern, *Sterna antillarum*, stand in species for little tern):

Surveyor walking towards nesting site along a shoreline in Florida: Buffer zone = 154 to 180m (Rodgers and Smith,1995)

Surveyor walking towards nesting site in the USA: Buffer zone = 100 to 200m. A buffer zone of 200 to 300m may be required to protect colony sites early in the season before birds are established (Erwin, 1989).

Ecology and non-quantitative disturbance responses

Little tern is a summer visitor to the UK. The majority of little terns (c.75%) breed on beaches in England, the majority are located on three sections of the coast: the Humber/Lincolnshire, East Anglia and the Solent (Balmer *et al*., 2013). Other colonies exist in North Wales, the Isle of Man, Orkney, the southern Outer Hebrides and the Inner Hebrides (Balmer *et al*., 2013). This species makes a shallow scrape on the ground for a nest and forages by plunge diving for small fish and invertebrates (Snow and Perrins, 1998). After the breeding season, little terns migrate south to overwinter off the coasts of Africa and the Arabian Peninsula (Wernham *et al*., 2002).

Human disturbance is one of the main factors affecting breeding success and distribution of little tern colonies in England; birds avoid sites with regular human disturbance (Balmer *et al*., 2013; Mitchell and Hearn, 2004; Brown and Grice, 2005). Colonies subject to frequent human disturbance have often been abandoned by little terns in favour of areas away from human activity.

On the other hand, there have been examples of little terns taking to nest on flat gravel-covered roofs (where of course they avoid human disturbance despite people being active on the ground below and adjacent to the buildings). Foraging little terns often patrol along the shore a few metres from land, and in such situations can fly close to people without showing any strong response, so human disturbance of foraging little terns is less likely to be a problem than disturbance of birds at nests (Bob Furness, pers. obs.). Little terns do not attack people and nest in small numbers in scattered colonies; the apparent relatively low sensitivity of individuals to disturbance compared to high impact of human disturbance at colonies probably arises because people are often unaware that they are walking into a little tern colony; nests tend to be both cryptic and scattered, and adult behaviour tends to be cryptic when people are close to nests.

Likely sensitivity to disturbance = Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 100-300m

Little tern is assessed to have a medium sensitivity to human disturbance at breeding colonies, although away from breeding grounds, sensitivity is considered to be low.

There are no AD/FID records available for little tern during the breeding season, but the maximum FID value recorded for least tern when approached by a pedestrian during the breeding season is 64m. Buffer zones between 100 and 200m have been proposed to protect least terns from pedestrian disturbance during the breeding season, a larger buffer between 200 to 300m is suggested to protect colony sites early in the season before birds are established .

In the UK, little tern has the potential to be disturbed at breeding colonies. A minimum buffer zone of 100m is suggested to protect little tern colonies from pedestrian disturbance, but this may need to be increased to 300m to avoid disturbance early in the breeding season (i.e. during egg laying).

Knowledge gaps

Lack of studies on little tern providing AD/FID values during the breeding season.

Sandwich tern, *Thalasseus sandvicensis*

Conservation Status

UK: Amber List

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 14,000 (13,000-15,000) breeding pairs, 65 individuals in winter (Woodward *et al*., 2020); Scottish population = 1,100 Apparently Occupied Nests, 500 to 5,000 individuals during passage periods (Forrester *et al*., 2012).

UK long-term trend

Wide annual fluctuation in colony size due to variation in the proportion of adults breeding, but overall, there has been a 23% contraction in range since 1968-72 (Balmer *et al*., 2013). Colonies have been lost, particularly in eastern Scotland,

with increasing proportions of the breeding population at just one site (Sands of Forvie NNR) (Forrester *et al*., 2012).

AD/FID

Quantitative disturbance distances

Sandwich tern was not included in Ruddock and Whitfield (2007).

No AD/FID records for sandwich tern.

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone records for sandwich tern.

Ecology and non-quantitative disturbance responses

Sandwich tern is a summer visitor to the UK. This species breeds in a small number of large colonies patchily distributed around the coasts of Britain and Ireland; some of the highest densities are recorded in northeast Scotland, Northumberland and Norfolk (Balmer *et al*., 2013). Colonies are largely absent along the coast of northwest Scotland, central and southern Wales and southwest England (Balmer *et al*., 2013). Sandwich terns nest on exposed open ground at the coast and on inshore islands, they generally select areas that are distant from human activity. This species makes a nest of a shallow scrape on the ground and forages by plunge diving for fish (Snow and Perrins, 1998). After the breeding season, Sandwich terns migrate south to overwinter in West Africa (Wernham *et al*., 2002).

Sandwich tern colonies are considered to be highly vulnerable to human disturbance, and colonies may be deserted as a result (Gregersen, 2006; Forrester *et al*., 2007; Garthe and Flore, 2007; Herrmann *et al*., 2008; Spaans *et al*., 2018). However, the response of breeding Sandwich terns to human activity seems to vary considerably among colonies. At the Farne Islands, Sandwich terns have habituated to presence of people on limited footpaths around the perimeter of their colony and continue to incubate when people are no more than 20m away. At many other Sandwich tern colonies where people are not normally present, Sandwich terns will leave their nests and chicks when people approach at much greater distances. Recognising that monitoring numbers and breeding success of Sandwich terns by visiting colonies tends to cause excessive disturbance, Spaans *et al*. (2018) tested the use of a drone, flown 15-20 m above nesting Sandwich terns at appropriate dates through the breeding season at colonies in The Netherlands, to count breeding numbers and breeding success from photographs. They found that the drone caused “hardly any visible disturbance to the birds” but gave highly accurate data on breeding numbers and breeding success, so was considered much better than using human observations at Sandwich tern colonies. The same conclusion was reached by Valle and Scarton (2021) in Italy.

Away from their colonies, Sandwich terns seem to be at relatively low risk of human disturbance when at sea. Perrow *et al*. (2011) followed breeding adult Sandwich terns foraging at sea from colonies in north Norfolk over distances of up to 72 km, keeping the boat about 20 to 100m from the bird. They note that “birds generally seemed to ignore the boat”. On the rare occasions (<1% of tracked birds) where birds seemed to respond to the boat, they increased their distance from the bird, and considered that foraging tracks and behaviours were broadly unaffected by their boat following the selected individuals. Sandwich terns will rest on shore at quiet coastal sites, especially during late summer after breeding is completed. This study has been unable to find data on flight initiation distances at such sites, but the locations used by Sandwich terns for post-breeding roosting seem to indicate that they select open areas with low risk of human disturbance (Tierney *et al*., 2016).

Likely sensitivity to disturbance = High

Quantitative information = No evidence

Breeding season buffer zone ≥ 200m

Sandwich tern is assessed to have a high sensitivity to human disturbance at breeding colonies, although away from breeding grounds, sensitivity is considered to be low.

There are a lack of disturbance studies recording AD/FID values for Sandwich tern. However, non-quantitative studies suggest that buffer zones required to protect Sandwich terns during the breeding season may be similar to those required for other tern species.

In the UK, Sandwich tern has the potential to be disturbed at breeding colonies. From studies on other tern species, it is suggested that buffer zones around breeding colonies should not be less than 200m to protect from pedestrian disturbance.

Knowledge gaps

Lack of studies providing AD/FID values during the breeding season.

Common tern, *Sterna hirundo*

Conservation Status

UK: Amber List

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 11,000 (8,900-13,500) breeding pairs (Woodward *et al*., 2020); Scottish population = 4,800 Apparently Occupied Nests, 2,000-20,000 individuals during passage periods (Forrester *et al*., 2012).

UK long-term trend

Declining breeding distribution in Scotland and Ireland contrasting with gains in eastern and central England; the breeding range has virtually halved in Ireland since 1968-72, whilst in Britain a 13% expansion is apparent (Balmer *et al*., 2013). Gains in inland England are likely to have resulted from the creation of man-made waterbodies, losses in Scotland and Ireland have been attributed to increases in predation (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Common tern was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in tern colony in North America: Mean FID = 10m (Nisbet, 2000).

Surveyor walking in tern colony in the USA: Range of mean FID = 7.3 to 8.1m (Burger and Gochfeld, 1988).

Surveyor walking towards nesting site in the USA: Mean FID = 142m (n = 18); Min/Max FID = 48 to 400m (Erwin, 1989).

Drone in North America: Min/Max FID = 91 to 122m (n = 502) (Chabot *et al*., 2015).

Nonbreeding season:

Surveyor walking in a range of habitats in Australia: Mean FID = 20.5m (n = 8) (Weston *et al*., 2012).

Surveyor walking in Sir Lanka: FID = 66 (n = 1) (Gnanapragasam *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Pedestrian walking/running near a tern colony in a range of locations: Buffer zone = 100 to 400m (Carney and Sydeman, 1999).

Surveyor walking towards nesting site in the USA: Buffer zone = 200m. A buffer zone of 300m may be required to protect colony sites early in the season before birds are established (Erwin, 1989).

Motorised watercraft near a tern colony in a range of locations: Buffer zone = 100m (Carney and Sydeman, 1999).

Motorised watercraft (Jet-ski) in the USA: Buffer zone = 100m (Burger, 1998).

Ecology and non-quantitative disturbance responses

Common tern is a summer visitor to the UK. In Scotland, common tern is primarily a coastal breeding species, the main concentrations are on lochs and islands of the west coast, Outer Hebrides, Northern Isles and the Inner Moray Firth (Balmer *et al*., 2013). In central and eastern England, breeding common terns are more often located at inland colonies (although there are some coastal colonies such as those in Northumberland) and, in Ireland, colonies are clustered by the coast as well as inland (Balmer *et al*., 2013). This species breeds on the ground in the open, usually on bare substrate, and makes a shallow scrape on the ground for a nest (Snow and Perrins, 1998). Like other tern species, common terns chiefly feed on marine fish by plunge diving (Snow and Perrins, 1998). After the breeding season, British breeding common terns migrate south to overwinter off the west coast of Africa, principally along the Gulf of Guinea coast between Sierra Leone and Ghana (Wernham *et al*., 2002).

Common terns may tolerate some forms of human disturbance and are able to habituate to human presence within colonies. Research studies within common tern colonies have shown that even with repeated disturbance, handling and trapping of chicks and adults, breeding success is not significantly reduced (Nisbet, 2000; Galbraith *et al*., 1999; Morris and Burness, 1992; Burger and Gochfeld, 1991), although removing the first egg may cause some pairs to move to another nest site within the colony (Arnold *et al*., 1998). Morris and Burness (1992) found that attaching radio transmitters to common terns did not affect nest attendance or chick feeding rates. Nisbet (2000) found that after 30 years of visiting breeding tern colonies, common terns allow approach to within 10m. Chabot *et al*. (2015) have found that common terns quickly become habituated to the presence of a drone.

However, ecotourists visiting tern colonies that are not habituated to regular human presence may be a cause of disturbance. Erwin (1980) found that common terns were disturbed from preferred nesting sites on barrier beaches in New Jersey by human activity. Common terns nesting in colonies with more exposure to human leisure activity return faster to the colony after banding than terns nesting in more remote colonies (Burger and Gochfeld, 1991; Nisbet, 1981). Erwin (1998) regards a 200m buffer zone (300m early in the season before birds are established) is required to protect common tern colonies from disturbance (people on foot) at colonies in Virginia and New Carolina, although Nisbet (2000), recommends that waterbird colonies should be managed to promote habituation with the presence of wardens or monitors to disturb the colony '*frequently, regularly and predictably*'.

Likely sensitivity to disturbance = Medium/High

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 200-400m

Common tern is assessed to have a medium to high sensitivity to human disturbance at breeding colonies, although away from breeding grounds, sensitivity is likely to be low.

The maximum FID value recorded for common tern is 400m when approached by a pedestrian during the breeding season, although the majority of recorded FID values are under 200m. When approached by a drone during the breeding season, the maximum FID value recorded is 122m. During the breeding season, buffer zones ranging between 100 and 400m have been proposed to protect common terns from pedestrian disturbance and a buffer zone of 100m has been proposed for motorised watercraft disturbance.

In the UK, common tern has the potential to be disturbed at breeding colonies. A buffer zone between 200-400m is suggested to protect common tern colonies from pedestrian disturbance, although a larger buffer zone may be required if terns are not habituated to disturbance or if disturbance occurs early in the breeding season (i.e. during egg laying).

Knowledge gaps

Current studies provide a moderate range of FID values during the breeding season. Future studies should specify habituation to disturbance when recording AD/FID.

Arctic tern, *Sterna paradisaea*

Conservation Status

UK: Amber List

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 53,500 breeding pairs (Woodward *et al*., 2020); Scottish population = 47,300 Apparently Occupied Nests, 10,000-200,000 individuals during passage periods (Forrester *et al*., 2012).

UK long-term trend

UK breeding range shows an overall range contraction of 31% since 1968-72, losses are greatest in western Scotland (especially Northern Isles) which have been attributed to predation (particularly American mink) and food shortages (Balmer *et al*., 2013). Annual colony sizes fluctuate, a 29% decline in numbers was recorded for Britain and Ireland between 1985/88 – 1998/2002 and a 15% decline during 2000-11, poor productivity and poor recruitment are noted as reasons for the decline (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Arctic tern was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking towards nesting site in Canada: Range of mean FID = 37 to 92m (n = 143); Max FID = 160 (Mallory, 2016).

Aircraft (helicopter) flying over a tern colony in Canada: Mean FID = 1000m (Mallory, 2016).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Surveyor walking towards nesting site in Canada: Buffer zone = 100 to 200m (Mallory, 2016).

Aircraft (helicopter) flying over a tern colony in Canada: Buffer zone = 2000m (Mallory, 2016).

Ecology and non-quantitative disturbance responses

Arctic tern is a summer visitor to the UK where it is a breeding bird at the southern end of the species' Arctic range. Arctic terns breed predominantly in coastal areas of Scotland and Ireland; in Scotland the highest abundance is recorded in the Northern Isles, Outer Hebrides and northern Scotland (Balmer *et al*., 2013). There are relatively few colonies in England, some colonies are present along the Northumberland coast, north-east Anglia, Merseyside and one on the Isle of Man, in Wales colonies are restricted to Anglesey and its offshore islands (Balmer *et al*., 2013). As with other tern species, Arctic terns breed on open bare ground by making a shallow scrape for a nest; they forage on marine fish by plunge diving (Snow and Perrins, 1998). Arctic terns undertake some of the most extensive migration journeys undertaken by any bird; after the breeding season, Arctic terns migrate to Antarctic waters where they spread along food rich areas at the edge of the ice pack (Wernham *et al*., 2002).

During the UK breeding season, Arctic terns tend to nest in larger colonies than common terns, and also tend to be much more aggressive towards humans that approach their nests, swooping and pecking people on the head. Human disturbance of nesting Arctic terns is therefore less likely to cause problems than human disturbance of common terns, as people tend to be deterred from Arctic tern nesting areas by the birds' aggression (Bob Furness, pers. obs.). However, there is some evidence to suggest that in a highly disturbed environment, human disturbance can have an effect on Arctic terns. It has been demonstrated on the Isle of May that for Arctic terns, the presence of visitors substantially decreases chick provisioning rates compared to when visitors are not present on the island. The highest level of disturbance was found during the afternoon and evening, when peak chick provisioning occurred (Bogdanova *et al*., 2014).

Foraging Arctic terns show very little or no behavioural response to the presence of people on the shoreline, so disturbance of foraging or commuting Arctic terns is unlikely. Arctic terns will roost on beaches when not breeding, mostly after the breeding season, and at that time may be displaced from a resting area by human disturbance. However, they are more likely to simply move to a nearby undisturbed area (Bob Furness, pers. obs.).

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone ≥ 200m

Arctic tern is assessed to have a medium sensitivity to human disturbance at breeding colonies, although away from breeding grounds, sensitivity is considered to be low.

The maximum FID value recorded for Arctic tern during the breeding season is 160m when approached by a pedestrian and 1km when approached by a helicopter, although quantitative studies are limited for this species. Buffer zones between 100 and 200m and up to 2km have been suggested to protect Arctic terns from pedestrian disturbance and helicopter disturbance respectively during the breeding season.

In the UK, Arctic tern has the potential to be disturbed at breeding colonies. A minimum buffer zone of 200m is suggested to protect Arctic tern colonies from pedestrian disturbance, although a larger buffer zone may be required if terns are not habituated to disturbance or if there is likely to be aerial disturbance above the colony.

Knowledge gaps

Few studies producing AD/FID values during the breeding season.

Roseate tern, *Sterna dougallii*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 100 breeding pairs (Woodward *et al*., 2020); Scottish population = 4 breeding pairs, 5-20 during spring and autumn passage (Forrester *et al*., 2012).

UK long-term trend

Eaton *et al*. (2021) state a stable number of breeding birds (+26%) over 25 years.

Numbers of roseate terns at the UK's most important roseate tern colony on Coquet Island have continued to grow; the number of breeding adults that were hatched on the island itself has risen steadily from 20% in 2006 to nearly 60% in 2019 (Eaton *et al*., 2021).

AD/FID

Quantitative disturbance distances

Roseate tern was not included in Ruddock and Whitfield (2007).

