From: Sheila Downes <SDownes@clarecoco.ie>
Sent: Monday 7 February 2022 13:04
To: Antoinette Conroy (Alab) <Antoinette.Conroy@alab.ie>
Cc: Kieran ODonnell <kodonnell@clarecoco.ie>
Subject: Provision of Report relating to Appeal - AP11/2019

Antoinette,

As discussed, please find below a link from which you can download the requested report "*Waterfowl numbers, usage and distribution on the River Shannon and River Fergus Estuaries. Volume 1. Final Report*" pertaining to your appeal AP11/2019 (Site Ref: T08/106 B,C&D). If you could confirm receipt and download of same, it would be greatly appreciated. Should you require any further information please do not hesitate to contact me,

Kind Regards
Sheila

https://fx.topsec.com/?a=d&i=30JuTmbMRaBJLMe

Sheila Downes
BScEnv. Dip GIS. MSc. MCIWEM. C.WEM. CSci.
Environmental Assessment Officer
Economic Directorate
Clare County Council, Áras Contae an Chláir, New Road, Ennis, Co. Clare, V95 DXP2
T: 065 6846499 | **M:** 087 9914048 | **E:** sdownes@clarecoco.ie | **W:** www.clarecoco.ie

COMHAIRLE CONTAE AN CHLÁIR
CLARE COUNTY COUNCIL

An Bord Achomharc Um Cheadúnais Dobharshaothraithe
Aquaculture Licences Appeals Board

Clare County Council
Áras Contae an Chláir
New Road
Ennis
Co. Clare
V95 DXP2

Attention: Mr Pat Dowling
chiefexecutive@clarecoco.ie

4 February 2022

Our Ref: AP11/2019
Site Ref: T08/106 B,C&D

Re: Appeal against the decision of the Minister for Agriculture, Food and the Marine to refuse to grant a Licence to Moyasta Oysters for authorisation to cultivate Pacific Oysters using bags and trestles/hanging baskets and trestles on sites T08/106 B, C&D at Querrin, Poulnasherry Bay and Cammoge South, Shannon Estuary, Co Clare

Dear Mr Dowling

I refer to the above Appeal.

Pursuant to **Section 47(1)(a)** of the Fisheries (Amendment) Act, 1997, as amended, ("the Act"), where the Board is of the opinion that any document, particulars or other information is or are necessary for the purposes of enabling the Board determine the Appeal, it may serve a notice on a party requiring that party to submit to the Board such documents, particulars or other information as are specified in the Notice.

Having considered the appeal and the information provided to it, the Board has determined that further documents, particulars or information are necessary for the purposes of enabling the Board determine these Appeals.

The Board understands a Final Report was submitted to Clare County Council in 2019 from McCarthy Keville O'Sullivan (MKOS) Environmental Consultants entitled "Waterfowl numbers, usage and distribution on the River Shannon & River Fergus Estuaries. Volume 1. Final report." The Board requests a copy of this report to aid it in determining their appeal.

If you require further clarification of the Board's requirements, please contact the Board's Technical Advisor, Dr Ciar O'Toole on 087-4097160 or ciar.otoole@alab.ie.

In accordance with section 47 (1) (a) of the Act, the Board requires this information within **30 days** of receipt of this letter. Please note that if the documents, particulars or other information specified above are not received before the expiration of the period specified above, or such later period as may be agreed by the Board, the Board will, without further reference to you, determine the appeal.

Please also note that a person who refuses or fails to comply with a requirement under section 47 (1)(a) shall be guilty of an offence.

Yours sincerely

_____

Antoinette Conroy
Secretary to the Board

Waterfowl numbers, usage and distribution on the River Shannon and the River Fergus Estuaries 2017-2018

Volume 1: Final Report

McCarthy
Keville
O'Sullivan

Planning & Environmental Consultants

DOCUMENT DETAILS

Client:	Clare County Council
Project title:	CCC - Bird Usage Survey Data Shannon-Fergus Estuary
Project Number:	170160
Document Title:	Waterfowl numbers, usage and distribution on the River Shannon and River Fergus Estuaries - Final Survey Report
Doc. File Name:	170160 – F – Final Survey Report – 2019.01.30
Prepared By:	McCarthy Keville O'Sullivan Ltd. Planning & Environmental Consultants Block 1, G.F.S.C. Moneenageisha Road, Galway

Document Issue:

Rev	Status	Issue Date	Document File Name	Author(s)	Approved By:
01	Draft	14/01/2019	170160 – D1 – Final Survey Report – 2019.01.14	TG, IH, PM, SC, AA	PC, DO'D
02	Final	30/01/2019	170160 – F – Final Survey Report – 2019.01.30	TG, IH, PM, SC, AA	PC, DO'D

Table of Contents

SUMMARY

This report presents the results of a waterbird survey of the River Shannon and River Fergus Estuaries carried out in 2017/18. The survey covered 85% of the River Shannon and River Fergus Estuaries SPA and all the tidal habitat within Areas of Opportunity, and adjacent to Strategic Development Locations, identified within the Strategic Integrated Framework Plan for the Shannon Estuary. Counts were carried out monthly between May 2017 and April 2018 (apart from in July 2017), with five counts carried out at high tide and six counts carried out at low tide. The count methodology was based on that used for the 2010/11 Waterbird Survey Programme (WSP) counts of the River Shannon and River Fergus Estuaries.

The total number of waterbird species recorded across all subsites ranged from 53 species in October to 28 species in June. More than 20,000 waterbirds occurred in all the months across the traditional winter counting period (September-March) with the numbers peaking at nearly 44,000 in December. A total of 70 waterbird species were recorded across the survey. These included all 21 SCI species of the River Shannon and River Fergus SPA, although two of these species (Pintail and Scaup) were very rare.

This survey is the most comprehensive waterbird survey of the the River Shannon and Fergus Estuaries that has ever been undertaken, with year-round coverage of around 85% of the SPA. The only previous reasonably comprehensive survey was the WSP in 2010/11, which covered around 70% of the SPA and was limited to the October-February period. Overall comparison of the effects of reducing coverage to the WSP levels, indicates that most of the SCI species could be adequately covered by the WSP subsites with targeted additional coverage for Whooper Swan and Cormorant. Counts in September, at least, would be required to pick up the autumn peaks in abundances of several of the SCI species. However, coverage of regularly occurring non-SCI species would be more significantly affected.

During the survey, internationally important numbers of two SCI species (Whooper Swan and Black-tailed Godwit) were recorded. However, there are striking apparent declines in numbers of Light-bellied Brent Goose, Shelduck, Pintail, Scaup, Lapwing, Bar-tailed Godwit, Knot, Dunlin, compared with the mean annual peak counts from the baseline period of 1995/96-1999/00 used for the SPA designation, particularly so given that the latter are based on more limited survey coverage. Comparison of the 2010/11 and 2017/18 counts shows consistent patterns of increases in Wigeon and Greenshank and decreases in Pintail, Cormorant, Black-tailed Godwit, Bar-tailed Godwit and Dunlin. However, the counts of Cormorant at Bunlicky Lake during this survey suggest that there has been a substantial increase in the Cormorant breeding population since 2010.

Overall seasonal occurrences and broad patterns of distribution for most species were in line with previous surveys of the River Shannon and Fergus Estuaries and general patterns of seasonal occurrence and habitat associations in Ireland. However, somewhat surprisingly, the lower sections of the River Shannon and Fergus Estuaries held much higher densities of intertidal waterbirds than the Fergus Estuary and Upper Shannon, despite the latter having the most extensive areas of intertidal habitat. The Strategic Integrated Framework Plan areas with the highest concentrations of SCI species included Strategic Development Location F and Areas of Opportunity J, K, N and S.

1 INTRODUCTION

1.1 General Project Overview and Objectives

McCarthy Keville O' Sullivan was commissioned to carry out a bird usage survey of the River Shannon and River Fergus Estuaries Special Protection Area (SPA) comprising the entire estuarine habitat from Limerick City westwards as far as Doonaha in Co. Clare and Dooneen Point in Co. Kerry with an additional area westward on the north and south shore to encompass Strategic Integrated Framework Plan areas, as detailed below.

This survey was commissioned under the auspices of the Strategic Integrated Framework Plan for the Shannon Estuary 2013-2020, an inter-jurisdictional land and marine-based framework to guide the future development and management of the estuary. This plan identifies Strategic Development Locations for marine-related industry and Areas of Opportunity for aquaculture and renewable energy generation. Appropriate Assessment of any future developments requires that the most up-to-date and comprehensive geospatial data on bird populations is available.

Due to the size and complexity of the SPA, there have been problems in the past in carrying out a full and comprehensive survey of the site, as detailed in Lewis et al. (2016). The most complete ground-based survey of the estuary was undertaken in 2010/2011 by the National Parks and Wildlife Service (NPWS) as part of their Waterbird Survey Programme (WSP), which used 66 different count subsites across the estuary (Cummins and Crowe, 2011). I-WeBS counts have also taken place, although coverage of a maximum of only 25 subsites was achieved in one season with ten or less subsites counted in 12 seasons. Although the NPWS survey is currently the most complete survey of the site undertaken, it was not without limitations and not all subsites were covered (Lewis et al., 2016), including some subsites containing Strategic Integrated Framework Plan areas.

The objectives of this survey were to record bird usage across the entire estuary, allowing data from discrete subsites to be compared with one other, with a particular focus on the Strategic Integrated Framework Plan identified areas. Where possible, subsites used in previous NPWS and Irish Wetland Bird Surveys (I-WeBS) were used, with additional sites included to provide further coverage and some subsites modified to include Strategic Integrated Framework Plan areas. The methodology used follows that given in Lewis and Tierney (2014).

1.2 Site Description and Importance

The River Shannon and River Fergus Estuaries SPA comprises the entire estuarine habitat from Limerick City in the east and Doonaha in Co. Clare and Dooneen Point in Co. Kerry in the west. It consists of vast expanses of intertidal mudflats holding a rich macro-invertebrate community that provides an important food source for wintering and passage waterbirds. In addition to mudflats the site comprises areas of salt marsh vegetation which are important high tide roost areas. The SPA has a total area of 32,252 hectares (ha) and is listed under the EU Birds Directive (Site Code 4077).

The site is the largest estuarine complex in Ireland and is considered to be the most important coastal wetland site in the country, regularly holding over 50,000 waterfowl. A total of 21 waterbird species are listed as SCIs of the SPA: Whooper Swan, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Pintail, Shoveler, Scaup, Cormorant, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Bar-

tailed Godwit, Knot, Dunlin, Greenshank, Redshank and Black-headed Gull. These include four species which occurred in internationally important numbers during the baseline period that was used for the SPA designation: Light-bellied Brent Goose, Black-tailed Godwit, Dunlin and Redshank. Three of the SCI species are also listed on Annex I of the E.U. Birds Directive: Whooper Swan, Golden Plover and Bar-tailed Godwit. The SPA Site Synopsis is provided in Appendix I to this report.

1.3 Content of this Report

The surveys generated a large amount of data and there is wide scope for many types of detailed analyses of this data. The data analyses presented in this main section of this report are focused on summarising the broad patterns of waterbird occurrence within the River Shannon and Fergus Estuaries with particular reference to the Strategic Integrated Framework Plan Strategic Development Locations and Areas of Opportunity. More detailed analyses of occurrence patterns of individual species and within individual subsites are presented in the appendices.

Chapter 2 of the report describes the survey methodology. This includes definitions of the survey area and site divisions used in this report, the organisation and methodology of the field surveys, and the methods used for the data analyses presented in the main text of the report. Details of data analysis methods used for the additional analyses included in the appendices are presented in the relevant appendices.

Chapter 3 of the report presents the main results of the survey. These include: overviews of the total numbers and seasonal occurrence of the species recorded; analyses of the total numbers, species richness and biomass density of the waterbird assemblage; analyses of the habitat use, subsite occupancy and distribution of the species recorded; analyses of waterbird occurrence patterns in areas around the Strategic Integrated Framework Plan Strategic Development Locations and Areas of Opportunity; and summaries of disturbance events and raptor observations. Where relevant, comparisons are made with similar data from the 2010/11 survey.

Chapter 4 of the report discusses some of the findings of the survey. The issues discussed include the effects of the increased coverage in this survey on the waterbird numbers recorded; the seasonal occurrence patterns recorded in this survey with particular reference to occurrence of significant numbers outside the standard I-WeBS season; the factors that may affect the broad distribution patterns across the SPA and in the areas around the Strategic Integrated Framework Plan Strategic Development Locations and Areas of Opportunity; and the potential effects of disturbance on waterbird populations in the SPA.

Chapter 5 of the report summarises some of the key conclusions of the report.

The appendices include background information and additional data analyses. The background information includes the NPWS site synopsis for the River Shannon and River Fergus Estuaries SPA (Appendix 1), maps of the SPA and survey area (Appendix 2), further details on the waterbird survey methodology (Appendix 3), and scientific names and BTO species codes for all the waterbird and raptor species recorded (Appendix 4). The additional data analyses include detailed data on subsite waterbird species richness (Appendix 5), ranking of the subsite by total waterbird numbers and densities (Appendix 6), monthly count totals for all the waterbird species recorded (Appendix 7), detailed accounts for each of the SCI species (Appendix 8), detailed accounts for each subsite (Appendix 9) and dot density maps for each SCI species (Appendix 10).

2 METHODOLOGY

2.1 Survey Design

A combination of low and high tide counts was used due to the differences in behaviour and site use between tidal states, with different species likely to be foraging and roosting in different areas of the estuary depending on the stage of the tidal cycle.

2.2 Survey Area and Divisions

2.2.1 Survey area

The survey covered around 85% of the River Shannon and Fergus Estuaries SPA (**Error! Reference source not found.**). The sections of the SPA not covered were mainly areas of open water more than 2 km from the shoreline, as these could not be effectively surveyed from the shore. The survey also included a terrestrial zone extending 500 m inland from the shoreline. While this terrestrial zone is mainly outside the SPA, some waders and wildfowl are likely to use these areas for feeding and roosting and important populations associated with the SPA (and Strategic Integrated Framework Plan areas) might otherwise have gone unrecorded.

2.2.2 Subsites

The survey area was divided into 87 subsites (**Error! Reference source not found.**). These included all the subsites used during the 2010/11 WSP survey and the same subsite codes were used for this survey. The boundaries of four of these subsites were altered slightly to cover small parts of the SPA that were not counted during the WSP survey (shown in pink in **Error! Reference source not found.**). These subsites use the same codes. A further 21 additional subsites were added to cover additional areas within the Strategic Integrated Framework Plan and/or SPA (shown in green in **Error! Reference source not found.**). The new subsites are of a manageable size and their boundaries have easily identifiable, named features. These subsites have new subsite codes denoted by the prefix 0N.