Breeding season:

Pedestrian leisure (unspecified) along the shoreline of Cape Cod Peninsula: Mean FID = 115.3m (n = 356), Max FID = 200m (Althouse *et al*., 2019).

Surveyor walking in tern colony in America: Range of mean FID = 6 to 6.5m (Burger and Gochfeld, 1988).

Nonbreeding season:

Surveyor walking in Africa: FID = 44.0m (n = 1) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Pedestrian leisure (unspecified) along the shoreline of Cape Cod Peninsula: Minimum buffer zone = 100m (Althouse *et al*., 2019).

Pedestrian activity around a tern colony: Buffer zone = 100 to 180m (Carney and Sydeman, 1999).

Ecology and non-quantitative information on disturbance responses

Roseate tern is a summer visitor to the UK where it is a very rare and localised breeder at the coast; inland records are extremely rare for this species (Wernham *et al*., 2002). The majority (97%) of the UK and Ireland breeding population is located at three colonies including: Coquet Island (northeast England) and Rockabill and Lady's Island Lake in the east of Ireland; numbers occurring at other colonies are very small, this species occasionally attempts to breed with common terns (Balmer *et al*., 2013). Roseate terns prefer breeding sites close to clear, shallow sandy fishing grounds; they generally nest under some cover from vegetation or rocks but will also nest on open sand, and will use tern nest boxes which can give added protection from predators, weather and disturbance; birds forage by plunge diving for marine fish (Snow and Perrins, 1998). Roseate terns do not overwinter around the UK, after the breeding season, British birds migrate south to overwinter in coastal Ghana (Wernham *et al*., 2002; Forrester *et al*., 2012).

Roseate tern is considered to be a particularly sensitive species to human disturbance. As this species is confined to so few breeding colonies, there is potential for significant disturbance during the breeding season as colonies are vulnerable to localised, stochastic events (OSPAR Commission, 2009). Uncontrolled disturbance to nesting terns (by humans or predators) can lead to abandonment and long-term disuse of sites (Monteiro *et al*., 1996). In the Azores archipelago, disturbance to wildlife has increased through human recreational activities (fishing, boating, scuba-diving, crab and limpet collecting, picnicking). The largest Azorean colony of roseate terns (200 clutches) was completely abandoned in 1992 after disturbance from picnickers, and in 1990, about 40 eggs were broken by fishermen; in each case, roseate terns did not return to the colony the following year indicating that disturbance may play an important role in colony shifting from year to year (Monteiro *et al*., 1996). At a stopover site in Cape Cod, Althouse *et al*. (2019), found that pedestrian activity (particularly activity involving rapid movement such as jogging) caused terns to flush at greater distances compared with shorebirds and gulls, even though gulls are kleptoparasites of terns (although common terns are more commonly targeted in a mixed tern colony). Althouse *et al*. (2019) suggested that a minimum buffer zone of 100m should be used by managers to protect staging roseate terns, although larger buffer zones may be necessary in areas that are frequented by smaller tern flocks because terns in small flocks may be more sensitive to disturbance than when in larger flocks. Carney and Sydeman (1999) suggested that tern colonies should not be entered within 100 to 180m.

In overwintering grounds in coastal Ghana, roseate terns are vulnerable to trapping by humans for food, sport and sale, the majority of trappings involve first-year birds which affects recruitment into the breeding population (Forrester *et al*., 2012).

Likely sensitivity to disturbance = High

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone ≥ 200m

Roseate tern is assessed to have a high sensitivity to human disturbance at breeding colonies, particularly because this species is confined to so few breeding colonies.

Quantitative studies are limited for roseate tern, but the maximum FID value recorded for this species when approached by a pedestrian is 200m during the breeding season and 44m during the nonbreeding season. Buffer zones between 100 and 180m have been suggested to protect roseate terns from pedestrian disturbance during the breeding season.

In the UK, roseate tern has the potential to be disturbed at breeding colonies. A minimum buffer zone of 200m is suggested to protect roseate tern colonies from pedestrian disturbance.

Knowledge gaps

Lack of studies providing AD/FID values during the breeding season.

Species tables: Owls

Snowy owl, *Bubo scandiacus*

Conservation Status

UK: Former breeder, Schedule 1

European: Least Concern

UK status

Accidental, Former Breeder

UK and Scottish population estimate

Scottish population = 1 breeding pair annually 1967-75 (Forrester *et al*., 2012). No known breeding attempts since 2001 in Ireland (Balmer *et al*., 2013).

UK long-term trend

Small but fluctuating numbers occur. Five different individuals were on St Kilda in May-August 2007 (Miles and Money, 2008). Two nonbreeding mobile birds were recorded during the summer (one in the Outer Hebrides, the other in the Channel Islands) between 2008 and 11; six or seven mobile birds were present during the winters between 2007 and 11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Snowy owl was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor approaching a nest site on Baffin Island, Canada: Min/Max FID (of brooding female) = 274.3 to 548.6m. (Watson, 1957).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for snowy owl.

Ecology and non-quantitative information on disturbance responses

Snowy owl is a rare winter migrant to Scotland. This species has a circumpolar breeding distribution on the high-arctic tundra, migrants in Scotland may originate from the European Arctic (Balmer *et al*., 2013). One pair bred in Fetlar in Shetland between 1967-75, but successful breeding attempts ceased when the breeding male died during the winter of 1975/76 (Balmer *et al*., 2013). Snowy owl is a ground nesting species, the nest is usually a shallow scrape on a raised bit of ground above the snow (Snow and Perrins, 1998). In a study in Norway, Solheim *et al*. (2021) suggested that male snowy owls selected elevated mounds, rocks or heights around the nest site in order to have the best view of the territory and keep a look out for prey and potential threats. A wide distribution of a small number of overwintering birds (6-7 individuals) was recorded in the UK between 2007 and 11, mainly in the Outer Hebrides, Orkney, Scottish Highlands, Channel Islands and Western Ireland (Balmer *et al*., 2013). Snowy owls feed on small mammals and medium sized birds (lemmings or voles on tundra), foraging may take place during the day although most hunting is carried out in the twilight of morning or evening (Snow and Perrins, 1998). Nonbreeding birds at St Kilda in summer 2007 fed on mice, adult puffins and skua chicks (Miles and Money, 2008). Outside the breeding season, snowy owls are solitary birds, in over wintering areas they are often seen resting on the ground or on mounds, rocks and fences.

Due to their remote breeding grounds, breeding snowy owls are largely free from direct human disturbance. However, snowy owls that are disturbed by pedestrians and predators on breeding grounds will strongly defend their nest sites and this species is known to attack people as well as Arctic foxes and dogs that come too close (Wiklund and Stigh, 1983; Watson, 1957; Sutton and Parmelee 1956). On Baffin Island in Canada, Watson (1957) noted that surveyors could not approach a nest without being seen by the male snowy owl and he described the attack as “silent and unexpected”; the owls would sometimes beat their wings on the surveyor’s head and give a painful blow with the back of their feet, sometimes with claws extended. Sutton and Parmelee (1956) also report being struck by the talons of snowy owls on Baffin Island, but also note that some warning of an attack is given; owls would hoot from a distant hilltop or while flying from one lookout post to another. Wiklund and Stigh, (1983) noted that as soon as an intruder faced an approaching snowy owl, the owl generally interrupted the attack even when only 5-10m from the intruder. Sutton and Parmelee (1956) found that snowy owls would not attack until the surveyors were within 100 yards (ca 91.5m) of a nest or young. Watson (1957) recorded at one location on Baffin Island that brooding female snowy owls flew away from surveyors at 300 yards (ca 274.3m), alighting 500 yards (ca 457m) beyond, and the male came no nearer than 50 yards (ca 46m), although when the surveyor moved 300 yards away from the nest the female returned at once, while the male watched from a perch. At another location, Watson (1957) noted that the owls were a bit shyer and brooding females would fly when the surveyor was 600 yards (ca 548.6m) away and the males would not come closer than 200 yards (ca 183m), though the nests contained young.

In Norway, studies on snowy owls have suggested that this species is potentially sensitive to a wide range of human disturbance, sources of pedestrian disturbance may include: tourism, recreation, reindeer husbandry, motorised traffic, dogs, photographers, ornithologists and scientists (Heggøy and Øien, 2014). Other human related disturbance including: egg collection, illegal hunting (still legal hunting in Alaska), environmental contaminants (PCBs, POPs) and collisions (cars, aeroplanes and power lines) are also considered potential threats (Heggøy and Øien, 2014).

On the Outer Hebrides, flushing distances to human disturbance have been found to be quite variable as snowy owls often sit in open machair grassland areas where people can be visible at long distances, however, birds can often be approached quite closely (c. 10m) without flushing if the approach is done slowly and sensitively, although birds will flush if birdwatchers/tourists approach too closely or surround an individual (Andrew Stevenson, pers. comm.) Snowy owls can be flushed by crofting/farming activities as well, although these sorts of regular activities are often ignored by individual birds, especially if the activity is at a distance (Andrew Stevenson, pers. comm.) On St Kilda, the current resident snowy owl has habituated to some degree to human presence, although this bird will avoid the village on the island where human activity is highest (Andrew Stevenson, pers. comm.). In New Hampshire, pedestrians wishing to approach migrant snowy owls during the nonbreeding season are advised to keep at least 100 feet (ca 30.5m) away from birds on the ground, as at this distance snowy owls may stare at a human present and any closer may cause birds to flush (New Hampshire Audubon, 2021). New Hampshire guidelines state that “*flushed birds have collided with stationary objects and once airborne they attract the attention of crows, gulls and hawks, which will pursue and harass them, reducing opportunities to hunt*” (New Hampshire Audubon, 2021)

In a study in Norway, Solheim, (2021) found that nonbreeding male snowy owls would approach and attack a vole lure on a line that was pulled by a surveyor who was sitting on the ground or in a car ca 100-500m away, the two female owls included in the study did not show any detectable reaction to the lures. The authors also noted that snowy owls perched 100m or closer to the road; surveyors usually watched the owls from a car to prevent disturbing the birds (Solheim, 2021).

Hardey *et al*. (2013) recommend that snowy owls should not be disturbed during laying or incubation, the authors also recommend that due to the rarity of this species within Britain and Ireland, all observations on the breeding snowy owl should be made from a distance, unless licenced surveyors have a specific need to collect information on clutch or brood size.

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Nonbreeding season buffer zone = 150-500m

Snowy owl is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for snowy owl; the maximum FID value recorded for this species is 548.6m when approached by a pedestrian in Canada during the breeding season, but as this species does not breed in the UK, quantitative values recorded during the breeding season may not be relevant to disturbance in the UK. There are no records of AD/FID values for pedestrian disturbance during the nonbreeding seasons, but Solheim, (2021) indicates that snowy owls may approach people within 100-500m.

In the UK, snowy owl is most likely to be disturbed on foraging and roosting grounds during the nonbreeding season. There are no published protection buffer zones for snowy owls, but from non-quantitative studies as well as studies on other owl species, a minimum buffer zone of 150-500m is suggested to protect foraging and roosting snowy owls during the nonbreeding season from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions.

Knowledge gaps

Lack of British studies measuring AD/FID for a range of pedestrian disturbance activities.

Long-eared owl, *Asio otus*

Conservation Status

UK: Green List

European: Least Concern

UK status

Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 1,800-6,000 breeding pairs (Woodward *et al*., 2020); Scottish population = 600-2,200 breeding pairs, 2,000-12,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Census methods do not provide accurate population estimates for this elusive and cryptic species (Forrester *et al*., 2012; Balmer *et al*., 2013), so trends in numbers are uncertain. However, while numbers may have declined in Scotland and England, they seem to have increased in Ireland between 1968 and 72 and 2007-11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Spain: FID = 12m (n = 1) (Díaz *et al*., 2021).

Surveyor approaching a nest in Italy: Min/Max FID = 3 to 42.5m (Galeotti *et al*., 2000).

Surveyor walking in a forest habitat in the USA: Min/Max FID = c.3 to 8m (Wilson, 1938).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 30m (n = 5 to 6); Min/Max AD (80% opinion range) = <10 to 300m; Min/Max AD (90% opinion range) = 150 to 300m.

Range of median FID = 5 to 30m (n = 5 to 7); Min/Max FID (80% opinion range) = <10 to 300m

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Disturbance free zone = 75 to 125m (Petty, 1998).

Construction work in California: Exclusion zone = 150m (Ruddock and Whitfield, 2007).

Ecology and non-quantitative information on disturbance responses

Long-eared owl is a solitary and territorial resident breeder in the UK with a habitat preference for open spaces with coniferous and scrub habitats containing abundant prey; this species will also breed in deciduous woodland (Balmer *et al*., 2013; Snow and Perrins, 1998). Breeding locations are widespread and scattered across Britain and Ireland, although long-eared owls are relatively uncommon in Scotland and England (Balmer *et al*., 2013). In Ireland it is the most abundant owl species and probably benefits from the absence of competing dominant tawny owls; in England, numbers are highest in northern areas with declines in the southeast and Wales (Balmer *et al*., 2013). In Scotland, long-eared owls are predominantly present in the south, east and north-east (except for the Black Isle where numbers are declining) and are absent from the north-west and the Northern Isles, except for a few pairs on the Inner and Outer Hebrides (Balmer *et al*., 2013; Forrester *et al*., 2012). Long-eared owls generally nest in trees; this species doesn't build its own nest but reuses old nests of other species, principally crows, sparrowhawks and magpies; nest boxes will also be used (Forrester *et al*., 2012; Snow and Perrins, 1998). Some long-eared owls may not lay eggs after establishing a nesting territory and separating early breeding failure from genuine non-breeding is particularly difficult for this species (Hardey *et al*., 2013). The diet of long-eared owl is mainly small rodents, especially voles, but other prey items may also include some birds, larger mammals and shrews; the diet is often more diverse in summer (Snow and Perrins, 1998).

During the nonbreeding season, resident breeding long-eared owls are joined by migrants from Fennoscandia, Russia and elsewhere in eastern Europe; there are fewer movements between eastern Britain and the Low Countries (Wernham *et al*., 2002). British breeders are fairly sedentary, although male birds may remain further north than females in some parts of the range (Wernham *et al*., 2002), but generally distributions between breeding and nonbreeding seasons are fairly similar (Balmer *et al*., 2013). In winter, communal roosts form, often in scrub near water and always in proximity to open habitat suitable for hunting (Wernham *et al*., 2002).

Long-eared owls are highly cryptic in woodland, very secretive and difficult to find which makes this a problematic species to survey and may provide some protection against some sources of human disturbance. Nesting birds vary in their behaviour towards intruding people. At the approach of a human, most remain tight on the nest to within a few metres (Galeotti *et al*., 2000), a few fly to deeper cover, and a few will swoop at people or perform a distraction display a few metres away (Cramp, 1985). In a study in Italy, Galeotti *et al*. (2000) found that nest defence increased significantly throughout the breeding season because older chicks were defended more strongly than younger chicks and eggs; median flushing distances of females occurred in the range of 3-42.5m from the start of incubation to early fledging. In a study in the USA on breeding owls, Wilson (1938) recorded that once disturbed by a surveyor, long-eared owls would flush at distances of c.3-8m and land again c.22-90m away.

Whilst long-eared owls are mostly found in woodland in the UK, in eastern Europe this species often occurs in urban habitats, both for breeding and for communal roosting. In urban habitats, long-eared owls may apparently be highly tolerant of human activity and they are thought to benefit from milder microclimates in urban roosts as well as reduced predation risk and availability of urban bird prey (Makarova and Sharikov, 2015; Mérö and Žuljević, 2020; Mak *et al*., 2021). Pirovano *et al*. (2000) found that long-eared owls adapt well to urban environments in the winter, in a study in Italy the authors observed urban roosts of up to 75 birds in public parks and private gardens.

However, long-eared owls can be sensitive to disturbance, particularly early in the nesting cycle and at communal roosts (Hardey *et al*., 2013). Hardey *et al*. (2013) recommend that any disturbance of potential roost sites by surveyors should be carried out as close to dusk as possible so that birds are not forced to leave roosts for long periods during daylight.

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 100-300m

Nonbreeding season buffer zone = 100-300m

Long-eared owl is assessed to have a medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for long-eared owl, but the maximum FID value recorded for this species is 42.5m when approached by a pedestrian during the breeding season; there are no records of AD/FID values during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for long-eared owl during the breeding season is 150 to 300m.

Buffer zones range from 75 to 125m to protect long-eared owls from forestry operations during the breeding season in the UK. An exclusion zone of 150m around nest sites has been recommended for construction activity in the USA.

In the UK, long-eared owl is most likely to be disturbed at nest sites early on in the breeding season as well as at communal roosting areas during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 100-300m is suggested to protect both breeding and nonbreeding long-eared owl from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions, especially during the nonbreeding season. A buffer zone at the lower end of this range, or even lower may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

Lack of British studies measuring AD/FID for a range of pedestrian disturbance activities.