2.2.3 Waterbody divisions

Due to the large number of subsites and their wide variation in sizes, presentation of data at the subsite level is generally not an effective way of summarising the results. Therefore, to show broad patterns of waterbird distribution, the subsites were divided into four broad groups: the Upper Shannon, the Fergus Estuary, the Lower Shannon and the Mouth of the Shannon (**Error! Reference source not found.**). These groups are based on the division of the River Shannon and Fergus Estuaries into transitional and coastal waterbodies for the Water Framework Directive. However, small waterbodies covering bays/estuaries adjacent to the main channel, have been grouped with the adjacent larger waterbody: the Limerick Docks, Maigue Estuary and Shannon Airport Lagoon waterbodies were grouped with the Upper Shannon waterbody; and the Deel Estuary, Foynes Harbour and Clonderalaw Bay waterbodies were grouped with the Lower Shannon waterbody.

2.2.4 Strategic Integrated Framework Plan subsite groups

The Strategic Integrated Framework Plan identified nine Strategic Development Locations for marine-related industry, four Areas of Opportunity for renewable energy generation and eight Areas of Opportunity for aquaculture (**Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**). To analyse waterbird distribution patterns in relation to these areas, subsite

groups were identified for each area. For the aquaculture and renewable energy generation Areas of Opportunity, the subsite groups comprised the subsites that overlapped the Areas of Opportunity. The Strategic Development Locations are located in the terrestrial zone adjacent to the shoreline. Therefore, they generally do not have significant overlap with the subsites as mapped, although they do overlap the terrestrial zone that was covered for each subsite. However, development of the Strategic Development Locations has potential to cause disturbance to waterbirds in adjacent tidal habitats. Therefore, a 300 m buffer zone (representing the maximum likely disturbance distance; Cutts et al., 2013) was mapped around each Strategic Development Location. The Strategic Development Location subsite groups then included the subsites that overlapped the 300 m buffer zone. A few subsites were excluded from some of the groups where the area of overlap was very small relative to both the size of the subsite and the size of the Area of Opportunity or Strategic Development Location. The subsites included in each subsite group are shown in Error! Reference source not found. and are listed in Table 2.1-Table 2.3.

Table 2.1: Subsites included in the Strategic Development Location subsite groups

Strategic Development Location	Subsites included
A	0H534
B	0N023, 0N024
C	0I440, oN012
D	0I439, 0I440
E	0I458, 0I491
F	0I436, 0I437, 0I438, 0I439, 0I440
G	0I425, 0N011
H	0K509, 0N010, 0N011
I	0I427, 0I447

Table 2.2: Subsites included in the Areas of Opportunity for aquaculture subsite groups

Area of Opportunity	Subsites included
J	0K508, 0K509
K	0H517&8, 0H519, 0H520, 0N025, 0N026
L	0N028
M	0N029
N	0I437, 0I491
O	0I443
P	0N023
U	0H521, 0H522, OH523, 0H524

Table 2.3: Subsites included in the Areas of Opportunity for renewable energy generation subsite groups

Area of Opportunity	Subsites included
Q	0H516, 0I425, 0I426
R	0N023
S	0K508, 0K509
T	0K507, 0N008, 0N009

2.2.5 Habitat zones

The survey area was divided into four broad habitat zones (subtidal, intertidal, supratidal and terrestrial) for recording waterbirds in the field and analysing their distribution patterns. The definitions of these zones follow Lewis and Tierney (2014) and are reproduced in Table 2.4. The extents of the subtidal, intertidal and supratidal zones in each subsite were mapped using a mixture of habitat mapping provided by NPWS, aerial imagery of the River Shannon and Fergus Estuaries, and records provided by surveyors when conducting recce visits during April 2017. It should be

noted that there are significant issues with the mapping of intertidal habitat by NPWS in the River Shannon and Fergus Estuaries (see Gittings and O'Donoghue, 2017). Therefore, the mapping of the intertidal habitat zone in the present report should only be interpreted as indicating broad patterns of the distribution of intertidal habitat across the River Shannon and Fergus Estuaries and should not be relied for detailed analysis of habitat distribution at the subsite scale.

Table 2.4: Definition of habitat zones

Habitat zone	Description
Subtidal	Refers to areas that are covered by seawater during counts. During low-tide counts it will include offshore water, tidal channels and creeks as well as tidal rivers.
Intertidal	Refers to the area uncovered by the tide and most likely dominated by mudflats and sandflats. It may also include areas of rocky shoreline, areas of mixed sediment and gravel/pebbles or shingle and gravel shores.
Supratidal	This category pertains to the shore area and habitats immediately marginal to and above the mean high-water mark. The supratidal section is an integral part of the shoreline. This broad habitat also includes areas of saltmarsh where the saltmarsh is contiguous with coastal habitats lying above. Note that patches of lower saltmarsh (e.g., *Spartina* sp.) surrounded by intertidal flats, were included in the intertidal category.
Terrestrial	Used where birds were recorded within habitats close to the shoreline but were above the intertidal and supratidal levels. Includes aquatic habitats that are not tidal that occur within the study area (i.e., brackish lagoons, freshwater lakes).

Source: Lewis and Tierney (2014).

2.3 Survey Organisation and Methodology

2.3.1 Preparation and commencement of surveys

Following an initial meeting between the MKO project team and representatives from Clare County Council and NPWS, maps were created using GIS that showed all subsite boundaries and information showing proposed survey site boundaries, subsite boundaries, routes and vantage points.

2.3.2 Survey team workshop and recce visit

A workshop for the survey team was hosted by MKO prior to the commencement of surveys, in conjunction with a recce visit for all surveyors to their relevant survey areas. This allowed the project manager to make a presentation confirming the details of the required methodology including the manner in which data should be recorded, entered and submitted, discuss health and safety issues, practical arrangements, discuss any site-specific aspects of the surveys and respond to any queries from surveyors. Each surveyor was also presented with a survey pack with fieldsheets, methodology, maps and all pertinent information such as contact details of the survey team and health and safety information. Surveyors were also given all survey dates and times and a letter from Clare County Council explaining the survey to landowners and the public.

A recce visit involving all surveyors and the Project Manager followed this workshop. Each surveyor was given maps of their designated subsites with proposed subsite boundaries and vantage points and the suitability of these in the field was assessed. As well as this information, accessibility was also taken in to consideration with surveyors expected to assess access routes and make contact with landowners. Clare County Council also assisted with access arrangements in some areas, particularly around Shannon Airport and other sites including ports, power stations and areas of industry, where health and safety inductions were required.

2.3.3 Count dates and timings

Each count was scheduled over a two-day period using 14 surveyors on each day. As well as the 14 surveyors, the project manager was on site to assist and ensure that coverage was completed in the event of a surveyor being unable to attend or requiring assistance to complete a count. A stand in surveyor was also used on three occasions when a core surveyor was unable to be present. A text messaging group was used by the project manager to keep in touch with surveyors. Group emails were also used as required to communicate with the survey team.

Each surveyor covered a maximum of 10 km of shoreline on each day, counting 1-11 subsites (mean 3.3 subsites) as, based on the experience of the survey team, any more than this was not manageable in the 4-6 hour time window available. The same surveyor was allocated the same pre-designated subsites on each of the surveys to achieve continuity. This allowed surveyors to become well acquainted with their subsites and develop good relations with landowners.

The survey dates and tidal conditions are shown Table 2.5. The dates were chosen to give the best spread of days across the whole survey period where the low/high tide falls as close to midday as possible. Consideration was also given to avoiding weekends and bank holidays when surveyors may not have been available and leaving at least one date in each relevant period free to allow for a back-up date if weather forced a cancellation. Tide times used are those for Foynes Island, being as close to the centre of the estuary complex as possible.