Short-eared owl, *Asio flammeus*

Conservation Status

UK: Amber List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder, Passage/Winter Visitor

UK and Scottish population estimate

UK population = 620-2,200 breeding pairs (Woodward *et al*., 2020); Scottish population = 125-1,250 breeding pairs, 300-3,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Balmer *et al*. (2013) note widespread declines in numbers in Britain and Ireland, as also found in continental Europe. Declines have occurred in Scotland (Forrester *et al*., 2012) which most likely relate to maturing of plantation forestry so loss of nesting habitat in young plantations.

AD/FID

Quantitative disturbance distances

FID update (Booms *et al*., 2010) published since Ruddock and Whitfield 2007.

Breeding season:

Aircraft (helicopter) in Alaska: Mean FID = 55m, Min/Max FID = 50 to 60m.

(Booms *et al*., 2010).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 75 to 125m (n = 13 to 12); Min/Max AD (80% opinion range) = <10 to 500m; Min/Max AD (90% opinion range) = 300 to 500m.

Range of median FID = 5 to 75 m (n = 14); Min/Max FID (80% opinion range) = <10 to 500m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 300 to 600m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 275 to 325m (Petty, 1998).

Ecology and non-quantitative information on disturbance responses

Short-eared owl is a resident breeder and migrant species in the UK where it mainly inhabits areas of open country in Scotland and northern England (Balmer *et al*., 2013). Numbers are highest on Orkney, Outer Hebrides (Uists) and in the Pennines, elsewhere numbers of breeding birds are widely scattered and involve a small number of pairs in lowland coastal marshes and extensive grassland (Balmer *et al*., 2013). Short-eared owls have a habitat preference for upland heather grass-heather moorland, rough grassland, bogs and young forestry plantations populated with small mammal prey, particularly field voles (Balmer *et al*., 2013; Forrester *et al*., 2012). Arable areas are little used for breeding as are re-stocked conifer forests (Forrester *et al*., 2012). This species nests and often roosts on the ground; the nest is a shallow scrape roughly lined with pieces of vegetation in amongst the thick cover of grass, reeds and heather etc (Snow and Perrins, 1998).

In the nonbreeding season, some British breeding short-eared owls migrate to southern Europe while others remain in the UK but move from uplands to coastal marshes, dunes and farmland; birds remaining in the UK are joined by Fennoscandian breeders (Balmer *et al*., 2013;. Wernham *et al*., 2002). Overwintering birds can be found along the British east coast from Fife to Kent as well as around large river valleys and lowlands of England; birds breeding in Orkney, the Uists and the Pennines overwinter close to their breeding grounds (Balmer *et al*., 2013). In winter, short-eared owls generally roost communally, regularly on the ground at favoured locations in amongst vegetation (Wernham *et al*., 2002). Roosts can hold a dozen owls or more, but due to the mobility of the population in winter, there can be a high turn-over of numbers at roost sites (Wernham *et al*., 2002).

Fernandez-Bellon *et al*. (2021) reviewed the threats to short-eared owls and identified ecological factors (particularly prey availability, but also predation and extreme weather), changes in land use (habitat loss and agricultural intensification), persecution (shooting), and accidental nest destruction resulting from agricultural practices, as significant threats. They did not identify human disturbance as a threat. Forrester *et al*. (2007) identify habitat loss and illegal persecution as threats in Scotland, but did not indicate human disturbance to be a factor, although they note that short-eared owl roosts tend to be in remote locations away from human activity.

Van Gompel (1979) identified human disturbance as a major cause of displacement and abandonment of roost sites of short-eared owls wintering on the Belgian coast, though part of that related to illegal hunting of the species in Belgium. Cramp (1985) notes that short-eared owls are “wary”, but “not markedly shy”. However, Cramp (1985) states that birds in winter roosts tend to fly when a person approaches within ca.50m of a roost site, although such birds “rarely fly far before alighting”. Human disturbance near the nest normally results in the female sitting tight, often only flushing off the nest when almost stepped on (Cramp, 1985). Adults, mostly males, will sometimes attack people that approach the nest, sometimes use a distraction display, and sometimes alternate between these behaviours (Cramp, 1985). Reaction distance of males to humans increases when there are chicks in the nest, but typically the male may attack a person when they approach within 200m of the nest, barking in agitation and swooping towards the person, not normally making contact, but in some cases hitting and even drawing blood (Cramp, 1985).

Hardey *et al*. (2013) suggest that short-eared owls are potentially sensitive to disturbance during the breeding season, the authors recommend that the nests of this species should not be visited in cold, wet weather. Hardey *et al*. (2013) also recommend that vantage points for viewing short-eared owls are situated at least 500m away from areas of activity / nests to minimise the risk of disturbance and that searches for roost sites should be avoided due to the disturbance that this causes.

Likely sensitivity to disturbance = Medium/High

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone = 300-500m

Nonbreeding season buffer zone = 300-500m

Short-eared owl is assessed to have a medium to high sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for short-eared owl; the maximum FID value recorded for this species is 60m when approached by a helicopter in Alaska during the breeding season. There are no records of AD/FID values for pedestrian disturbance during either the breeding or nonbreeding seasons, but Cramp (1985) indicates that pedestrian disturbance may have an FID value within c.50m. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for short-eared owl during the breeding season is 300 to 500m.

Buffer zones range from 275 to 600m to protect short-eared owls from forestry operations during the breeding season in the UK.

In the UK, short-eared owl is most likely to be disturbed at nest sites in the breeding season as well as at communal roosting areas during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 300-500m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect both breeding and nonbreeding short-eared owls from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a larger buffer zone up to 600m to avoid disturbance during the breeding period.

Knowledge gaps

Lack of studies measuring AD/FID for a range of pedestrian disturbance activities.

Tawny owl, *Strix aluco*

Conservation Status

UK: Amber List

European: Least Concern

UK status

Resident Breeder

UK and Scottish population estimate

UK population = 50,000 breeding pairs (Woodward *et al*., 2020); Scottish population = 6,000 breeding pairs, 12,000 individuals plus ‘floaters’ in winter (Forrester *et al*., 2012).

UK long-term trend

Atlas survey methods are not very good for tawny owl, and trends in numbers are uncertain. Balmer *et al*. (2013) suggest increases in north and west Scotland between 1968-72 and 2008-11. Forrester *et al*. (2012) predict an increase in tawny owl numbers in Scotland as new native woodlands develop and increasing areas of plantation conifer forests reach maturity.

AD/FID

Quantitative disturbance distances

Tawny owl was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat: FID = 26.1m (n = 1) (Díaz *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Forestry operations in the UK: Disturbance free zone = 75 to 125m (Petty, 1998).

Breeding season (Barred owl, *Strix variata,* stand in species for tawny owl):

Forestry operations in Ontario: Buffer zone = 200m (Naylor, 2009).

Ecology and non-quantitative information on disturbance responses

Tawny owl is a widespread, common resident breeding species in deciduous and mixed woodlands throughout Britain (Balmer *et al*., 2013). Tawny owls will also inhabit tree-dotted farmland, urban parks and orchards, and even large gardens (Snow and Perrins, 1998). This species is absent from treeless areas including the Northern Isles, Outer Hebrides, some Inner Hebridean islands, Isles of Scilly and open areas of northern Scotland, it is also absent in the Channel Islands and Ireland (Balmer *et al*., 2013). Tawny owl is generally a hole nesting species, selecting holes usually up to 12m above ground (although they can be up to 25m above ground), they will readily take to using nest boxes; this species will also nest on cliffs or buildings often in old magpie nests or occasionally squirrel dreys (Snow and Perrins, 1998). Compared with other owls, tawny owls have a fairly wide diet depending on location. In woodland the diet is mainly rodents (but also birds, amphibians, shrews, earthworms and beetles), in towns, mainly birds are eaten, although also small rodents and other prey as available (Snow and Perrins, 1998). Tawny owls are highly sedentary and show a high degree of site fidelity, birds rarely move more than a few kilometres from their natal sites throughout their lives (Wernham *et al*., 2002); breeding and nonbreeding distributions are very similar (Balmer *et al*., 2013). Tawny owl is a solitary species and individuals remain alone or in their pairs throughout the year.

Forrester *et al*. (2007) did not suggest that human disturbance represented a significant threat to tawny owls in Scotland, their range of habitats brings them into close contact with people, especially in urban environments. While they appear to be tolerant of human activity, van der Horst *et al*. (2019) attributed lower densities of tawny owl territories close to main roads due to a combination of collision mortality and disturbance of owls by vehicle traffic. When disturbed at the nest, tawny owls vary considerably in terms of behaviour. Females guard the nest, and most go silently into cover if disturbed by a human at the nest, but a few individuals will attack, especially birds in urban habitats where they experience more human disturbance (Cramp, 1985). The most aggressive individuals may attack a person when they come within 50m of a nest containing young, usually swooping from behind and in extreme cases making physical contact and drawing blood (Cramp, 1985). Sacchi *et al*. (2004) found that tawny owls in urban parkland preferred nest boxes that were more than 6m above the ground, and suggest that this is part of a protection strategy against human disturbance. Frohlich and Ciach (2018) found that urban areas with high levels of human noise at night held lower densities of tawny owls. They suggest that tawny owl hunting efficiency may be reduced in noisy environments, indicating that human noise may be a stronger influence on tawny owls than visual disturbance.

Likely sensitivity to disturbance = Low/Medium

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 50-200m

Nonbreeding season buffer zone ≥50m

Tawny owl is assessed to have low to medium sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for tawny owl; the maximum FID value recorded for this species is 26m when approached by a pedestrian during the breeding season; there are no records of AD/FID values for pedestrian disturbance during the nonbreeding season. Cramp (1985) indicate that pedestrians shouldn't approach nests any closer than c.50m. Buffer zones range from 75 to 125m to protect tawny owls from forestry operations during the breeding season in the UK.

In the UK, tawny owl is most likely to be disturbed at nest sites in the breeding season, but there is also potential for disturbance at roosting and foraging areas during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 50-200m is suggested to protect nesting tawny owls and a buffer zone of ≥50m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence.

Knowledge gaps

Lack of studies measuring AD/FID for a range of pedestrian disturbance activities. Lack of MAD/buffer zones for tawny owl.

Barn owl, *Tyto alba*

Conservation Status

UK: Green List, Schedule 1

European: Least Concern

UK status

Resident Breeder

UK and Scottish population estimate

UK population = 4,000-14,000 breeding pairs (Woodward *et al*., 2020);

Scottish population = 500-1,000 breeding pairs (Challis *et al.,* 2020; Forrester *et al*., 2012), 1,000-2,000 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

According to Balmer *et al*. (2013), barn owls declined from the mid-19th century to the present, owing to changes in agriculture, loss of nest sites, and road traffic collision mortality. However, milder winters, nest box provision and agri-environment schemes may have mitigated that decline in recent years. Atlas maps show a large increase in barn owl distribution in Britain and Ireland between 1968-72 and 2007-11. Forrester *et al*. (2012) note that the Scottish population has been steadily growing since the 1980s.

AD/FID

Quantitative disturbance distances

No AD/FID updates published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a forest habitat in the USA: Min/Max FID = c.1.5 to 30m (Wilson, 1938).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 5m (n = 10 to 11); Min/Max AD (80% opinion range) = <10 to 100m; Min/Max AD (90% opinion range) = 50 to 100m.

Median FID = 5m (n = 11); Min/Max FID (80% opinion range) = <10 to 100m

(Ruddock and Whitfield 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Shawyer, 2011) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian walking/running in the UK: Buffer zone = 10 to 20m

Artificial lighting in the UK: Buffer zone = 20 to 30m

Motorised vehicle (general) in the UK: Buffer zone = 30 to 40m

Light commercial vehicle/machine (construction activity) in the UK: Buffer zone = 40 to 60m

Heavy commercial vehicle/machine (construction activity) in the UK: Buffer zone = 150 to 175m (Shawyer, 2011).

Forestry operations in the UK: Safe working distance = 100 to 250m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Forestry operations in the UK: Disturbance free zone = 75 to 125m (Petty, 1998).

Ecology and non-quantitative information on disturbance responses

Barn owl is a resident breeding species in the UK. This species is widespread across Britain, but these owls avoid high-altitude and urban areas and are absent from remote islands including the Outer Hebrides and Northern Isles; distribution is patchy in Ireland (Balmer *et al*., 2013). Barn owls can exploit a wide range of habitats, but they prefer lowlands with trees, especially farmlands with a combination of trees, hedges and aquatic areas with some rough grasslands where mice and other prey can be hunted in low flight (Snow and Perrins, 1998). Barn owl is a cavity nesting species using holes in trees, buildings, cliffs, quarries or rocky outcrops; nests are reused for successive broods and in successive years (Snow and Perrins, 1998). The diet is made up of small mammals, mostly mice and voles, some shrews and also some small birds and amphibians are eaten (Snow and Perrins, 1998). Adult barn owls are sedentary, but juveniles will disperse a median distance of 12km away from their natal sites in the first few weeks after fledging (Wernham *et al*., 2002); breeding and nonbreeding distributions are very similar (Balmer *et al*., 2013). Barn owl is a solitary species and individuals remain alone or in their pairs throughout the year.

As the name indicates, barn owls frequently nest in farm buildings, but will also use nest boxes or natural holes in trees. When nesting, barn owls tend to sit tight when a person approaches the nest, even when they come very close (Cramp, 1985). Although eggs may be deserted due to disturbance, barn owl chicks and adults can be ringed at the nest with almost no risk of adults deserting the nest due to the disturbance (Arthur French, pers. Comm.). Barn owls that are hunting show very little avoidance of people or of vehicles. Collision with road traffic is a major cause of mortality in barn owls (Forrester *et al*., 2007; de Jong *et al*., 2018).

Barn owls can be sensitive to disturbance at the nest site, particularly early in the nesting cycle. Hardey *et al*. (2013) recommend that licenced surveyors should take special care to avoid disturbance during pre-laying through to hatching, although the authors also state that nest inspections should not have a detrimental effect if carried out carefully. Hardey *et al*. (2013) also recommend that barn owls should not be flushed from nests or roosts in daylight because they may be mobbed by other birds and will be reluctant to return, which may affect their survival, particularly in the winter months. In a study in the USA on breeding owls, Wilson, (1938) recorded that once disturbed by a surveyor, barn owls would flush at distances of c.1.5-30m and land again c.90-150m away.

Likely sensitivity to disturbance = Low

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 50-100m

Nonbreeding season buffer zone ≥50m

Barn owl is assessed to have a relatively low sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for barn owl; the maximum FID value recorded for this species is 30m when approached by a pedestrian during the breeding season; there are no records of AD/FID values for pedestrian disturbance during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for barn owl during the breeding season is 50 to 100m, although the authors state that, as barn owl frequently nest in nest boxes '*overly prescriptive 'exclusion zones' based on the upper limits of apparent signs of disturbance in some pairs or situations may not be an appropriate management option in several situations'.*

Buffer zones range from 75 to 250m to protect barn owls from forestry operations during the breeding season in the UK. The Wildlife Conservation Partnership guidance recommends buffer zones of 10-20m to protect barn owl from pedestrian disturbance and buffer zones from 20-175m to protect against a range of other disturbances.

In the UK, barn owl is most likely to be disturbed at nest sites in the breeding season, but there is also potential for disturbance at roosting and foraging areas during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 50-100m (considered to be the upper disturbance limit estimated by expert opinion (Ruddock and Whitfield, 2007)) is suggested to protect nesting barn owls and a buffer zone of ≥50m is suggested to protect roosting and foraging birds during the nonbreeding season from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions. A buffer zone at the lower end of this range may be sufficient to protect individuals that have some habituation to human presence. Forestry operations may require a wider buffer zone up to 250m to avoid disturbance during the breeding period.

Knowledge gaps

Lack of studies measuring AD/FID for a range of human disturbance activities.

Species: Other species

Corncrake, *Crex crex*

Conservation Status

UK: Red List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 1,000 territorial breeding males mostly in Scotland (Woodward *et al*., 2020). Scottish population estimate has increased since Forrester *et al*. (2012) estimated a population of 1,060 breeding pairs in 2004, 0-10 birds in passage.

UK long-term trend

Eaton *et al*. (2021) state a strong increase in breeding birds (+108%) over 25 years.

Once an abundant and widespread breeding bird in the UK, there has been a long-term population decline since 1968/72 (Balmer *et al*. 2013). However, the British range increased by 14% between 1988/91 and 2008/11 and the population increased by 141% between 1993 and 2009, although there have been continued losses in Ireland (Balmer *et al*. 2013). Gains are largely a result of conservation measures, agri-environmental schemes and a reintroduction programme in eastern England (Balmer *et al*. 2013).

AD/FID

Quantitative disturbance distances

Corncrake was not included in Ruddock and Whitfield (2007).

Nonbreeding season:

Pedestrian walking/running at a stopover site in Egypt: Mean FID = 2.8m (Eason et al., 2010).

MAD and/or

Buffer zone

Quantitative distances

Breeding season:

Pedestrian (bird monitoring methods in the UK): MAD = 100m (not necessary to approach closer than 100m to pinpoint singing male) (Gilbert *et al*.,1998).