Table 2.5: Survey schedule

Count no	Count period	Tide stage	Date	Day	Tide height	Tide time
1	May-July	High	18/05/2017	Thursday	4.0	11:50
			19/05/2017	Friday	4.0	13:03
2	May-July	Low	22/06/2017	Thursday	0.3	11:04
			23/06/2017	Friday	0.2	12:01
3	August-September	High	29/08/2017	Tuesday	4.2	12:06
			30/08/2017	Wednesday	4.0	13:14
4	August-September	Low	04/09/2017	Monday	1.1	11:41
			05/09/2017	Tuesday	0.8	12:20
5	October-February	Low	18/10/2017	Wednesday	0.4	12:01
			19/10/2017	Thursday	0.3	12:35
6	October-December	High	27/11/2017	Monday	4.1	12:09
			28/11/2017	Tuesday	4.2	13:28
7	October-February	Low	18/12/2017	Monday	0.7	12:00
			19/12/2017	Tuesday	0.7	12:35
8	January-February	High	25/01/2018	Thursday	4.5	11:40
			26/01/2018	Friday	4.4	12:56
9	October-February	Low	01/02/2018	Thursday	-0.2	12:34
			02/02/2018	Friday	-0.3	13:17
10	March-April	Low	015/03/2018	Thursday	1.09	10:08
			16/03/2018	Friday	0.86	10:41
11	March-April	High	23/04/2018	Monday	4.5	13:11
			24/04/2018	Tuesday	4.2	14:41

Tide height and times are from http://www.sfpc.ie/download/SFPC%20Tidetables%202017.pdf.

A number of counts were undertaken outside of the dates listed above: two sections were surveyed on the 20th December 2017 and one surveyor completed surveys on the 19th and 21st of December 2017 and the 2nd and 3rd of February 2018.

2.3.4 Waterbird count methodology

The survey methodology followed that of Lewis and Tierney (2014). A summary of the methods used is given here with a full description being found within that document.

Waterbirds were counted within a 2-3 hour period either side of low/high tide on the 'look-see' basis (Bibby et al., 2000) and the positions of major flocks were also recorded on field maps. The number of each species recorded in each subsite was recorded with numbers divided into the four broad habitat zones and also divided between birds that were foraging and birds that were roosting or engaging in other behaviour (such as preening, bathing, etc.).

Surveyors were provided with detailed maps of their subsites, which clearly showed the boundaries of each subsite and the extent of each of four tidal habitat zones. An example of a subsite map is shown in **Error! Reference source not found.** and the tidal habitat zones are defined in Table 2.4 above. Field recording forms were also provided as found in Appendix 3.

Significant flocks were recorded, with surveyors being asked to use their judgement to decide what might constitute a significant flock for each species, as prescribed in Lewis and Tierney (2012). The project manager was open to consultation on this subject and a precautionary approach was taken. These maps along with the recording form allowed the spatial extent of each flock to be mapped as well as the number of each species.

2.3.5 Disturbance recording

Activities that could potentially cause disturbance to waterbirds, and the occurrence of birds of prey, were recorded following the methodology in Lewis and Tierney (2014).

The following categories were used to record activities:

1. Human, on foot – shoreline
2. Human, on foot – intertidal aquaculture
3. Bait-diggers
4. Non-powered watercraft
5. Powered watercraft
6. Water-based recreation
7. Horse-riding
8. Dogs
9. Aircraft
10. Shooting
11. Other
12. Winkle-pickers
13. Aquaculture machinery
14. Other vehicles

Each occurrence of an activity in a subsite was recorded as a disturbance event, even if no disturbance response was observed. Where a disturbance response was observed, the disturbance impact was recorded using the categories shown in Table 2.6. The duration of the activity was also recorded using the categories shown in Table 2.6, and a record was made as to whether the activity was already occurring within the subsite when the count started.

Table 2.6: Categories used for recording the impact and duration of disturbance events

Parameter	Category	Definition
Impact	**W**	Weak response: waterbirds move slightly away from the source of the disturbance
	M	Moderate response: waterbirds move away from the source of the disturbance to another part of the subsite; they may return to their original position once the activity ceases
	H	High response: waterbirds fly away to areas outside the subsite and do not return during the count session
Duration	**A**	Short/discrete event.
	B	Activity occurs for up to 50% of the count period.
	C	Activity length estimated at >50% but <100% of the count period.
	D	Activity continues after the count period has ended.

Any raptors encountered were also recorded and their disturbance impact was recorded using the categories shown in Table 2.6.

2.3.6 Data management

As well as survey maps for each subsite showing site boundaries and tidal habitat types, each surveyor was provided with a customised spreadsheet to enter their data to ensure standardisation of data collection and reduce time collecting data. Surveyors were also instructed to send all maps to MKO immediately after each survey for digitisation by trained staff. The data management team at MKO compiled and checked the quality of all incoming data.

2.4 Data Analysis

2.4.1 General

The surveys generated a large amount of data and there is wide scope for many types of detailed analyses of this data. The data analyses presented in this main section of this report are focused on summarising the broad patterns of waterbird occurrence within the River Shannon and Fergus Estuaries with particular reference to the Strategic Integrated Framework Plan Strategic Development Locations and Areas of Opportunity. More detailed analyses of occurrence patterns of individual species and within individual subsites are presented in the appendices.

2.4.2 Species included

The analyses of the occurrence patterns of individual species include 19 of the 21 SCI species. The two SCI species not included are Pintail and Scaup. These species were excluded because they were recorded so rarely (one record of Pintail and two records of Scaup) that meaningful analyses were not possible.

In addition to the 21 SCI species, another 49 non-SCI waterbird species were recorded. Some of these were regularly recorded in large numbers, while others were very rare. The following 17 non-SCI species were included in the analyses of species occurrence patterns: Mute Swan, Greylag Goose, Mallard, Little Egret, Grey Heron, Great Crested Grebe, Oystercatcher, Turnstone, Sanderling, Snipe, Common Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull. These species were all recorded in more than 50% of the counts and either occurred in large numbers and/or were widely distributed.

2.4.3 Overall distribution patterns

Overall distribution patterns were examined by looking at the total abundance and species richness of all waterbirds, and the numbers, biomass and density of intertidal waterbirds.

The analyses of waterbird abundance compared the total counts of all waterbirds, and the total counts of all SCI waterbirds, recorded each month and within each waterbody division and each subsite.

The analyses of waterbird species richness compared the total numbers of waterbird species, and the numbers of SCI waterbird species, recorded each month and within each waterbody division and each subsite.

Most of the SCI species are primarily associated with intertidal habitats or make significant use of intertidal habitats. Therefore, specific analyses of intertidal waterbirds were carried out. These were defined as waterbirds that, when they occur in the intertidal zones, feed predominantly on intertidal invertebrates. Therefore, this group of species provide an indication of the overall carrying capacity of the intertidal zone within the River Shannon and Fergus Estuaries. Instead of just analysing the waterbirds recorded as feeding in the intertidal zone, the analyses sought to capture all the waterbirds that were potentially using the benthic food resources of the intertidal zone. This provides a better overall picture of the intertidal carrying capacity and also allowed data from the high tide counts to be included.

The intertidal waterbird group included all the wader and gull species as well as Shelduck and Teal. Some of these species feed almost exclusively on intertidal invertebrates, while others make significant use of other food resources in the other habitat zones. Therefore, before analysing the data the species were classified into two groups (INT1 and INT2) as shown in Table 2.7.

Species in group INT1 mainly feed on intertidal invertebrates and will interrupt their feeding to roost for short periods during the low tide period. Therefore, all individuals in the intertidal zone at low tide are likely to be utilising the intertidal invertebrate resource. These species do not generally occur in subtidal habitat, but some birds may have been recorded in the subtidal zone if they were wading in shallow water, or due to recording issues. Some species may also feed on saltmarsh or fields, so individuals in the supratidal and terrestrial zones at low tide were excluded from the analyses. However, at high tide, many of the birds that were feeding in the intertidal zone at low tide move to the supratidal or terrestrial zones to roost, so at high tide all birds recorded in all the zones were included in the analyses.