Ecology and non-quantitative information on disturbance responses

Corncrakes are summer visitors to the UK. The breeding population of corncrake is now mainly confined to a small number of coastal and island strongholds in Scotland and Ireland; the main breeding concentrations are in the Outer and Inner Hebrides with smaller numbers in Orkney, Shetland and coastal areas of Co. Donegal and West Connaught (Balmer *et al*., 2013). A growing breeding population is also present in the Nene Washes in eastern England where this species was introduced in 2002; a small number of passage birds moving to breeding grounds are also regularly recorded in eastern areas of Scotland and England (Balmer *et al*., 2013). Corncrakes prefer habitats that are composed of cool, moist stands of grass or herbage (including machair and fields of clover and cereals) that are tall enough to provide concealment; a nest is formed out of dead leaves on the ground concealed by vegetation (Snow and Perrins, 1998). Corncrakes are omnivorous feeding mainly on invertebrates, but small amounts of plant material, especially seeds, are also eaten (Snow and Perrins, 1998). Although there are historical records of corncrakes wintering in the UK, this species is largely migratory; after the breeding season, corncrakes migrate south through France crossing into Africa via Morocco to overwinter in trans-Saharan Africa (Wernham *et al*., 2002).

Isolated corncrake populations may be vulnerable to disturbance from birdwatchers, but in general this species is not thought to be very sensitive to human disturbance (RSPB, 1996). The decline in corncrake numbers was first noticed in the middle of the 19th century (Balmer *et al*. 2013; Cocker and Mabey, 2005), but even up to the late 1960s this species was an abundant and widespread breeding bird in the UK. Corncrakes were unable to adapt to changes in land management practices that followed agricultural intensification, particularly the changes that led to the motorisation and early mowing of grass crops for silage which kill their young (Balmer *et al*. 2013). Conservation measures brought about by the RSPB and adopted into agri-environmental schemes to delay mowing until August and to mow fields from the centre outwards to allow chicks to escape (these methods are referred to as Corncrake Friendly Mowing, CFM) have resulted in recent gains in corncrake numbers (RSPB, 2021b; Balmer et al., 2013; O'Brien *et al*., 2006).

Despite being a rather timid and highly cryptic species, more often heard than seen, corncrakes are able to tolerate human presence; this species inhabits agricultural areas and will live in close proximity to human activity. For example, in the UK, corncrakes have been reported to call within close proximity to human habitation (e.g. Norris, 1945; Cocker and Mabey, 2005) and the number of corncrakes recorded in a Moscow city park reportedly remained stable between 1928 and 1994 despite heavy recreational pressure (summarised in RSPB, 1996). Some corncrakes are able to habituate to human presence to such an extent that they will visit human dwellings to be fed (Cocker and Mabey, 2005).

However, the small, isolated populations that are now present in the UK are more likely to be impacted by disturbance than a widespread species (RSPB, 1996). In 2014, a male corncrake was heard calling for the first time in 15 years on Rathlin Island in Northern Ireland, but it is thought that this bird left the island due to disturbance caused by a helicopter landing briefly in an uncropped hayfield where the corncrake had been calling (RSPB, 2014).

Likely sensitivity to disturbance = Medium

Quantitative information = Low agreement & Limited evidence

Breeding season buffer zone ≥100m

Corncrake is assessed to have a medium sensitivity to human disturbance; the sensitivity of this species has increased as breeding populations have become more isolated.

Quantitative studies measuring AD/FID are very limited for corncrake; the maximum FID value recorded for this species when approached by a pedestrian is 2.8m during the nonbreeding season. A MAD of 100m has been recommended to protect corncrakes from pedestrian disturbance during the breeding season.

In the UK, corncrake has the potential to be disturbed on breeding grounds. Depending on the level of habituation to disturbance, a buffer zone of at least 100m is suggested to protect breeding corncrake from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions.

Knowledge gaps

Lak of any AD/FID studies during the breeding season.

European nightjar, *Caprimulgus europaeus*

Conservation Status

UK: Amber List

European: Least Concern, Annex 1

UK status

Migrant Breeder, Passage Visitor

UK and Scottish population estimate

UK population = 4,600 (3,700-5,500) territorial breeding males (Woodward *et al*., 2020); Scottish population = 27 territorial males, 1 record in winter, 0-4 during spring and autumn passage (Forrester *et al*., 2012).

UK long-term trend

Historically a widespread breeding species in the UK, the range contracted by 51% and 88% in Britain and Ireland respectively between 1968/72 and 1988/91 (Balmer *et al*., 2013). However, since this time the British breeding population doubled from 2,100 territorial males in 1981 to 4,600 in 2004, the breeding range also expanded by 18% between 1988/91 and 2008/11 (Balmer *et al*., 2013; Woodward *et al*., 2020).

AD/FID

Quantitative disturbance distances

FID update (Dolman, 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a forest habitat in England: Mean FID = 10m (n = 22) (Dolman, 2010).

Pedestrian walking/running, disturbance estimated by expert opinion:

Range of median AD = 5 to 18m (n = 12); Min/Max AD (80% opinion range) = <10 to 150m; Min/Max AD (90% opinion range) = 100 to 150m.

Median FID = 5m (n = 14); Min/Max FID (80% opinion range) = <10 to100m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

MAD and/or

Buffer zone

Quantitative distances

Buffer zone update (Langston *et al*., 2007) published since Ruddock and Whitfield (2007).

Breeding season:

Pedestrian leisure activity (general) on a heathland habitat in England: Buffer zone = 150m (Langston *et al*., 2007)

Pedestrian leisure activity (general) on a heathland habitat in England: Buffer zone = 500m (Murison, 2002).

Forestry operations in the UK: Safe working distance = 50 to 200m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative information on disturbance responses

Nightjars are summer visitors to the UK. Only a small proportion of the European population breeds in the UK, the majority of birds breed in Spain (Wernham *et al*., 2002). Nightjars in Britain are widely distributed across England and Wales, the highest concentrations are in East Anglia and southern England (Balmer *et al*., 2013). Although historically nightjar was once widespread in Scotland (as they were throughout the UK), this is now a very scarce breeding species mostly confined to the south-western area of Dumfries and Galloway (Balmer *et al*., 2013) in clearings within conifer plantations (Forrester *et al*., 2012). This is a nocturnal species which feeds on flying insects, mostly moths and beetles (Snow and Perrins, 1998). The preferred habitat of nightjars in the UK includes lowland heathland and felled or recently planted conifer plantations, though coastal moorland (Cornwall), sweet chestnut coppice (Kent) and sand dunes (Suffolk) may also be occupied (Balmer *et al*., 2013). Nightjars make a shallow scrape on the ground for a nest which may be located in the open, in woodland clearings or in amongst scrub and tall vegetation (Snow and Perrins, 1998). . Some suitable habitat is available in Scotland in the form of young conifer plantations, but the lowland dry heaths generally associated with this species in England are rare in Scotland (Forrester *et al*., 2012). Nightjars do not overwinter in the UK, after the breeding season, this species migrates south to overwinter in eastern and southern Africa (Wernham *et al*., 2002).

Nightjars are highly cryptic in woodland, secretive and difficult to find. Their camouflage may provide protection against some sources of human disturbance (e.g. some pedestrians and predators) and birds will often sit unseen on the ground at their roost or nest site until approached within a few metres (Wernham *et al*., 2002). Ruddock and Whitfield (2007) discuss that nightjars avoid movement because they may in part rely on their cryptic plumage to avoid detection, therefore, records of AD may be unreliable for this species as passive disturbance is very hard to detect.

In a study investigating nightjar predation within forest habitats in England, Dolman (2010) recorded no evidence to show that recreational disturbance caused birds to flush close to paths or that nightjar breeding success was impacted by disturbance; the authors found that nightjar nests were only predated by mammalian predators (primarily fox and badger), with no predation by crow or any other diurnal avian predator and no instances of flushing by dogs were observed.

However, conversely, other studies have shown that nightjars are impacted by disturbance and breeding success is known to be lower in areas where there are high levels of human recreation. In a study investigating the effects of recreational disturbance on breeding nightjars on heathland sites in England, Langston *et al*. (2007) found that failed nests were significantly closer to paths than successful nests (median distance from nearest path = 45m for unsuccessful nests (n = 26) versus 150m for successful nests). Langston *et al*. (2007) also found that nightjar nests surrounded by a greater total path length were associated with higher losses (mainly due to predation by corvids); the authors suggested that paths should be buffered by 150m to protect breeding nightjars from dogs and pedestrians. In a similar study involving the same habitat in England, Murison (2002) also showed that sites with no public access had significantly higher breeding success than sites with open access; nightjar density was lower within 500m of heavily traversed pathways and nest failures were found up to 225m from paths. Along routes with known territories and nest sites adjacent to paths, Murison (2002) suggested that dogs should be kept on leads or excluded from key sites between May and August to protect breeding nightjars. In another study on English heathland habitat, Liley and Clarke (2003) found that nightjar density was lower within 500m of urban development, although this may have been at least partly due to a lack of woodland near urban developments which is one of the preferred foraging habitats of nightjars.

In a long-term study (10 years) at Sherwood Pines Forest Park in Nottinghamshire, Lowe and Durrant (2014) found that breeding nightjar density significantly decreased in areas that were heavily disturbed by recreational activities; the authors suggested that human recreational disturbance may drastically alter settlement patterns and the nest site selection of arriving females and that buffer zones around territories should be based on the response to disturbance of females rather than males.

Likely sensitivity to disturbance = Medium/High

Quantitative information = Medium agreement & Limited evidence

Breeding season buffer zone = 150-500m

Nightjar is assessed to have a medium to high sensitivity to human disturbance.

Quantitative studies measuring AD/FID are very limited for nightjar; a mean FID value recorded for nightjar is 10m when approached by a pedestrian during the breeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for nightjar during the breeding season is 150 to 300m although they noted that '*estimates of static disturbance distances should be viewed with some scepticism because avoiding any movement is probably part of the suite of behaviours nightjars use to escape detection. This trait is also likely to lead to low active disturbance distances, with birds only flushing from the nest when an approaching potential predator is close*'. Buffer zones for nightjar range from 150 to 500m for pedestrian disturbance and 50 to 200m for forestry operations.

In the UK, nightjar has the potential to be disturbed on breeding grounds. A buffer zone of 150-500m is suggested to protect breeding nightjar from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions.

Knowledge gaps

Further AD/FID studies required during the breeding season investigating a range of disturbance sources.

Kingfisher, *Alcedo atthis*

Conservation Status

UK: Green List, Schedule 1

European: Least Concern, Annex 1

UK status

Migrant/Resident Breeder

UK and Scottish population estimate

UK population = 3,850-6,400 breeding pairs (Woodward *et al*., 2020); Scottish population = 330-450 breeding pairs, 1,200-1,800 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Breeding range has fluctuated over the last 40 years, losses have generally outweighed gains although there have been gains in eastern areas of England and Scotland (Balmer *et al*., 2013). Breeding numbers increased between the mid-1980s and 2005, but since this time numbers have fallen (Balmer *et al*., 2013). Wintering distribution increased between 1981/84 and 2007/11, possibly linked to milder winters (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

Kingfisher was not included in Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in a rural habitat in Spain: FID = 24m (n = 1) (Díaz *et al*., 2021).

Surveyor walking in an urban habitat in France: Mean FID = 9.5m (n = 2), Min/Max FID = 5 to 14m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Poland: FID = 24.6m (n = 1) (Díaz *et al*., 2021).

Nonbreeding season:

Surveyor walking in Europe: FID = 24m (n = 1) (Møller and Erritzøe, 2010).

Surveyor walking in Europe: Mean FID = 16.27m (n = 2) (Møller, 2008a).

Surveyor walking in a range of habitats in Sir Lanka: Mean FID = 14.8 (n = 8); Min/Max FID = 3 to 26m (Gnanapragasam *et al*., 2021).

Nonbreeding season (Azure kingfisher, *Ceyx azureus*, stand in species for European kingfisher):

Surveyor walking in a range of habitats in Australia: Mean FID = 11.7m (n = 10) (Weston *et al*., 2012).

Unknown season (Malachite kingfisher, *Alcedo cristata*, stand in species for European kingfisher):

Surveyor walking in Africa: Mean FID = 10.3m (n = 4) (Weston *et al*., 2021).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone available for kingfisher.

Ecology and non-quantitative information on disturbance responses

Common kingfishers are resident birds in the UK which inhabit lowland river areas. This species is one of the most northerly members of a mainly tropical family, the *ispida* race is present in the UK and much of Europe, but is replaced in the Mediterranean Basin by the nominate *atthis* which also breeds in central Asia (Wernham *et al*., 2002). Kingfisher is absent from the Scottish Highlands and islands, but in lowland areas of England and Wales it is widespread; only a small population is present in Scotland which is concentrated on the mainland mainly in the southern and eastern lowlands (Balmer *et al*., 2013), but smaller numbers are also found north to the Moray Firth (Forrester *et al*., 2012). Preferred habitats of this species are still or gently flowing freshwater streams, small rivers, canals, drains and ditches where birds can plunge dive from a perch to catch small fish and aquatic insects, although occasionally insects may be caught in the air (Snow and Perrins, 1998). Kingfishers breed in tunnels that are excavated into steep or vertical banks, usually (but not always) over water (Snow and Perrins, 1998). In the UK, this species is mainly sedentary, although juveniles disperse away from breeding territories; some kingfishers move to coastal habitats in winter, although generally distribution is similar in both the breeding and nonbreeding seasons (Balmer *et al*., 2013). Migration is rare in the UK, although some individuals may cross the English Channel or the North Sea (Wernham *et al*., 2002).

Kingfishers are shy, reclusive birds and are potentially sensitive to human disturbance, particularly during the breeding season. If the presence of humans prevents kingfishers from entering their nests for extended periods of time, chicks may weaken from cold or hunger and reduce their begging calls, which in turn may stimulate the parents to provide less food (RSPB, 2021c). Kingfishers may not nest in areas if there is ongoing disturbance nearby; a study on watercourses in Ireland indicated that kingfisher numbers were lowest in areas that had the highest percentage of paths and tracks, roads and human trampling, which may suggest that such disturbances could be having a negative effect on the kingfisher population, although low fish densities also likely impacted kingfisher density in the Irish study (BirdWatch Ireland, 2010). A study in Spain indicated that the highest densities of kingfishers are located along rivers with the lowest human population density as well as minor agricultural use, indicating that this species prefers more pristine watercourses (Peris and Rodriguez, 1997). However, kingfishers can breed successfully on rivers within urban areas such as the River Kelvin in Glasgow and the Rivers Black Cart and White Cart in Paisley, and appear to be unaffected by people walking along the riverbank paths, possibly because the rivers are wide enough to mitigate disturbance.

A number of studies in Asia have investigated the impact of human disturbance on common kingfishers. In a study in Dhaka, Bangladesh, investigating daily activity patterns of common kingfishers, Sultana and Sarker, (2016) found that kingfishers were more active in the morning compared with the afternoon, which the authors suggested was due to increased human presence and high traffic noise along waterbodies during the afternoon. Biswas and Rahman (2012) estimated that approximately 15% of the major threats for kingfishers at Chittagong University in Bangladesh were due to human disturbance around nesting, feeding and roosting areas, as well as some public superstition and dislike towards kingfishers. Noor *et al*. (2014) found that kingfisher density was low in areas with high levels of vehicular traffic and human habitation along the bank of the Dal Lake in Jammu and Kashmir, India.

Likely sensitivity to disturbance = Low/Medium

Quantitative information = High agreement & Limited evidence

Breeding season buffer zone = 50-100m

Nonbreeding season buffer zone = 50-100m

Kingfisher is assessed to have a low to medium sensitivity to human disturbance.

The maximum FID value recorded for kingfisher when approached by a pedestrian is 25m during the breeding season and 26m during the nonbreeding season. There are no published buffer zones for kingfisher.

In the UK, kingfisher has the potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season; as a hole nesting species kingfisher may be less likely to be disturbed when on the nest. Depending on the level of habituation to disturbance, a minimum buffer zone of 50-100m is suggested to protect breeding kingfisher from pedestrian disturbance, but further studies on the impacts of human disturbance are required to help inform such decisions.

Knowledge gaps

Further AD/FID studies required during the breeding and nonbreeding seasons to investigate a range of disturbance sources.

Crested tit, *Lophophanes cristatus*

Conservation Status

UK: Green List, Schedule 1

European: Least Concern

UK status

Resident Breeder

UK and Scottish population estimate

UK population = 1,000-2,000 breeding pairs in Scotland (Woodward *et al*., 2020; Forrester *et al*., 2012); Scottish winter population = 5,600-7,900 individuals in winter (Forrester *et al*., 2012).

UK long-term trend

Crested tit was probably widespread in Scotland when ancient native pinewood covered much of the highlands, but this species declined and fragmented as the forest was cut down (Forrester *et al*., 2012). However, new pine plantations planted in the 20th century have allowed the range to extend again and it is likely that the population has also increased (Forrester *et al*., 2012). The Scottish breeding range increased by 28% between 1968/72 and 2007/11 and the wintering range expanded by 50% between 1981/84 and 2007/11 (Balmer *et al*., 2013).

AD/FID

Quantitative disturbance distances

FID updates (Jiang and Møller, 2017; Møller, 2008a; Dolman, 2010) published since Ruddock and Whitfield (2007).