The INT2 group includes a diverse mixture of species, including some that habitually feed in the subtidal zone (Shelduck, Teal and the gulls), some that mainly use the intertidal zone for roosting (Golden Plover and Lapwing), and some for which the intertidal zone is only a minor resource. Therefore, for species in this group, only individuals recorded as feeding within the intertidal zone were included in the analyses.

Table 2.7: Classification of intertidal species into two groups with rules for inclusion in analyses of numbers, biomass and density of intertidal species

Group	Species	Zone	Include			
			high tide		low tide	
			F	R	F	R
INT1	Oystercatcher, Grey Plover, Ringed Plover, Whimbrel, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Turnstone, Knot, Ruff, Curlew Sandpiper, Sanderling, Dunlin, Little Stint, Common Sandpiper, Green Sandpiper, Spotted Redshank, Greenshank, Redshank, Long-billed Dowitcher	SUB	√	√	√	√
		INT	√	√	√	√
		SUP	√	√		
		TER	√	√		
INT2	Shelduck, Teal, American Golden Plover, Golden Plover, Lapwing, Jack Snipe, Snipe, Black-headed Gull, Mediterranean Gull, Common Gull, Ring-billed Gull, Lesser Black-backed Gull, Herring Gull, Yellow-legged Gull, Iceland Gull, Great Black-backed Gull	SUB				
		INT	√		√	
		SUP				
		TER				

In addition to looking at total numbers and densities of intertidal waterbirds, the total biomass and biomass densities of intertidal waterbirds were also examined. Larger waterbirds will consume more food resources per bird, so biomass, rather than total numbers, provides a better indication of the overall pressure on the intertidal food resources (although daily energy requirements will not be linearly related to biomass). Weights for each species were obtained from www.bto.org/about-birds/birdfacts (accessed 06/12/2018).

The inclusion rules in Table 2.7, and the weights of each species, were used to calculate the total numbers and biomass of intertidal waterbirds in each waterbody division on each count. These were divided by the area of intertidal habitat in each waterbody division to give densities.

2.4.4 Seasonal occurrence patterns

The surveys covered a full year while most waterbird species show strongly seasonal patterns of occurrence. Therefore, to avoid analyses being biased by atypical occurrence patterns in months when species were present in very low numbers, for each species, a main period of seasonal occurrence was defined. This included all the months where the count was 20% or more of the maximum count for the species. All the analyses presented in this report of species occurrence patterns only include data from counts within the main period of seasonal occurrence for each species (referred to as qualifying counts), unless otherwise stated.

2.4.5 Habitat use

The occurrence patterns of many of the waterbird species across the habitat zones is likely to differ between high and low tide. Therefore, these occurrence patterns were analysed separately for the high and low tide counts. As the number of qualifying counts for many of the species would have been too small for meaningful analyses when divided between high and low tide counts, these analyses simply used summed totals of birds in each habitat zone across all the counts.

2.4.6 Subsite and area occupancy

The subsite occupancy of each species was analysed by calculating the percentage of subsites occupied on each qualifying count.

To calculate the area occupancy, the available area in each subsite was calculated using a weighting procedure based on the species overall distribution patterns between the Habitat Zones (HZ).

For most of the species, the available area was assumed not to include the subtidal zone. These species either do not occur in the subtidal zone (the wader species), or generally only make significant use of a narrow band of the subtidal zone adjacent to the tideline (Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Gadwall Mallard, Shoveler, Little Egret and Grey Heron). For these species, the following formula was used to calculate the available area:

$$A = (p_{sub} + p_{int} + p_{sup})*(a_{int} + a_{sup}) + p_{ter} * a_{ter}$$

where A = available area; p_{sub}, p_{int}, p_{sup} and p_{ter} are the overall proportions of the species occurrence in the subtidal, intertidal, supratidal and terrestrial zones, respectively; and a_{sub}, a_{int}, a_{sup} and a_{ter} are the areas of the subtidal, intertidal, supratidal and terrestrial zones, respectively, in the subsite.

For Cormorant and the gulls, which can make use of the full extent of the subtidal zone, the following formula was used to calculate the available area:

$$A = p_{sub} * a_{sub} + (p_{int} + p_{sup})*(a_{int} + a_{sup}) + p_{ter} * a_{ter}$$

For Great Crested Grebe, which occurs almost exclusively in the subtidal zone, the available area was assumed to be simply the area of the subtidal zone.

The area occupancy for each species, on each qualifying count was then calculated by summing the available areas of the occupied subsites and dividing by the total available area across all subsites.

2.4.7 Species distribution patterns

The distribution of species between the waterbody divisions and their occurrence in the Strategic Integrated Framework Plan areas were analysed by calculating the percentage of the total numbers recorded across the entire survey area that occurred in each waterbody division or Strategic Integrated Framework Plan subsite group on each qualifying count. For the Strategic Development Location subsite groups, this percentage was also calculated using only the numbers within the terrestrial zone as the numerator to provide an indication of the usage of the terrestrial zone (as the Strategic Development Location sites occur within the terrestrial zone). The mean percentage occurrence was then calculated across all the qualifying counts.

The Strategic Development Locations and Areas of Opportunity occupy varying proportions of the total areas of the Strategic Integrated Framework Plan subsite groups. Therefore, to help interpret the significance of the species occurrence patterns within each Strategic Integrated Framework Plan subsite group, the percentages of the tidal habitat zones in the subsite group that is within the Area of Opportunity, or within the 300 m buffer around the Strategic Development Location, and, for the Strategic Development Location subsite groups, the percentage of the terrestrial zone in subsite group that is within the Strategic Development Location, were calculated.

2.4.8 Disturbance events and raptor occurrences

The overall effect of each disturbance event and raptor occurrence was calculated as a disturbance score. This was the product of the score for the duration of the disturbance event (which range from 1-4; see Table 2.6) and the score for the observed impact of the event (which range from 1-3; see Table 2.6). Therefore, the disturbance score can range from 1-12. Scores of 1-4 were given a rating of low, scores of 5-8 were given a rating of moderate, and scores of 9-12 were given a rating of high. Disturbance events which had no observable impacts had a disturbance score of zero.

The types of disturbance pressures and species involved in raptor occurrences were analysed by summing disturbance events / raptor observations and their disturbance scores across all counts for each disturbance type and raptor species. The seasonal pattern of occurrence of disturbance pressures and raptor occurrences was analysed by summing disturbance events / raptor observations and their disturbance scores across all subsites for each count. The distribution of disturbance pressures and raptor occurrences was analysed by summing disturbance events / raptor observations and their disturbance scores across all counts for each subsite and for the waterbody divisions.

2.4.9 Comparisons with the 2010/11 WSP counts

Where relevant, analyses of the present survey were compared with the analyses of the 2010/11 WSP counts. For these comparisons, the data from the present survey was re-analysed, excluding subsites that were not covered by the WSP counts, and restricting the analyses to the same period (October-February) as the WSP counts. The analysis of the data from the WSP counts excluded one subsite that was not covered by the present survey.

Some of the comparisons look at seasonal patterns across the October-February period. For these comparisons, the WSP counts were paired with the relevant count from the present survey (Table 2.8). The WSP counts included two counts in January (because of bad weather at the time of the planned December count; Cummins and Crowe, 2011). Therefore, the early January WSP count was paired with the December count from the present survey.

Table 2.8: Comparison of timings of the 2010/11 WSP and 2017/18 MKO counts across the winter period (October-February.