Breeding season:

Surveyor walking in Europe: Mean FID = 6.2m (n = 34) (Jiang and Møller, 2017).

Pedestrian leisure (unspecified) in Denmark: Mean FID = 6.08m (n = 7) (Møller *et al*., 2007).

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 75m (n = 9); Min/Max AD (80% opinion range) = <10 to 100m; Min/Max AD (90% opinion range) = 50 to 100m.

Range of Median FID = 5 to 30m (n = 10); Min/Max FID (80% opinion range) = <10 to100m.

(Ruddock and Whitfield, 2007; Whitfield *et al.*, 2008a).

Breeding season (Willow tit, *Parus montanus*, stand in species for crested tit):

Surveyor walking in Europe: Mean FID = 5.6m (n = 7) (Jiang and Møller, 2017).

Breeding season (Marsh tit, *Parus palustris*, stand in species for crested tit):

Surveyor walking in Europe: Mean FID = 6.3m (n = 40) (Jiang and Møller, 2017).

Breeding season (Blue tit, *Parus caeruleus*, stand in species for crested tit):

Surveyor walking in Europe: Mean FID = 5.4m (n = 262) (Jiang and Møller, 2017).

Breeding season (Coal tit, *Periparus ater*, stand in species for crested tit):

Surveyor walking in Europe: Mean FID = 5.8m (n = 13) (Jiang and Møller, 2017).

Breeding season (Great tit, *Parus major*, stand in species for crested tit):

Surveyor walking in Europe: Mean FID = 5.9m (n = 450) (Jiang and Møller, 2017).

Nonbreeding season:

Surveyor walking in Europe: Mean FID = 6.32m (n = 18) (Møller and Erritzøe, 2010).

Surveyor walking in Europe: Mean FID = 6.08m (n = 7) (Møller, 2008a).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season:

Forestry operations in the UK: Safe working distance = 50 to 200m (Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Ecology and non-quantitative information on disturbance responses

In the UK, crested tit is a resident species confined to pinewoods of northern Scotland; the core range covers the Caledonian pinewoods of upper Strathspey and pinewoods of lower Strathspey; the *scoticus* race occurs almost exclusively in native pinewoods and Scots pine plantations in the coastal plains of Moray and Nairn (Balmer *et al*., 2013; Wernham *et al*., 2002). Smaller numbers of crested tits are also recorded in pine plantations in Easter Ross and east Inverness-shire, as well as remnant pine forests of the glens from Strathbran and Strathfarrar south to Glen Garry (Balmer *et al*., 2013). The density of wintering crested tits has been found to be ten times higher in ancient native pinewoods compared with planted pinewoods (Summers e*t al*., 1999). Crested tit is a hole nesting species, generally in rotten tree stumps, and nest boxes are regularly used (Thom, 1986). Food is mainly insects and spiders, although plant material (mainly conifer seeds) may be eaten outside of the breeding season (Snow and Perrins, 1998), this species often forages on the ground or in low branches (Svensson *et al*., 2009). Adult crested tits are sedentary and although juveniles disperse over short distances post-breeding, breeding and nonbreeding distributions are similar (Balmer *et al*., 2013).

Crested tits can be tolerant of human presence; there are a number of records of birds visiting garden bird tables and feeders on Skye and in Gairloch, (Balmer et al., 2013) the RSPB Loch Garten Nature Centre in Speyside and in Moray (Forrester et al., 2012), particularly during the winter (Highland Nature, 2014) although Svensson *et al*. (2009) mentions that this behaviour is relatively rare. Like other species of the tit family, crested tits can be very inquisitive and at times may approach humans making a noise, but this behaviour depends on the stage of nesting; in the spring this species can be very elusive and difficult to find (Highland Nature, 2014). Svensson *et al*. (2009) note that crested tits are usually difficult to approach, although this species is not known to be particularly shy.

In studies using distance sampling analysis to estimate the density of crested tits in Scotland, the distance at which a pedestrian walking a transect line could detect a crested tit ranged between 39.3 to 62.5m; tits recorded along transects are usually detected by a contact or scolding call and therefore FID values are likely to be lower than detection distances (see summary in Ruddock and Whitfield, 2007; Calladine 2006; Summers *et al*., 1999).

Likely sensitivity to disturbance = Low

Quantitative information = High agreement & Limited evidence

Breeding season buffer zone = 10-50m

Nonbreeding season buffer zone = 10-50m

Crested tit is assessed to have a relatively low sensitivity to human disturbance.

Quantitative studies measuring AD/FID are limited for crested tit; the maximum mean FID value recorded for this species when approached by a pedestrian is 6.2m during the breeding season and 6.3m during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for crested tit during the breeding season is 50-100m. Buffer zones for crested tit range from 50 to 200m for forestry operations.

In the UK, crested tit may have some potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 10-50m is suggested to protect breeding and nonbreeding crested tits from pedestrian disturbance.

Knowledge gaps

Further AD/FID studies required during the breeding and nonbreeding seasons to investigate a range of disturbance sources.

Crossbill species, *Loxia spp.*

Conservation Status

Common crossbill (*Loxia curvirostra*):

UK: Green List, Schedule 1

European: Least Concern

Scottish crossbill (*Loxia scotica*):

UK: Amber List, Schedule 1

European: Least Concern, Annex 1

Parrot crossbill (*Loxia pytyopsittacus*):

UK: Amber List

European: Least Concern

UK status

Common crossbill:

Migrant/Resident Breeder, Passage/Winter Visitor

Scottish crossbill:

Endemic (Scotland) breeder

Parrot crossbill: Scarce Visitor, Occasional Breeder (Scotland)

UK and Scottish population estimate

Common crossbill:

Breeding: UK = 26000 pairs; Scotland = 5,000 to 50,000 pairs depending on cone crops elsewhere in Europe and in UK (Forrester *et al*., 2007).

Scottish crossbill:

Breeding Scotland only = 300 to 1,300 pairs (Forrester *et al*., 2007).

Parrot crossbill:

Breeding: Scotland only = ca. 100 pairs

UK long-term trend

Huge fluctuations, but also a long-term (20th and 21st century) increase in common crossbill numbers and range relating to increase in amount of mature plantation forestry (Balmer *et al*., 2013; Forrester *et al*., 2007).

AD/FID

Quantitative disturbance distances

FID update (Díaz *et al*., 2021; Møller and Erritzøe, 2010; Møller, 2008b; Møller *et al*., 2007) published since Ruddock and Whitfield (2007).

Breeding season (common crossbill, *Loxia curvirostra*):

Surveyor walking in a rural habitat in Denmark: Range of mean FID = 4.7 to 5.5m (n = 7); Min/Max FID = 4.1 to 8.2m (Díaz *et al*., 2021).

Surveyor walking in a rural habitat in Spain: Mean FID = 9.2 to 16.4 (n = 4); Min/Max FID = 6.4 to 16.4m (Díaz *et al*., 2021).

Pedestrian (general) in Denmark: Mean FID = 4.6m (n = 12) (Møller *et al*., 2007).

Breeding season (parrot crossbill, *Loxia pytyopsittacus*):

Surveyor walking in a rural habitat in Denmark: Mean FID = 4.2m (n = 2); Min/Max FID = 2.8 to 5.72m (Díaz *et al*., 2021).

Breeding season (crossbill spp, *Loxia spp*):

Pedestrian walking/running, disturbance estimated by expert opinion:

Median AD = 5m (n = 16); Min/Max AD (80% opinion range) = <10 to 150m; Min/Max AD (90% opinion range) = 100 to 150m.

Median FID = 5m (n = 17); Min/Max FID (80% opinion range) = <10 to 150m.

(Ruddock and Whitfield, 2007; Whitfield *et al*., 2008a).

Nonbreeding season (common crossbill, *Loxia curvirostra*):

Pedestrian (general) in Europe: Mean FID = 4.74m (n = 2) (Møller and Erritzøe, 2010).

Pedestrian (general activity) in Europe: Mean FID = 4.73m (n = 2) (Møller, 2008b).

MAD and/or

Buffer zone

Quantitative distances

No MAD or buffer zone updates published since Ruddock and Whitfield (2007).

Breeding season (common crossbill, *Loxia curvirostra*):

Forestry operations in Canada: Buffer zone = 70m (Waterhouse and Harestead, 1999).

Forestry operations in the UK: Safe working distance = 50 to 150m

(Currie and Elliot, 1997; Forestry Commission Scotland, 2006).

Breeding season (Scottish crossbill, *Loxia scotica*):

Forestry operations in the UK: Safe working distance = 150 to 300m

(Currie and Elliot, 1997).

Forestry operations in Scotland: Safe working distance = 50 to 150m

(Forestry Commission Scotland, 2006).

Breeding season (parrot crossbill, *Loxia pytyopsittacus*):

Forestry operations in Scotland: Safe working distance = 50 to 150m

(Forestry Commission Scotland, 2006).

Ecology and non-quantitative disturbance responses

Where ranges overlap, common and Scottish crossbills cannot reliably be told apart using visual identification, however, Scottish crossbills are limited in range to northeast Scotland and the eastern Highlands, so outside of this range, records refer solely to common crossbills (Balmer *et al*., 2013). Crossbills are associated with conifer plantations and are widely distributed throughout most of Scotland and Wales, exceptions are treeless areas of northwest Scotland, Northern Isles and some Hebridean islands (Balmer *et al*., 2013). Distribution in England is patchy, some of the higher densities are in conifer plantations in Norfolk, Hampshire and Dorset (Balmer *et al*., 2013). Crossbills forage by extracting seeds from conifers, this species may start breeding as early as midwinter, depending on availability of conifer seeds and consequently, breeding and nonbreeding distributions in the UK are fairly similar (Balmer *et al*., 2013; Snow and Perrins, 1998). Within northern Europe, this species feeds mainly on the seeds of Norway spruce, whereas the larger-billed parrot crossbill and Scottish crossbill are able to extract seeds from the tougher cones of Scots pine (Summers, 2018). Crossbills build nests high in conifer trees (Snow and Perrins, 1998).

Common crossbills can be found in deep dense forest, woodland edges or detached stands, they appear to tolerate human disturbance as they can be found in mature conifers in small towns and they will occasionally use overhead cables for perching or drinking from roof-top water tanks (Snow and Perrins, 1998). Crossbills are rarely found on the ground and disturbance studies on crossbill spp. indicate that human disturbance distances are relatively low (Díaz *et al*., 2021; Møller and Erritzøe 2010; Møller, 2008b; Møller *et al*., 2007), likely because their foraging and breeding habitat high up in trees keeps crossbills at a distance from human disturbance.

Likely sensitivity to disturbance = Low

Quantitative information = Medium agreement & Medium evidence

Breeding season buffer zone = 50-200m

Nonbreeding season buffer zone = 50-200m

Crossbill species are assessed to have a relatively low sensitivity to human disturbance.

The maximum FID value recorded for crossbill species when approached by a pedestrian is a maxmum of 16.4m during the breeding season and a mean of 4.7m during the nonbreeding season. Ruddock and Whitfield (2007) considered from expert opinion that the upper pedestrian disturbance distance limit for crossbill species during the breeding season is 100 to 150m, which is consistent with safe working distances used by Forestry Commission Scotland. Currie and Elliot (1997) suggest that safe working distances should be larger for Scottish crossbill (up to 300m), likely due to species differences in conservation status (Ruddock and Whitfield, 2007).

In the UK, crossbill species may have some potential to be disturbed on breeding grounds as well as on foraging and roosting grounds during the nonbreeding season. Depending on the level of habituation to disturbance, a buffer zone of 50-200m is suggested to protect breeding and nonbreeding crossbills from pedestrian disturbance.

Knowledge gaps

Lack of studies measuring AD/FID for Scottish crossbills during the breeding season.

Recommendations for further research

It has been acknowledged that all bird species assessed in this review are likely to vary their response to human disturbance in different areas due to differing levels of habituation between individuals as well as a wide range of other factors that can influence behavioural responses to disturbance (see '**Habituation and other factors influencing disturbance distance**' section). Furthermore, this review has identified that there are a number of bird species where quantitative data on disturbance distances in relation to human activities are lacking (see '**Data gaps**' section). Therefore, due to these variable factors and data gaps, the range of disturbance distances presented in this review are intended as a guide only. For studies that require to understand more precisely the distance a focal species will respond to a given source of disturbance under a given set of environmental conditions, specific bird disturbance distance studies need to be carried out on a site-specific basis.

Future disturbance distance studies investigating the impacts of human activity on bird disturbance should aim to record quantitative records of disturbance distances in terms of AD and FID. These measures of disturbance distances can be recorded by measuring the distance between a source of disturbance and the position of a focal bird when 1) the focal bird is first alerted to the source of disturbance (AD) and 2) when the focal bird first responds to the source of disturbance by moving away (FID). FID should still be recorded even if it is not possible to record AD; AD is usually more difficult to determine than FID, as alert behaviour is often cryptic compared with the FID response of physically moving away from the source of disturbance.

Standardised data should be collected in order to efficiently compare data recorded in different disturbance distance studies. Any study aiming to deliberately disturb birds in Scotland should also discuss the plan with NatureScot in advance in order to ensure that the work is compliant with legislation and with conservation objectives and welfare considerations. The following list provides a guide to basic information that should be recorded at the time of a disturbance distance study:

- Focal bird species, and age/sex of bird where that can be determined from plumage;
- Study location;
- Date;
- Weather conditions;
- Details of the source of disturbance (e.g. person walking, dog running, rock climber, motorboat, canoe, drone etc. moving towards focal bird);
- Whether the source of disturbance is visual or acoustic or both;
- AD distance (if it is possible to identify);
- FID distance; and
- Whether the study location is likely to be disturbed or undisturbed; if it is disturbed then what the likely source of disturbance is (e.g. is the study location frequented by people/boats/aircraft etc., or is it a remote and relatively undisturbed site).

Secondary factors that would be useful to record at the time of a disturbance distance study include the following:

- The initial distance between the source of disturbance and the focal bird (i.e. the study starting distance before the point of AD or FID has been reached);
- A record of whether the focal bird is likely to be breeding or nonbreeding;
- Specific habitat of the study location (e.g. sandy beach, cliffs, estuary mudflats etc.);
- Time of day;
- Tidal state (where coastal);
- Type of behaviour focal bird is displaying before the disturbance event (e.g. foraging/roosting/nesting/loafing);
- Type of AD behaviour (e.g. head-up, alarm calling, aggressive display, unknown);
- Type of FID behaviour (e.g. walk/run away, fly away 50m, swim/dive away from source of disturbance);
- Whether the focal bird is alone or with other birds (if it is the latter, then record the identity of other bird species and the flock size); and
- Length of time spent flying away from the source of disturbance.

Outside the field of applied impact assessments and academic research, there is also a need to record disturbance distances for bird species in a range of study locations under a variety of environmental conditions (including different seasons and weather conditions) in order to better understand the realistic range of natural disturbance distances. Disturbance distance studies do not necessarily involve sophisticated equipment or a particular knowledge of disturbance-based research. Disturbance distance studies can be carried out by anybody who can use a measuring device (e.g. a measuring tape or a range finder) and who has a good knowledge of bird species identification. Disturbance distance studies would, therefore, be highly appropriate as a Citizen Science project to build up a more detailed picture of sensitivity of birds to human disturbance. Alternatively, studies of disturbance responses would make excellent undergraduate or Masters research projects. Collating disturbance responses into one database will help to build a clearer picture of the potential impacts of disturbance on birds caused by human activities.

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APPENDIX 2: TECHNICAL NOTE RE BLAST FURNACE SIGHTLINES (REF: NE8)

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Project name: H2Teesside

To: Natural England

From: [redacted]

CC:

Date:
18 December 2024

H2Teesside Memo: Relevant Representation NE8 – effects of the Proposed Development on waterbirds at Blast Furnace Pool

Background to NE8

Natural England Relevant Representation NE8 identified the following item for further discussion:

"*It appears that the new hydrogen production facility will reduce sightlines from the Blast Furnace Pool (sector 3a) and the area will become less 'open'. This could have a number of negative impacts on waterbirds ranging from increased vigilance when using the pool and increased predation risk to direct avoidance of the pool. These impacts have not been adequately addressed in the assessment*."

The Applicant provided the following initial response at Deadline 1 (17th September 2024):

"*There is currently little evidence that this pool or any part of the dune system in the vicinity of the Proposed Development is used in any more than an occasional way by SPA birds, although it is likely to be targeted for measures to improve SPA condition by NE in attempts to reverse this. Across all of the high and low tide surveys of this sector (which collectively number 24) 4 SPA species occurred and none of them occurred more than twice, nor did any occur in numbers significant in the context of the SPA populations. Sightlines may be reduced to the south-west by the Proposed Development, an area that has previously accommodated infrastructure and buildings albeit not of the same specification or layout. Sightlines to the north (Coatham Sands) and west (Bran Sands Bay) will not be affected.*"

Natural England subsequently stated that their position was unchanged and that the impact pathways identified by them that might affect wetland birds at this location should be assessed in full. They provided the following further comment:

"*We note the bird survey results and believe that although the pool's use by SPA birds is at a low level, it serves an important function as a refuge when tidal/weather conditions are less favourable*".

This memo provides the assessment requested by them.

Baseline data

Blast furnace pool (Grid Reference: NZ 56999 25886) is one of a series of pools within Coatham Dunes, albeit it is the only one that currently includes any open water habitat, all the other ponds being choked by reedmace and other swamp vegetation. It is shallow, approximately 160 m long and 35 m wide and orientated northwest – southeast, sitting in a depression that is 5m deep, immediately north of South Gare Road within the rolled slag deposits that form the southern margins of the dunes system. Its surface is predominantly open water, with small stands of reedmace and other marginal vegetation encroaching from the eastern and northern sides. The pond and its immediate environs are periodically subject to recreational disturbance from beachgoers making their way to and from Coatham Sands to the north. The pool is approximately 110 m east of the Main Site, but the distance between the pool and the nearest proposed infrastructure is greater than this (see below).

The following birds were recorded over a year of monthly surveys carried out by AECOM on high and low tides:

Low tide

Black-headed gull (*Chroicocephalus ridibundus*): Peak (and only) count 1 (February 2022);

Curlew (*Numenius arquata*): Peak (and only) count 2 (October 2022);

Lapwing (*Vanellus vanellus*): Occurred twice, Peak count 2, which occurred in June 2023;

Ringed plover (*Charadrius hiaticula*): Peak (and only) count 1 in July 2023;

Little ringed plover (*Charadrius dubius*): Occurred twice, Peak count 2 (June 2023);

Mallard (*Anas platyrhynchos*): Peak and only count 2 (March 2023); and

Moorhen (*Gallinula chloropus*): Occurred 4 times, Peak count 2 (July 2023).

High tide

Black-headed gull: Peak and only count 1 (January 2022);

Canada goose (*Branta canadensis*): Peak and only count 3 (March 2023);

Grey heron (*Ardea cinerea*): Peak and only count 1 (March 2023);

Lapwing: Peak and only count 1 (July 2023);

Little ringed plover: Peak and only count 2 (June 2023);

Moorhen: 8 occurrences, Peak count 3 occurred in July 2023;

Redshank (*Tringa totanus*): Peak and only count 13 (November 2022); and

Teal (*Anas crecca*): Occurred twice, Peak count 2 (March 2023).

Further information has been gathered to inform the assessment of the potential impact pathways identified by Natural England, including:

Details of some of the key historical infrastructure associated with the former steelworks;

Details of key elements of the proposed H2Teesside infrastructure, including locations and heights;

A topographical survey carried out to inform preliminary Ground Investigation (GI) works for Net Zero Teesside (NZT);

A plot plan and 3D model of the proposed H2Teesside main site infrastructure; and

Photographs taken from the shores of Blast Furnace Pool intended to demonstrate a “bird’s eye view” of the surroundings, from ground level.

Main Site History and Proposed Infrastructure

The majority of the former steelworks infrastructure had been demolished by late October 2022. The key elements of the steelworks (and their approximate dimensions) included a steelworks building up to 70 m tall, a blast furnace standing approximately 110 m tall and various supporting infrastructure (conveyors, storage buildings, administration buildings and chimneys) of various heights.

The H2Teesside infrastructure is sited partially on the footprint of the former steelworks and includes the key infrastructure listed in Appendix A. These are shown on the 3D model of the Main Site, which identifies the locations and heights of the tallest buildings (Appendix B). None of them exceed the heights or dimensions of any single steelworks building, although the flare stacks are a similar height to the former blast furnace building.

Sightlines from Blast Furnace Pool

To address the relevant representation, sightlines must be considered from the point of view of a bird that is either on the open water of the pond, or that is otherwise utilising shoreline habitat and to do this it is critical to understand the topography of the dune system in relation to its surroundings. The dune system and the rolled slag deposits create a varied topography characterised by deep depressions, surrounding which are steep embankments and sloped ground rising to levels similar to those at South Gare Road. This can be seen on the extract of the topographical survey carried out to support GI works for NZT (Appendix C). The road and the land within Teesworks are approximately 7 m - 7.5 m Above Ordnance Datum (AOD), while the dunes and rolled slag deposits plateau at slightly greater maximum height (up to 9.25 m), dropping to around 2.9 m AOD at the shoreline of Blast Furnace Pool and across its surface.

From the southern and eastern edges of the pond, which are vegetated with marginal scrub and swamp vegetation, the land immediately rises steeply, meeting South Gare Road to the south; to the southwest the bowl of the depression is flat for several metres west of the water's edge before it rises sharply to around 8 m. To the north, the land remains relatively open and flat, before rising towards the dunes. The cross sections presented in Appendix C show that there is a narrow ridge of high ground along the northern edge of the road, before the heights drop away slightly within Teesworks to the south and southwest. This topography presents a natural visual barrier between the dunes and the Teesworks site for any fauna using the majority of the pond's surface and its margins.

A series of photographs taken with the camera held close to ground level (to simulate the sightline of a bird on or close to the pond) are provided as Plates 1 – 5 in Appendix D for various points around the perimeter of the pond. These show that along the majority of the pond's length there is an immediate and significant obstruction of sightlines towards the Main Site and that the southern, western and eastern perimeter of the pool are significantly enclosed. The effect of this is to close off sightlines between the pool and the proposed Main Site for birds at ground level. Only at the northern end of the pool does the topography to the west open up sufficiently to allow some views towards the proposed infrastructure. This perspective allows some longer ranging views to the south and southwest also.

The 3D models (Appendix C) represent the outline appearance of the Main Site from the point of view of an individual looking southwest from South Gare Road (Figure 1), from where the majority of infrastructure would be clearly visible; and from the point of view of a bird on the open water at the northern end of the pool (Figure 2), where the views of the proposed infrastructure would be impeded the least by topography and landforms.

Structures with potential to affects sightline and predation levels of Special Protection Areas (SPA) birds

The closest structure to the pool, approximately 135 m west, is the proposed water treatment plant that stands at approximately 10-12 m tall; this would not be visible from the pool. The majority of the structures proposed as part of the Main Site complex are either similar in height and/or are more distant from the dune system and the pool and are not visible to a bird on any part of the pool. It therefore follows that the majority of the proposed infrastructure would be highly unlikely to create adverse effects associated with closing off sightlines, reducing openness or increasing predation of SPA birds at Blast Furnace Pool.

The tallest structures that would be visible from the northern parts of the pool's surface and shoreline are:

The Phase 2 ASU Coldbox, at 52 m high and approximately 400 m west of blast Furnace Pool, approximately 50% of which would be visible, however it’s distance from the pool would negate it’s potential to affect openness or sightlines for birds;

The Phase 2 Start-up Fired Heater (45 m high and 385 m southwest) – approximately 30% of which would be visible;

The Phase 2 Aux Boiler Stack (70 m high and 320 m southwest), approximately 70% of which would be visible;

The Phase 2 Flash Vessel (65 m high and 400 m southwest), approximately 50% of which would be visible;

The Phase 2 CO_2 absorber Column (48 m high and 425 m southwest), which would project above the horizon but would be obscured by the Phase 2 Flash Vessel;

The Phase 1 LP Flare Stack (100 m high and 603 m southwest), approximately 50% of which would be visible; and

The Phase 2 LP Flare Stack (100 m high and 523 m southwest), approximately 50% of which would be visible.

Moving southwards along the long axis of the pool or shoreline would result in the views of these structures diminishing rapidly, especially in the southern half of the pool where it is anticipated that very little, or none of each of these structures would be visible. Where these buildings are likely to be visible at the northern end of the pool, their spatial arrangement would not result in a substantial closing off of sightlines, since the structures appear widely spaced and, with the exception of the ASU Coldbox, all of them have a very limited “footprint” (in other words they appear as narrow towers that present a very limited silhouette).

Assessment of potential impacts

The combined use of baseline data, photographic evidence, topographical survey and 3D modelling of the proposed infrastructure within the Main Site demonstrates that:

Blast Furnace Pool lies within a topography that is already significantly enclosed to the south, east and southwest, and is within an area immediately adjacent to South Gare Road that is subject to frequent disturbance from passing vehicular traffic plus recreational users of the dunes and beach;

Substantial buildings and other steelworks infrastructure, some of which attained heights of over 100m, were present south of South Gare Road until late October 2022 and it is therefore likely that birds utilised the habitats in this area are accustomed to the presence of infrastructure;

The pool itself plays a role in providing opportunities for roosting and feeding water birds, but the baseline data show that such occurrences are rare and involve very small numbers of birds;

The topography provides effective screening of much of the pool’s surface and shoreline from activities and infrastructure within Teesworks and would prevent the visual intrusion of most of the proposed infrastructure at ground level at and adjacent to the pool, except in the northern half of the pool, where limited views of the some of the proposed infrastructure would be expected. The infrastructure visible is relatively distant from the pool (the closest being the Phase 2 Aux Boiler Stack, 320 m from the closest part of the pool.

It is therefore highly unlikely that the proposed infrastructure would deter wetland birds from using the pool and its environs; the potential effects of reductions of openness and sightlines for birds at Blast Furnace Pool are therefore predicted to be **Not Significant**.

The potential for increased predation of water birds, through provision of nesting and roosting opportunities for predatory birds on the proposed infrastructure, when considered against a recent baseline of the presence of steelworks infrastructure that for decades provided similar opportunities to predatory birds, is unlikely to result in significant effects on use of this habitat by water birds. The potential effects of predation on wetland birds are predicted to be **Not Significant**.

Therefore, **no significant effects** are anticipated to occur on water birds and on the Cleveland and Teesmouth Coast designations as a result of the impact pathways discussed herein.

These conclusions are summarised in Table 1, for the following receptors.:

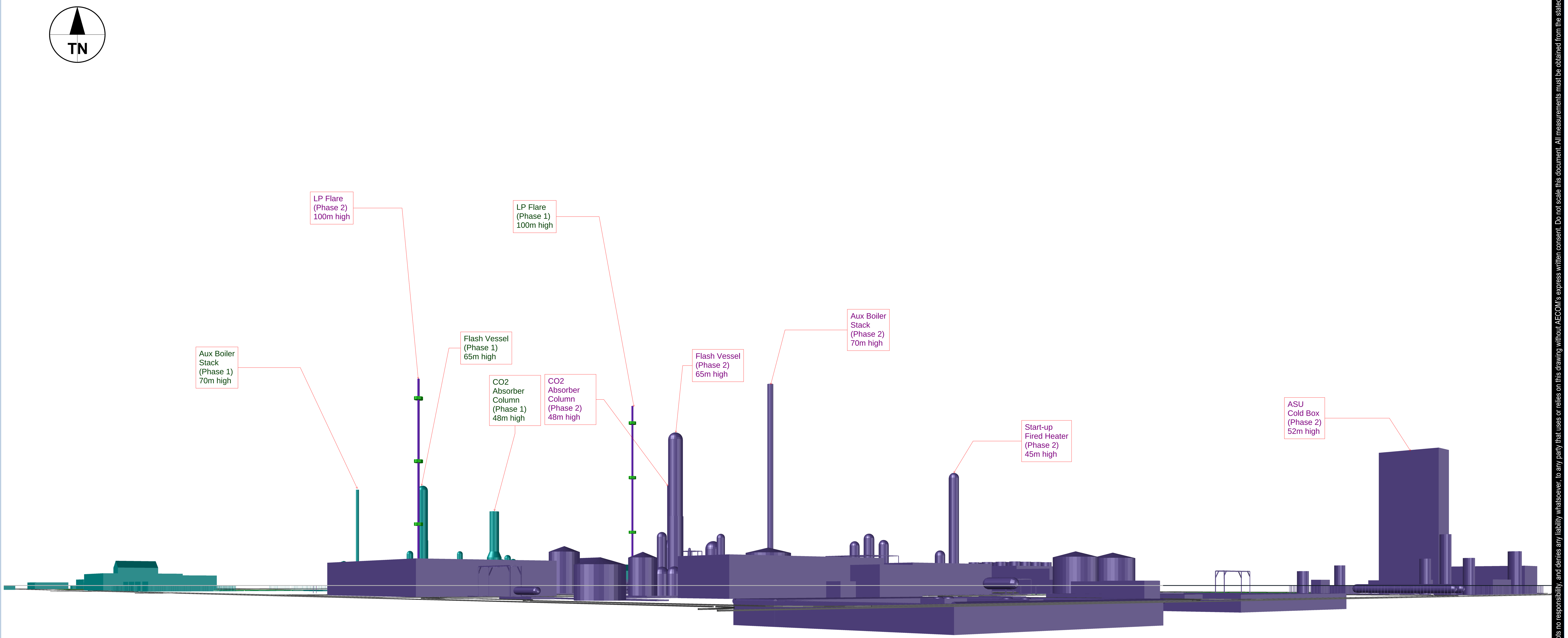
- Teesmouth and Cleveland Coast SPA and Ramsar (International Value);
- Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI) (National Value); and
- Non-breeding waterbird assemblage, including any and all water birds occurring regardless of their contribution to the function of designated sites (Regional value).

All potential impact pathways assessed are for the operational stage of the Proposed Development and no mitigation is proposed over and above the embedded mitigation described in Chapter 13 of the Environmental Statement [APP-065].

Ornithological Feature	**Value**	**Description of potential impacts**	**Duration**	**Potential significance of effect**
Teesmouth and Cleveland Coast Ramsar and SPA	International	Reduction of sightlines and habitat openness for qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**
		Increased predation of qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**
Teesmouth and Cleveland Coast SSSI	National	Reduction of sightlines and habitat openness for qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**
		Increased predation of qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**
Non-breeding waterbird assemblage (Teesside)	Regional	Reduction of sightlines and habitat openness for qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**
		Increased predation of qualifying species using Blast Furnace Pool	Long term	**Not Significant (Negligible)**

Appendix A – Table of Main Site Buildings/Structures

Building / Equipment Name	**Height / m**
Warehouse / Stores	25
Control Room	5.5
Offices / Workshop	12
Administration Building	8
Security	3
Valve Isolation Station	3
Emergency Diesel Generators	5
Transformers/ HV substation / LV Substation	10
AGIs and Metering Package	5
Pipe rack crossings over roads	8
ASU	52
Water Treatment Chemical Storage	5
Demin Water Plant	10
Oily Water Separator	8
Water Treatment Dosing Package	4
Waste Water Treatment	10
Raw Water Buffer Tank	12
Treated Water Buffer Tank	10
GAC Tanks	6
Chemical Dosing	4
Chemical Treatment	6
Tail Gas Compressors	6
Antifoam Dosing Package	5
H2 Compressor Shelter	12
F-201 Start-up Fired Heater	45
LP Flare 21-X-32001	100
Auxiliary Boiler	10
Auxiliary Boiler Flare Stack	70
CO2 Absorber Column C-08001	48
Flash Vessel DV113-B (Phase 1 & 2)	65m Option 1 65m Option 2 50m Option 3



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PROJECT

H2Teeside DCO

CLIENT

H2Teeside Limited

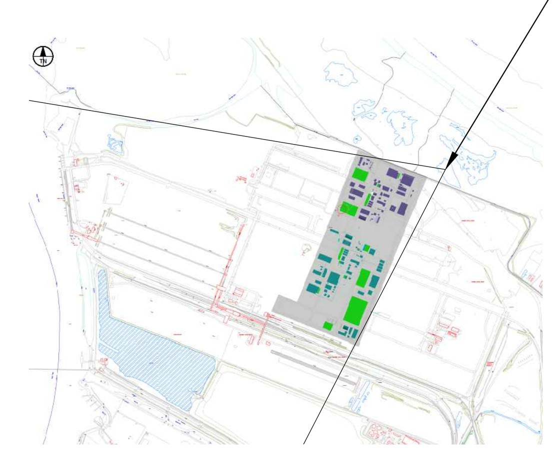
CONSULTANT

AECOM Limited
100 Embarkment,
Cathedral Approach,
Manchester, M3 7FB
www.aecom.com

LEGEND

	PHASE 1 DEVELOPMENT
	PHASE 2 DEVELOPMENT
	SITE AREA
	POND

NORTH WEST VIEW (AS SHOWN ON DRAWING)