Count number	Winter	Month	Dates	Tide
1	2010/11	October	20-21 October	low tide
	2017/18	October	18-19 October	low tide
2	2010/11	November	22-24 November	low tide
	2017/18	November	28-29 November	high tide
3	2010/11	January	06-07 January	low tide
	2017/18	December	18-21 December	low tide
4	2010/11	January	26-27 January	high tide
	2017/18	January	24-25 January	high tide
5	2010/11	February	18-19 February	low tide
	2017/18	February	01-03 February	low tide

2.4.10 Additional analyses included in the appendices

2.4.11 Sub-site ranking

Data analysis was carried out to create subsite by species matrixes for each SCI species recorded during surveys. The results indicate the proportional use of each subsite by each of the SCI species thus ranking the relative importance of the subsites. This analysis was carried out month by month. Each variable analysed is presented in Table 2.9. Each subsite from tables (a-e) was ranked as Very High, High, Moderate or Low importance in accordance with Lewis and Tierney (2014). Tables (f-h) were ranked numerically from 1-n (n=Number of subsites in which SCI species were recorded). More than one subsite could be ranked as "Very High" for the same species. This is because several subsites can be equally important for the species being analysed. The data was interpreted on a temporal basis allowing for consideration of the movement of birds as they move in response to weather, prey distribution and other environmental factors.

Table 2.9: Sub-site ranking categories

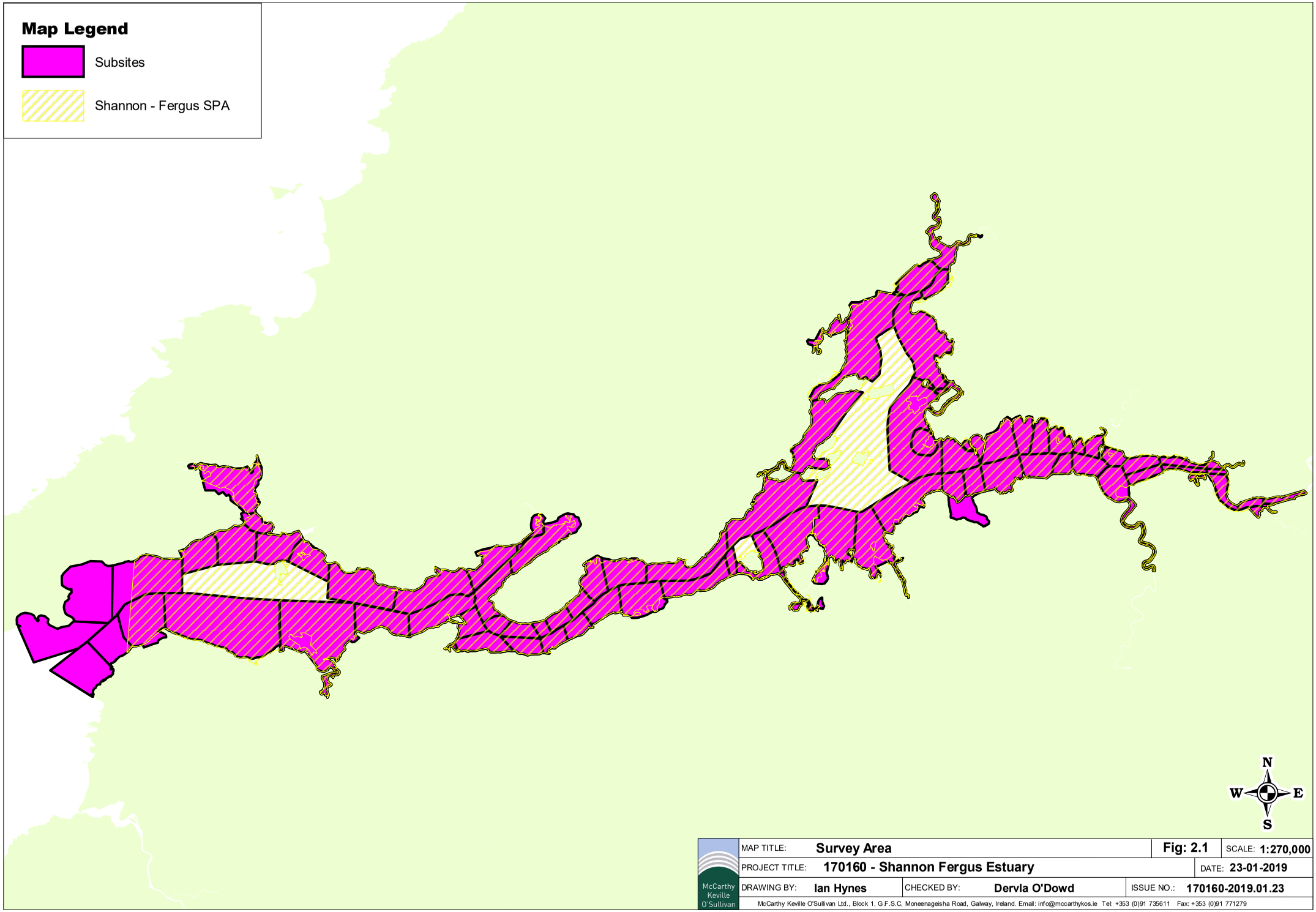
Ranked (Very High, High, Medium, Low)	
(a)	Rank for total numbers during low tide surveys (all behaviours and habitats)
(b)	Rank for total numbers during high tide surveys (all behaviours and habitats)
(c)	Rank for total numbers foraging intertidally during low tide surveys
(d)	Rank for total numbers foraging intertidally during high tide surveys
(e)	Rank total numbers foraging subtidally within high tide surveys
Ranked as numbers	
(f)	Rank for total numbers (roosting/other behaviour) within high tide surveys
(g)	Rank for total numbers during high tide surveys (all behaviours and habitats)
(h)	Rank average intertidal foraging density

2.4.12 Dot density maps

To allow comparison with the 2010/11 WSP survey, dot density maps were mapped using the same methodology as described in Lewis & Tierney (2012). Dot density maps showing foraging or roosting/other distribution for Special Conservation Interest species within each tidal habitat are given in Appendix 10. The results are discussed as part of the species summaries in Appendix 8.

2.4.13 Intertidal Foraging Density

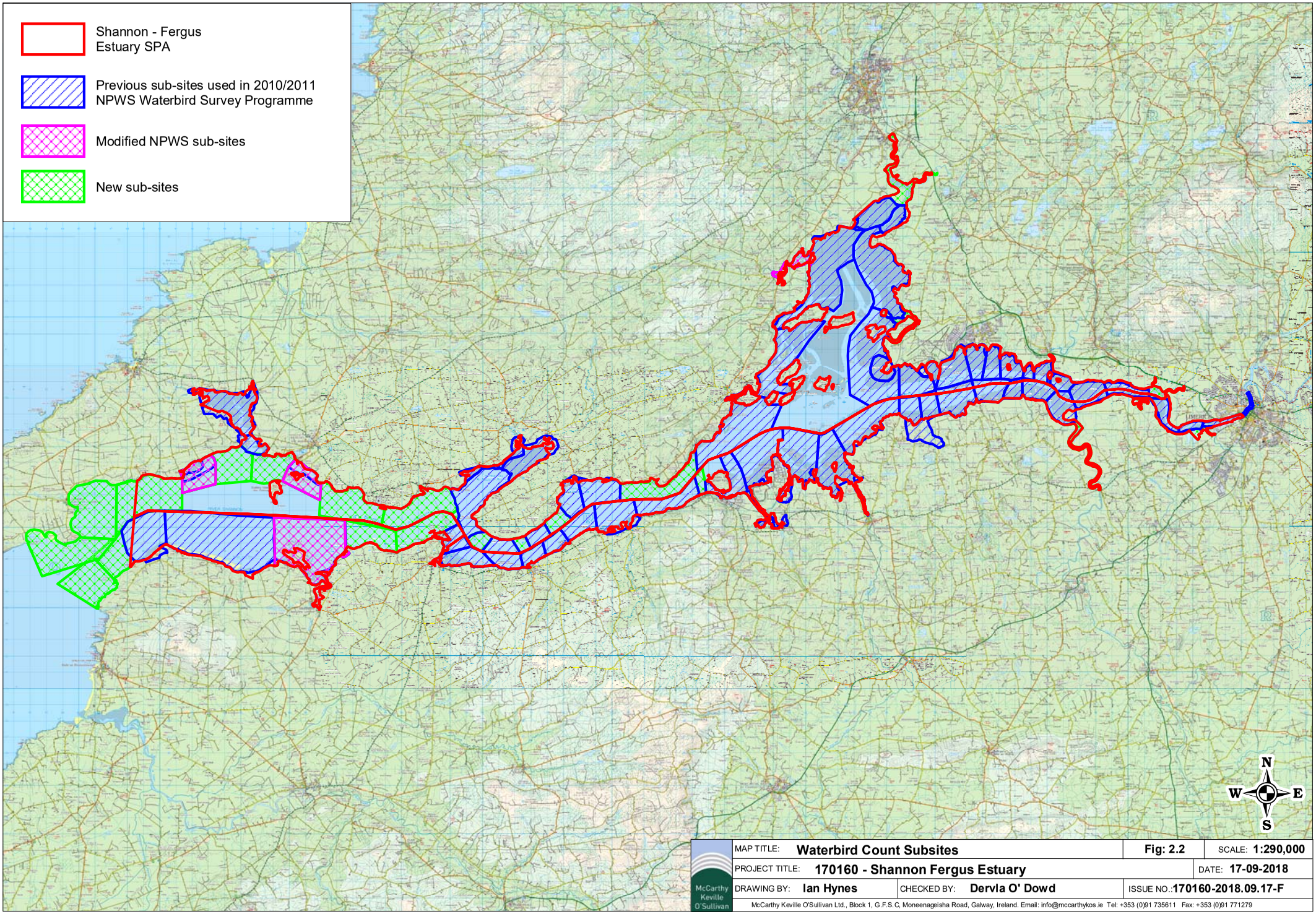
Intertidal foraging density was calculated for each species by dividing the number of birds foraging in intertidal habitat within each subsite by the area of intertidal habitat within the same subsite. For each species, the peak intertidal foraging density across all surveys are presented in the relevant species account in Appendix 8.



MAP TITLE:	Survey Area		Fig: 2.1	SCALE: 1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary			DATE: 23-01-2019
DRAWING BY:	Ian Hynes	CHECKED BY:	Dervla O'Dowd	ISSUE NO.: 170160-2019.01.23

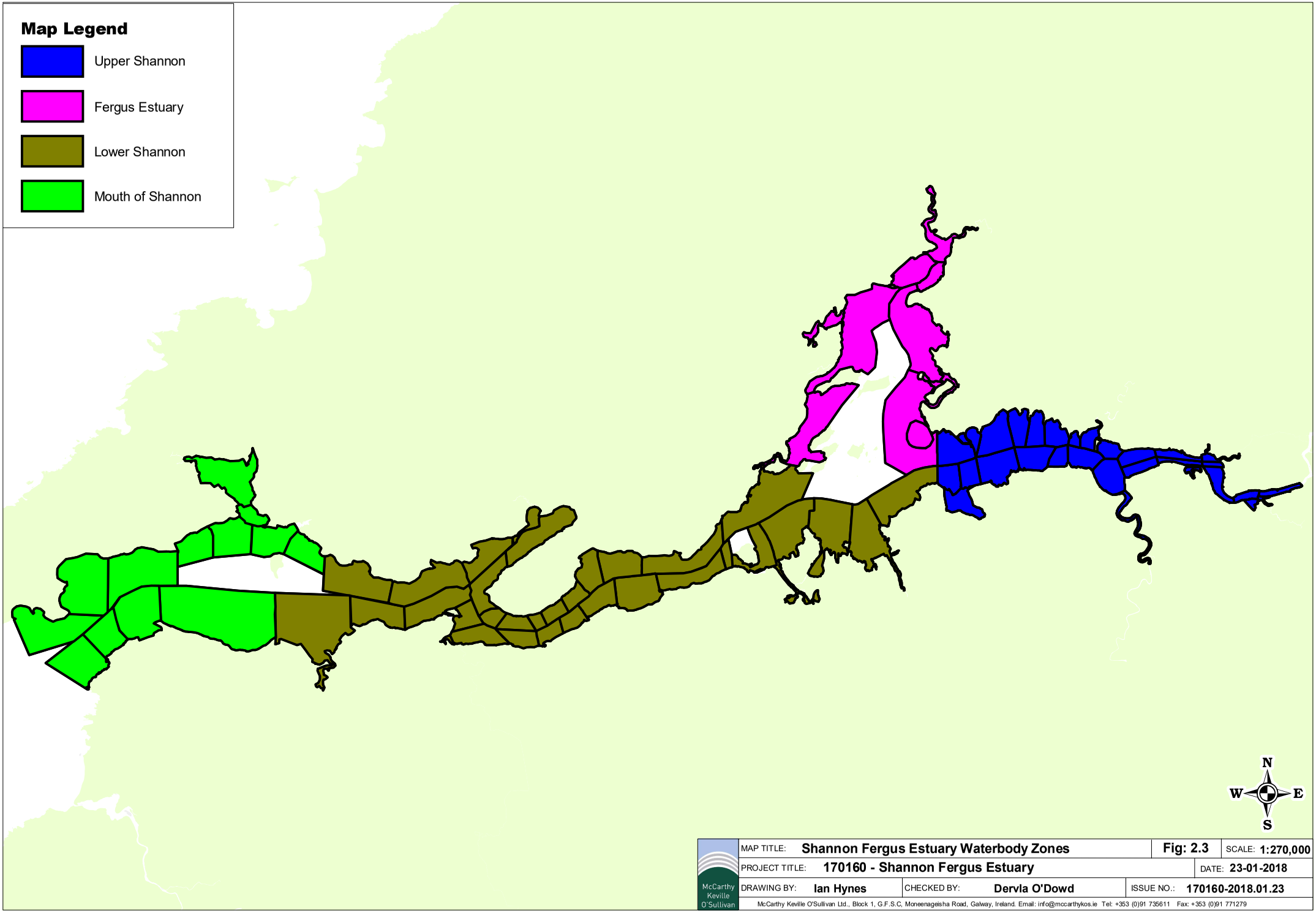
McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE: **Waterbird Count Subsites**		**Fig: 2.2**	SCALE: **1:290,000**
PROJECT TITLE: **170160 - Shannon Fergus Estuary**			DATE: **17-09-2018**
DRAWING BY: **Ian Hynes**	CHECKED BY: **Dervla O' Dowd**	ISSUE NO.: **170160-2018.09.17-F**	