PLAN VIEW

NOTES

1. DRAWING IS FOR INDICATIVE PURPOSES ONLY.

0 50 100 m

1:2000 @ A1

APPROVED FOR ISSUE

1	AS	JC	IU
I/R	DRAWN BY	CHECKED	APPROVED

ISSUE/REVISION

1	06/12/2024	DRAFT
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60689030

SHEET TITLE

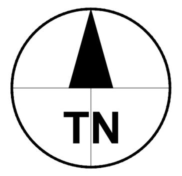
H2TEESIDE DCO
3D PLANT DRAWING
NORTH EAST VIEW - 0m ELEVATION

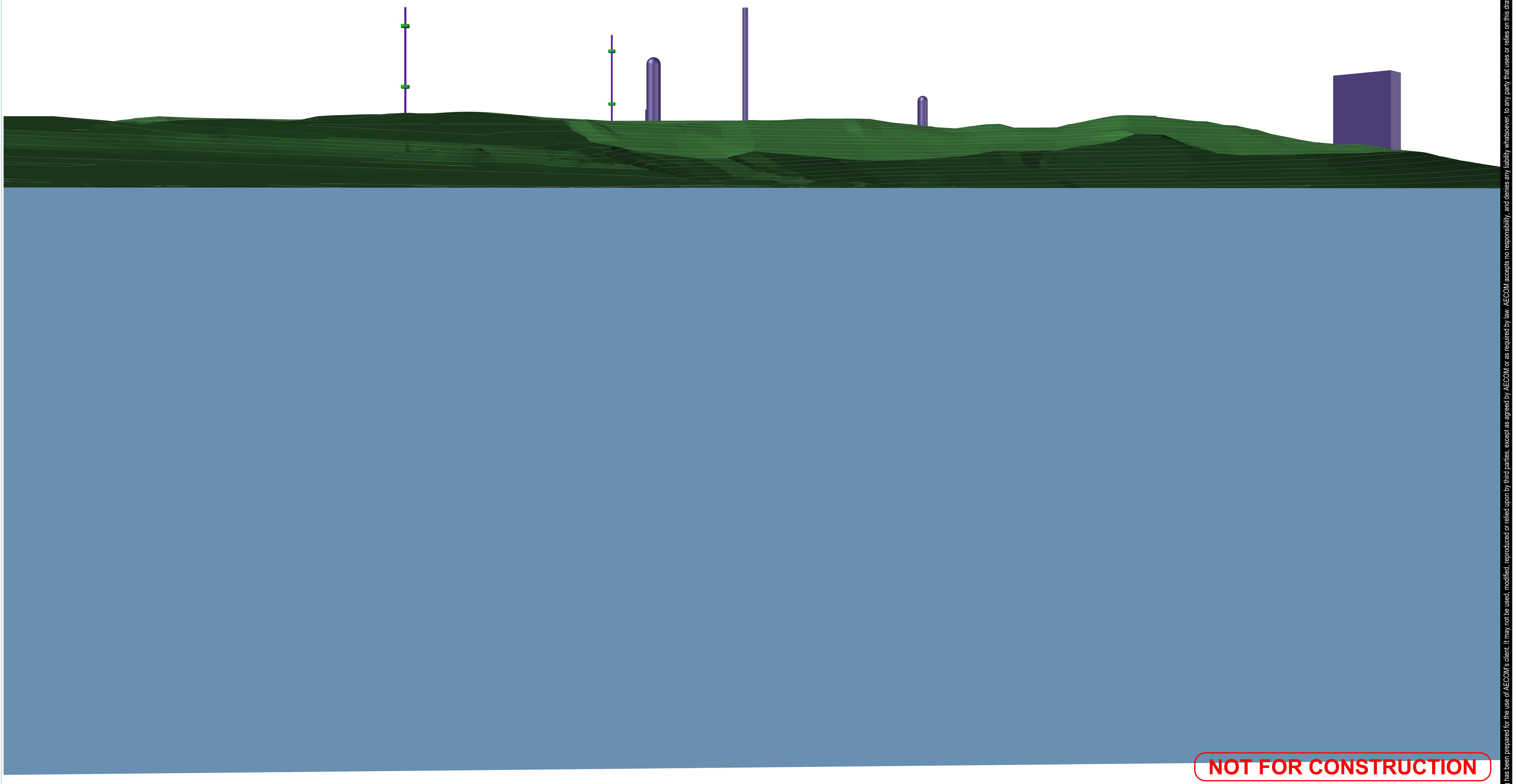
DOCUMENT NUMBER

60689030-H2T-DR-00X

NOT FOR CONSTRUCTION

FOR INFORMATION ONLY





AECOM

PROJECT

H2Teeside DCO

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Manchester, M3 7FB
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LEGEND

	PHASE 1 DEVELOPMENT
	PHASE 2 DEVELOPMENT
	SITE AREA
	POND

NORTH EAST VIEW (AS SHOWN ON DRAWING)

PLAN VIEW

NOTES

1. DRAWING IS FOR INDICATIVE PURPOSES ONLY.
2. VIEW FROM THE PERSPECTIVE OF POND LEVEL LOOKING TOWARDS THE SITE.

0 50 100 m

1:2000 @ A1

APPROVED FOR ISSUE

I/R	DRAWN BY	CHECKED	APPROVED
1	AS	JC	IU

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3D PLANT DRAWING
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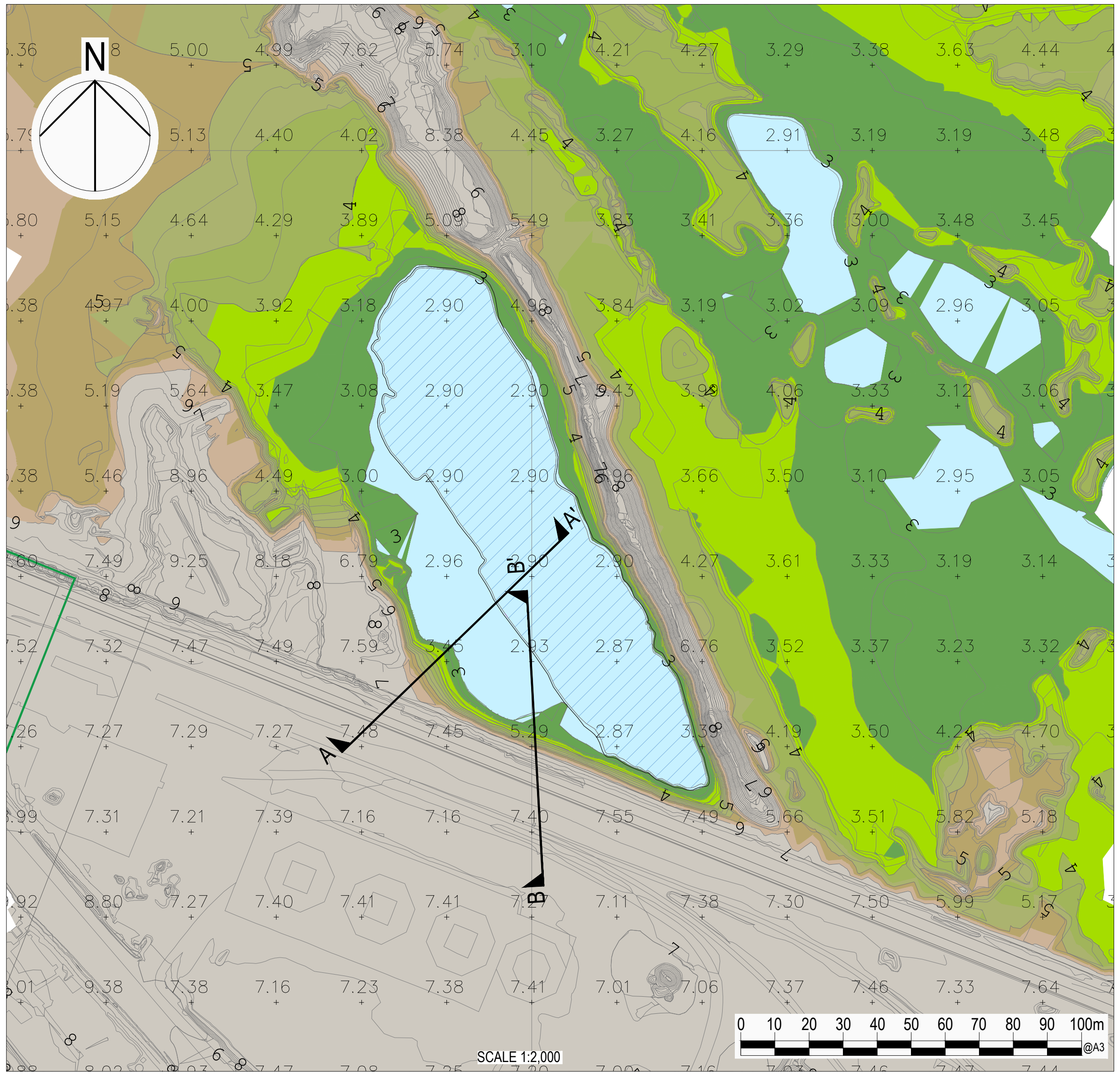
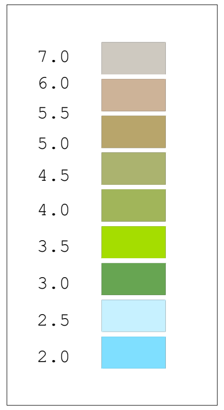
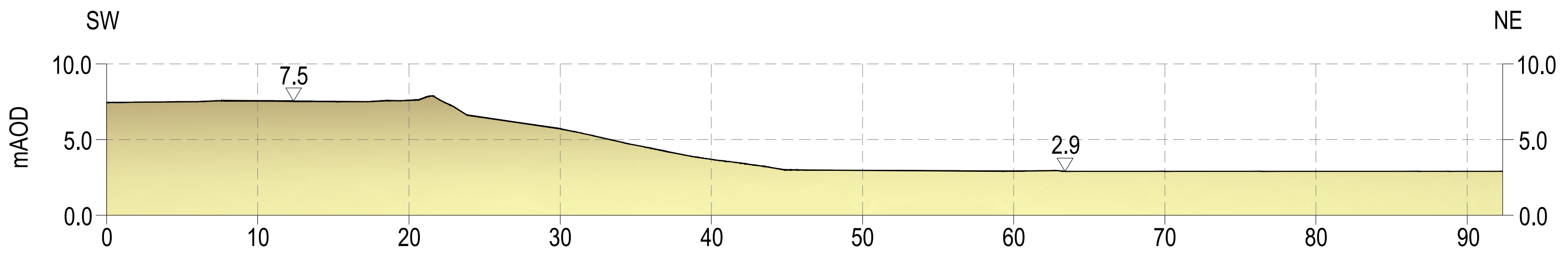


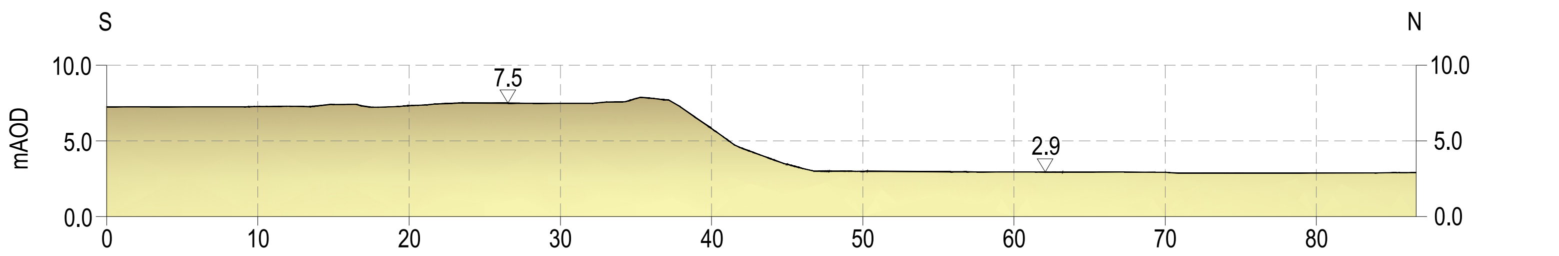


NOTES



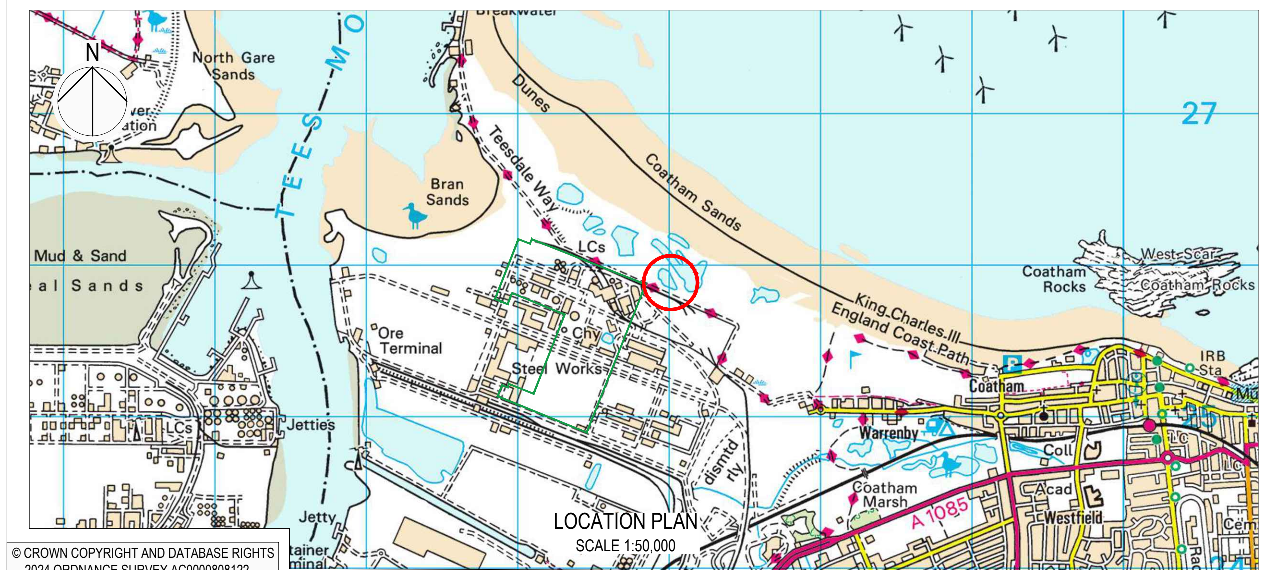
SECTION A-A'

SCALE 1:500



SECTION B-B'

SCALE 1:500



LOCATION PLAN

SCALE 1:50,000

Project Title: H2Teesside DCO

Client: H2Teesside Limited

Drawing Title: Extract of Topographical Survey and Cross Sections Showing Landforms

Purpose of issue: FOR INFORMATION

Designed	Drawn	Checked	Approved	Date
-	AO	RW	RW	12/24

AECOM Internal Project No.

Suitability

Scale @ A3: AS SHOWN

Zone / Mileage: -

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Drawing Number

Rev

Appendix D: Photographs

Plate 1 – Looking down to the pool along its northwest (long) axis from South Gare Road. Teesworks is behind and to the left of the photographer; South Gare Road is just visible at the left of the image. Proposed Main Site buildings would be to the left (south) of South Gare Road.

Plate 2 –Looking east, showing open shoreline along western edge of pool. The photographer was standing part way up the steep vegetated bank shown in Plate 3.

Plate 3 – Taked from western shore, showing enclosed nature of southern half of pool and limited views towards Teesworks site

Plate 4 – Looking west from southwestern shore of pool, toward South Gare Road and Main Site.

Vehicles parked on South Gare Road are clearly visible, but Teesworks cannot be seen

Plate 5 – Panoramic view from northwestern end of pool, looking (from left to right) along open water and western shoreline southeast toward Teesworks site; south, and southwest towards proposed Main Site.

APPENDIX 3: TECHNICAL NOTE RE SOILS AND ALC (REF: NE35)

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Project name: H2Teesside

To: Natural England

From: [redacted]

CC:

Date:
18 December 2024

Technical Note – Discussion on Soils and Agricultural Land Classification (ALC) in the H2Teesside Project

Background of NE35: Soils and best and most versatile agricultural land

Natural England has raised concerns about the impact of the H2Teesside project on soils and agricultural land, particularly Best and Most Versatile (BMV) land. While acknowledging that permanent loss of agricultural land due to development cannot be mitigated, they emphasise the need to restore disturbed land to its baseline Agricultural Land Classification (ALC) grade wherever possible. They call for detailed ALC surveys for all agricultural land lacking post-1988 data to provide an accurate baseline for assessing impacts and informing mitigation measures.

Natural England noted the use of non-standard ALC mapping colours and requested updates. They also stressed the importance of a site-specific Soils Management Plan (SMP), addressing soil stripping, stockpiling, nutrient analysis, and the sustainable reuse of surplus soils. Soil handling should occur only when dry and friable, ideally during the drier months, to prevent damage. The SMP should aim to restore temporarily disturbed BMV land to its original quality and include an aftercare programme to ensure the land is suitable for agricultural use.

The Applicant has declined to conduct additional ALC surveys, stating that most affected land is urban or non-agricultural, with limited BMV land. They have assumed a worst-case scenario by classifying some Grade 3 land as BMV for assessment purposes. The Applicant has committed to including an SMP in the final Construction Environmental Management Plan (CEMP) and updating ALC mapping colours. They have continued discussions with Natural England and incorporated commitments into a revised Framework CEMP [REP3-002] at Deadline 3.

Natural England, however, in its Deadline 4 submission insists that detailed ALC surveys are essential to establish an accurate baseline and design effective mitigation. They argue that without this data, the Environmental Statement cannot fully assess impacts or ensure proper restoration. While they welcome the Applicant's commitment to an SMP, they expect an Outline SMP at this stage, incorporating the Defra Construction Code to guide sustainable soil use.

Applicant's response at Deadline 5

The Applicant notes Natural England's position. However, it wishes to clarify that most sections of the pipeline routes which are mapped within areas of ALC 2, 3, 4, and 5 are not currently used for agricultural purposes. Please refer to Figure 10-19 as amended with the standard colours [REP2-017] and Extracts 1A, 2A, 3A and 4A.

This is discussed further below, but in summary:

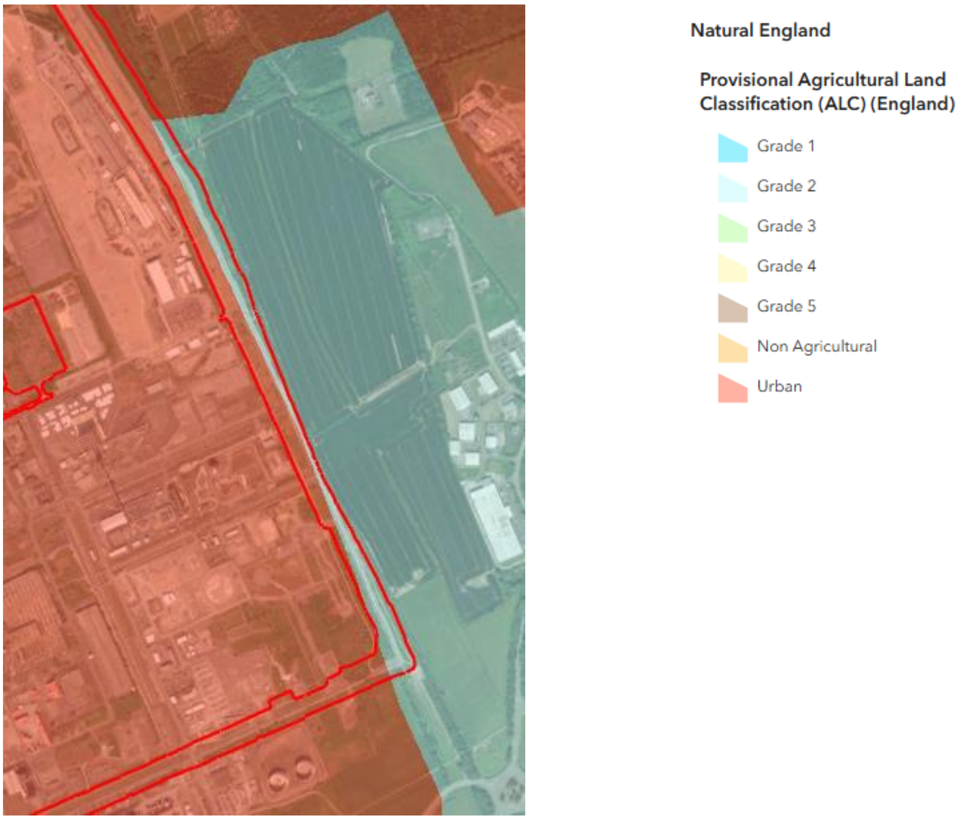
- The eastern section of the pipeline route adjacent to Mains Dike and an area mapped as ALC Grade 2 land is currently in use for above ground pipelines and a roadway, i.e. not agricultural use.
- Land at Cowpen Bewley, whilst mapped as ALC Grade 3, is currently in use as a road (unnamed) and Cowpen Bewley Woodland Park; and Billingham Cemetery is present adjacent to the western boundary of the unnamed road, i.e. not agricultural use.
- Land between Salthome Substation and the railway line is ALC Grade 4 land in agricultural use.
- The replacement land adjacent to Cowpen Bewley Woodland Park (north-west, between the A1185 and Cowbridge Beck) is mapped as ALC Grade 3 (no sub-division) and is noted to be currently in agricultural use.

It should also be noted that soils present in these sections of the pipeline route, which are noted to be classified as ALC Grade 2, 3 or 4, are described as Stagnosol – Soils with stagnating water; structural or moderate textural discontinuity based on World Reference Base (WRB) mapping on UK Soil Observatory website (https://mapapps2.bgs.ac.uk/ukso/home.html). Theses soils are described on Soilscapes as ‘slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils’ with loamy and clayey texture, impeded drainage and moderate fertility. The only other soil types are ‘unclassified’ by Soilscapes which are urban areas or are described as ‘loamy and clayey soils of coastal flats with naturally high groundwater’ by Soilscapes with loamy and clayey texture, naturally wet and lime-rich to moderate fertility. These soils are described on WRB mapping as Gleysol – Soils influenced by groundwater; groundwater affected soils. However, the areas mapped as Gleysol are noted to be within areas of existing industrial use, including existing pipeline routes.

The following paragraphs provide context of the sections identified of the pipeline route in relation to the ALC grade currently mapped and the current land use along these sections. All other sections of the route are classified as Urban or as ALC Grade 5, either following an existing pipeline route or within industrial areas.

Proposed pipeline route adjacent to Mains Dike:

The area of ALC Grade 2 (Stagnosol), see Extract 1A, is mapped primarily to the east of Mains Dike and partly along the eastern side of Mains Dike within the existing pipeline route. The Order Limits are entirely on the western side of Mains Dike. However, the land within the Order Limits is in industrial land use (pipelines and a roadway) not agricultural use, see extract 1B. Therefore, an ALC survey is not considered necessary in this section of the pipeline route. However, prior to construction, a soil resource survey, following guidance within DEFRA (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, will be undertaken to inform soil management pursuant to a Soils Management Plan which will be developed pursuant to the fCEMP [REP3-002].

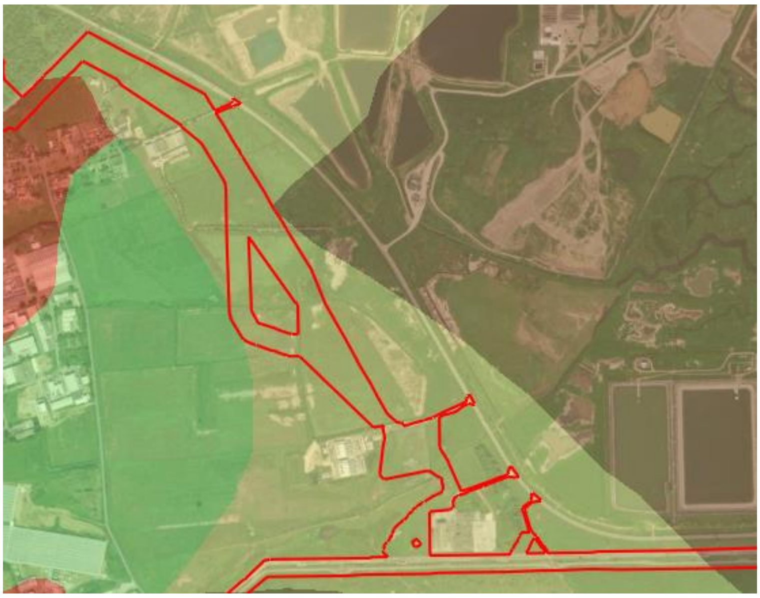


Extract 1A – ALC grade of land along pipeline route adjacent to Mains Dike

Extract 1B – Aerial image showing land use along section of pipeline route adjacent to Mains Dike

Proposed pipeline route on land between Salthome electricity substation and railway adjacent to Cowpen Bewley Park:

The pipeline route crosses ALC Grade 4 land (Stagnosol) (see Extract 2A), which is in agricultural use (see Extract 2B), between Salthome and the railway line at Cowpen Bewley. As the land has been mapped pre-1988as ALC Grade 4 additional ALC survey is not considered necessary. As the majority of the pipeline will be installed below ground using open cut techniques, prior to construction a soil resource survey will be undertaken to inform soil management pursuant to a Soils Management Plan which will be developed pursuant to the fCEMP [REP3-002]. Where the pipeline is placed below ground using trenchless techniques there is no need to undertake a soil survey. The proposed pipeline route to the south of Salthome electricity substation that generally extends east – west is shown within an area of ALC Grade 4. However, this section of the route is already in use as a pipeline corridor and not in agricultural use.



Extract 2A – ALC grade of land between Salthome Electricity Substation and railway adjacent to Cowpen Bewley Park

Extract 2A – Aerial image showing land use along section of proposed pipeline between Salthome Electricity Substation and railway adjacent to Cowpen Bewley Park

Pipeline Route at *Cowpen Bewley Woodlands Park:*

An area of ALC Grade 3 land (Stagnosol), see Extract 3A, within the Order Limits is located along the unnamed road adjacent to Billingham Cemetery. The Order Limits stop at Wolviston Back Lane. The ALC Grade has not been subdivided to 3a or 3b, where ALC subgrade 3a is considered BMV land. The majority of the Order Limits at this section are within ALC Grade 4 (Stagnosol), see Extract 3A. The areas of Grade 3 and Grade 4 land at Cowpen Bewley Woodlands Park are not in agricultural use but are used as parkland / woodland, roadway and industrial use, see Extract 3B. The Outline Landscape and Biodiversity Management Plan notes that the pipeline will be constructed using trenchless techniques beneath an area of mature trees. An ALC survey is not considered necessary in this section of the pipeline route as the land is not in agricultural use. However, prior to construction a soil resource survey will be undertaken to inform soil management pursuant to a Soils Management Plan which will be developed pursuant to the fCEMP [REP3-002].

Extract 3A – ALC grade of land of proposed pipeline route at Cowpen Bewley Woodlands Park

Extract 3B – Aerial image showing land use along section of proposed pipeline at Cowpen Bewley Woodlands Park

Replacement Land adjacent to Cowpen Bewley Woodland Park.

An area of ALC Grade 3 land (Stagnosol), see Extract 4A, within the Order Limits is located adjacent to Cowpen Bewley Woodland Park, to the northwest and located between the A1184 and Cowbridge Beck. The ALC Grade has not been subdivided to 3a or 3b, where ALC subgrade 3a is considered BMV land. The land is noted to be in agricultural use, see Extract 4B. The Proposed Development will be changing the use of land to replacement woodland park, so it will be no longer in agricultural use. The Environmental Statement has assumed this to be a loss of BMV land as a worst-case scenario. In any event prior to construction a soil resource survey will be undertaken to inform soil management pursuant to a Soils Management Plan which will be developed pursuant to the fCEMP [REP3-002].

Extract 4A – ALC grade of land at replacement land adjacent to Cowpen Bewley Woodlands Park

Extract 4B - Aerial image showing land use of proposed replacement land adjacent to Cowpen Bewley Woodlands Park

Summary

Sections of the proposed pipeline route are noted to be within areas mapped as ALC 2, 3 and 4. The remainder of the proposed pipeline route is within existing pipeline corridors or within existing industrial or urban land use.

In all areas of land, a soil resource survey will be undertaken within the Order Limits of these sections discussed in this Technical Note where the proposed pipelines will be placed above ground only. There is no requirement for a soil resource survey where the pipeline is constructed below ground using horizontal directional drilling.

There is only one area of land that is mapped as BMV quality but is also used as agricultural use within the Order Limits. This land is lost to the Proposed Development to become replacement woodland park, and the ES has assumed a loss of' BMV land' as a worst case scenario. As it is to be permanently used as woodland park, there is no requirement to undertake ALC survey, as the land will not be 'restored' to agricultural use in the future, and it is therefore not required to understand the ALC status of the land to help inform that later restoration.

An outline of the Soil Management principles, which the fCEMP [REP3-002] will require are taken into a Soils Management Plan, that will be followed are set out on the following page. As a result an Outline Soils Management Plan does not need to be produced at this stage.

SOILS MANAGEMENT

General Principles

A Soil Resources Survey shall be undertaken before any works are undertaken to obtain data on natural topsoil and subsoil to inform a Soils Management Plan. A soil resources survey is not required within the Main Site boundary as no natural topsoil or subsoil are present as the Main Suite has been reclaimed, historically, with made ground and fill materials.

To mitigate and reduce the impacts on soil resources (topsoil and subsoil) during the works associated with the Proposed Development, it is recommended that the following guidelines are adhered to (the details of which will form part of the Soils Management Plan):

- Vehicle and plant movements within the working areas should be restricted;
- Multiple handling of soils should be avoided and, where possible, soils should be moved directly from the source area to the placement area;
- During handling, mixing of soils of different functions such as topsoil and subsoil should be avoided;
- Handling of soils should not occur during or immediately after periods of prolonged or heavy rainfall. Soil must be sufficiently dry before any soil handling works are carried out.
- Plant employed for soil handling should only operate in suitable ground conditions to avoid damaging the soil structure;
- Weather conditions will be continuously monitored by on-site personnel and soil handling will stop in line with the following criteria (taken from the Institute of Quarrying (2021) Good Practice Guide for Handling Soils in Mineral Workings):
  - if there is very light rain or drizzle, handling can proceed for up to four hours unless the soils are already too wet (determined by field tests);
  - if there is normal rain, handling will cease if the rain has not stopped in 15 minutes;
  - if there is heavy rain (as from intense showers, slow-moving depressions) handling will stop immediately.

Where topsoils are largely consistent across the Site, these can be stripped and stored as one unit within individual landownerships, in order to minimise the risk of disease transmission between different ownerships and so that the same soils can be returned to landowners on restoration. Woodland soils should also be kept separate from agricultural soils. Any excavated subsoils can also be stored as one unit within each landownership, if they are found to be consistent across the site. Where topsoils and/or subsoils are found to be inconsistent across the site they shall be stripped and stored as separate units within individual land ownership.

Preparation

Where stripped soil is to be placed at a location different from the source area, soil stripping shall be undertaken only after analysis of the soil survey results has taken place to provide baseline for agricultural reinstatement and/or to reinform re use of material at the site. Soil samples should be undertaken using a hand-auger by a suitably qualified and competent person.

Areas where soil stripping is required to be undertaken shall be demarcated and fenced ahead of any major construction plant, vehicles or machinery entering the works area.

Temporary ditches shall be excavated, where required, to act as cut-off drains to deal with surface water from adjacent fields. Stockpiles of soil shall be located away from watercourses or other water features, to reduce the potential risk of pollution from suspended solids.

Intrusive archaeological investigations shall be undertaken ahead of construction works to avoid soil stripping resulting in damage to buried archaeology, in accordance with the approach and techniques presented within the Archaeological Written Scheme of Investigation.

Soil stripping controls and checks

Prior to undertaking any soil stripping operations, the following checks shall be undertaken:

- Ensure all necessary pre-construction surveys have been completed;
- Follow and implement all identified mitigation requirements for the location and method of stripping;
- Ensure adequate stockpile storage areas have been designated and prepared;
- Check whether an archaeological watching brief is required by a suitably qualified archaeologist to supervise any soil stripping operations; and
- Check whether an ecological watching brief is required.

Topsoil stripping

Topsoil stripping and handling shall be undertaken in line with guidance within DEFRA Code of Practice.

Subsoil stripping

Following topsoil stripping, the subsequent operation shall be to strip existing subsoil as required. Subsoil stripping operations shall be undertaken using similar equipment and techniques as the topsoil strip and undertaken immediately following topsoil strip operations to avoid any degradation of subsoil resources. Subsoil stripping shall be undertaken to the depths specified on the Proposed Development earthworks plans. Subsoil stripping and handling shall be undertaken in line with guidance within DEFRA Code of Practice.

Stockpile Construction

Following soil stripping activities, topsoil and subsoil shall be stored in separate stockpiles, the construction and design of which shall be in accordance with IOQ (2021) guidance. The location, volume and type (topsoil and subsoil) of each stockpile shall be recorded.

Reference shall also be made to the DEFRA Code of Practice which details how stockpile size is dependent on multiple factors including the nature / composition of the soil, the prevailing weather conditions at the time of the stripping, space limitations and any planning-related conditions or requirements attached to the consent for the Proposed Development.

Management of stockpiles

Soil stockpiles shall be placed on top of heavy-duty plastic sheeting to minimise any potential leaching of nutrients and contamination from underlying ground and construction materials.

Covering or seeding (mix of grass and clover) of the stockpiles will be required where they are not intended for re-use within a reasonable timeframe of six months, to ensure they maintain their geophysical/geochemical characteristics and where there is risk of significant rainwater run off or creation of excessive dust.

Soil Reinstatement

Soil being re-used within the area of excavation are not subject to the acceptability criteria.

A structured, uncompacted and well-aerated soil profile shall be formed for the successful establishment and subsequent growth of vegetation.

The subsoil shall be properly de-compacted to break up any panning or sealing of the ground surface, in order to reduce flood risk and to promote deeper root growth.

Dedicated haul routes shall be utilised to transport the subsoil to the first placement site and, thereafter, adherence to designated haul routes shall continue.

The application of topsoil to each designated area will be excavated from temporary storage stockpiles by 360-degree excavator, transported as required and placed in a windrow at appropriate centres from the edges of the Site and spread evenly across the Site. In spreading, the material operations shall commence at the furthest location from the access point and work backwards to avoid tracking over newly placed topsoil

Soil Tracking

A soil tracking procedure during construction activities should be established, that will track soil stripping, storage and reuse activities including details on location, type and volumes of soils excavated and stockpiled as well as records of any chemical testing undertaken.

The purpose of the tracking system is to provide an auditable trail of all topsoil and subsoil subject to excavation, testing and reuse/reinstatement or disposal. The Contractor is to make sure that a system is put in place to identify and track all material movements and stockpiling.