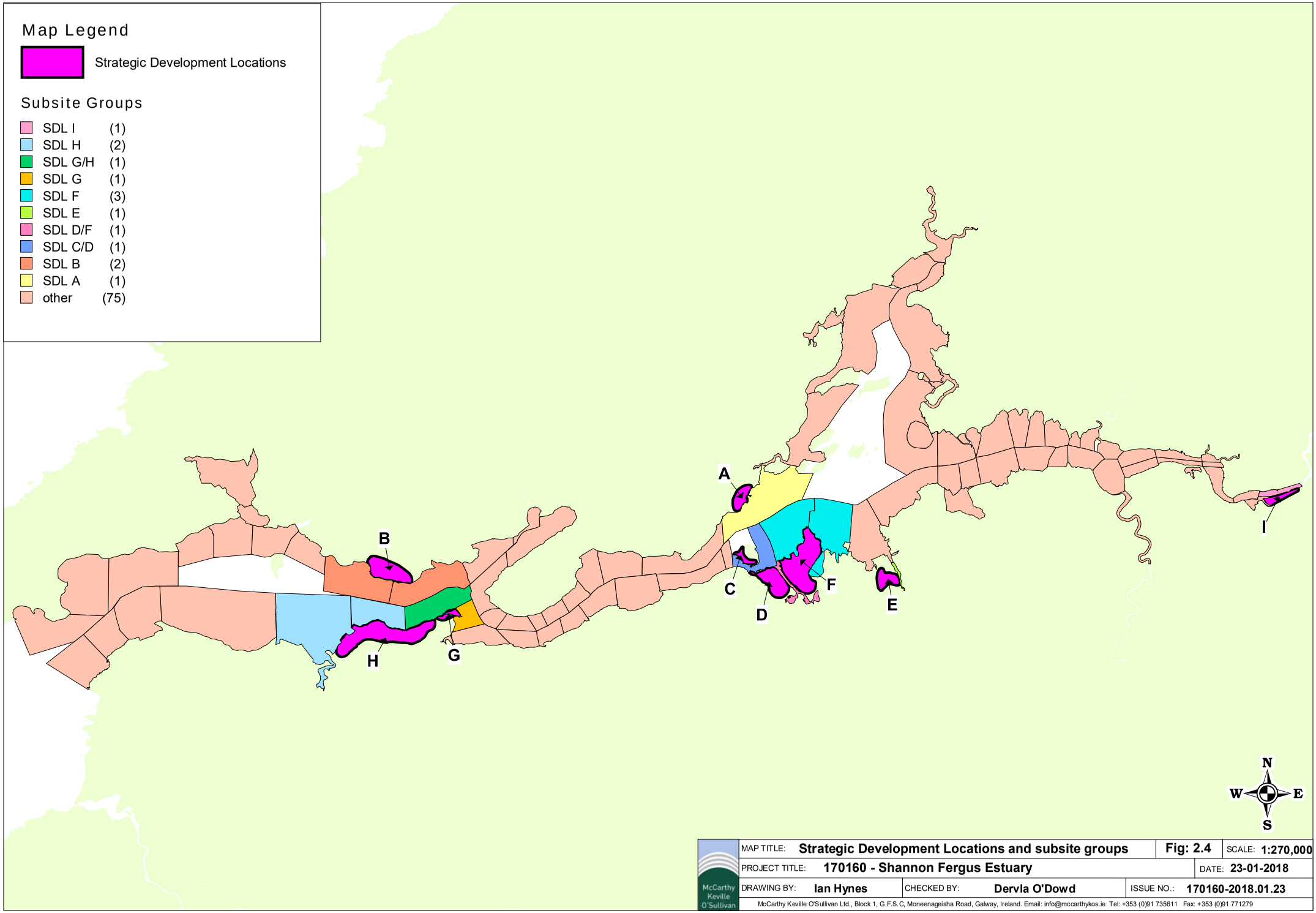
McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE:	Shannon Fergus Estuary Waterbody Zones	Fig: 2.3	SCALE:	1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary		DATE:	23-01-2018
DRAWING BY:	Ian Hynes	CHECKED BY: Dervla O'Dowd	ISSUE NO.:	170160-2018.01.23

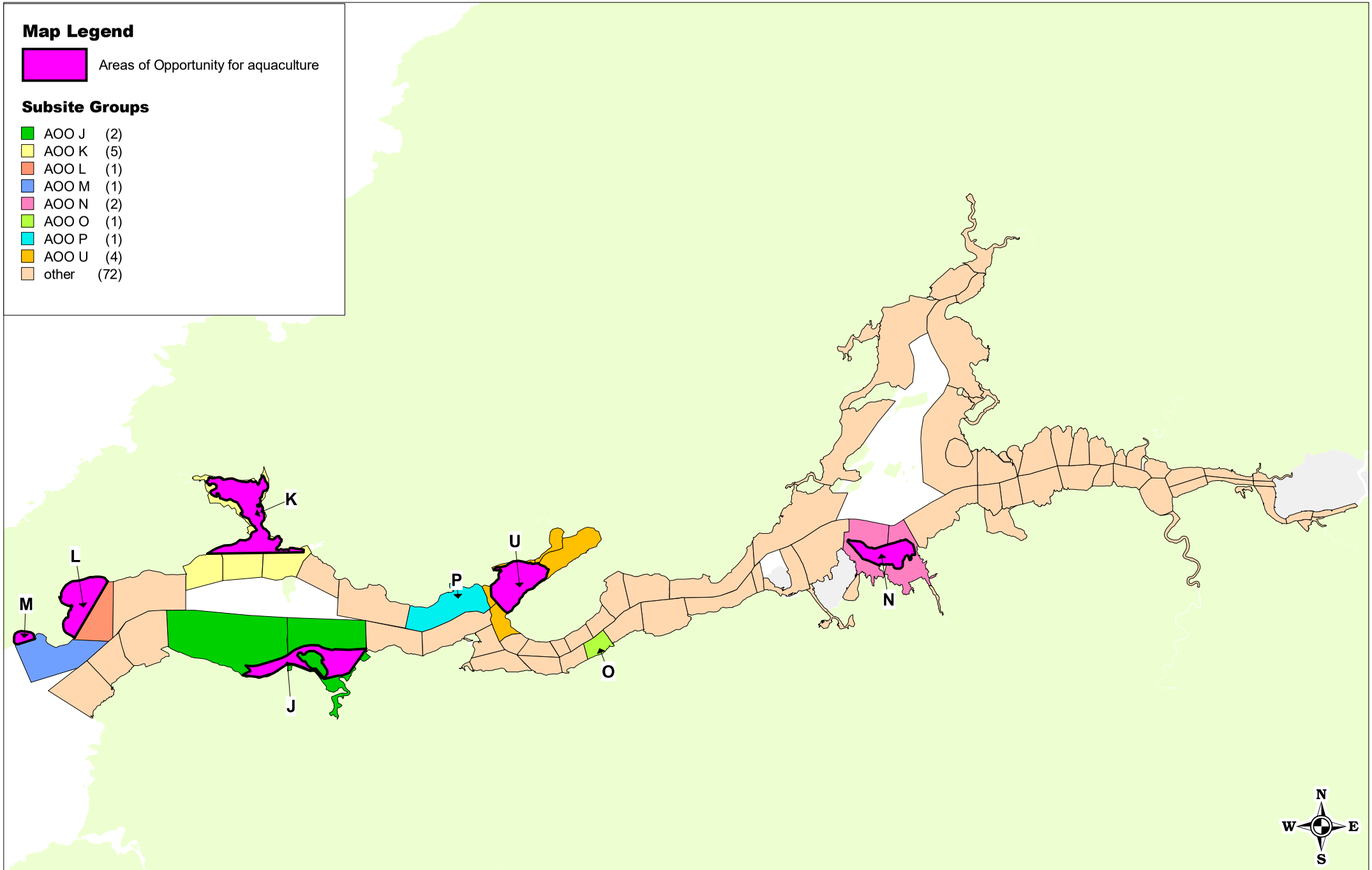
McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



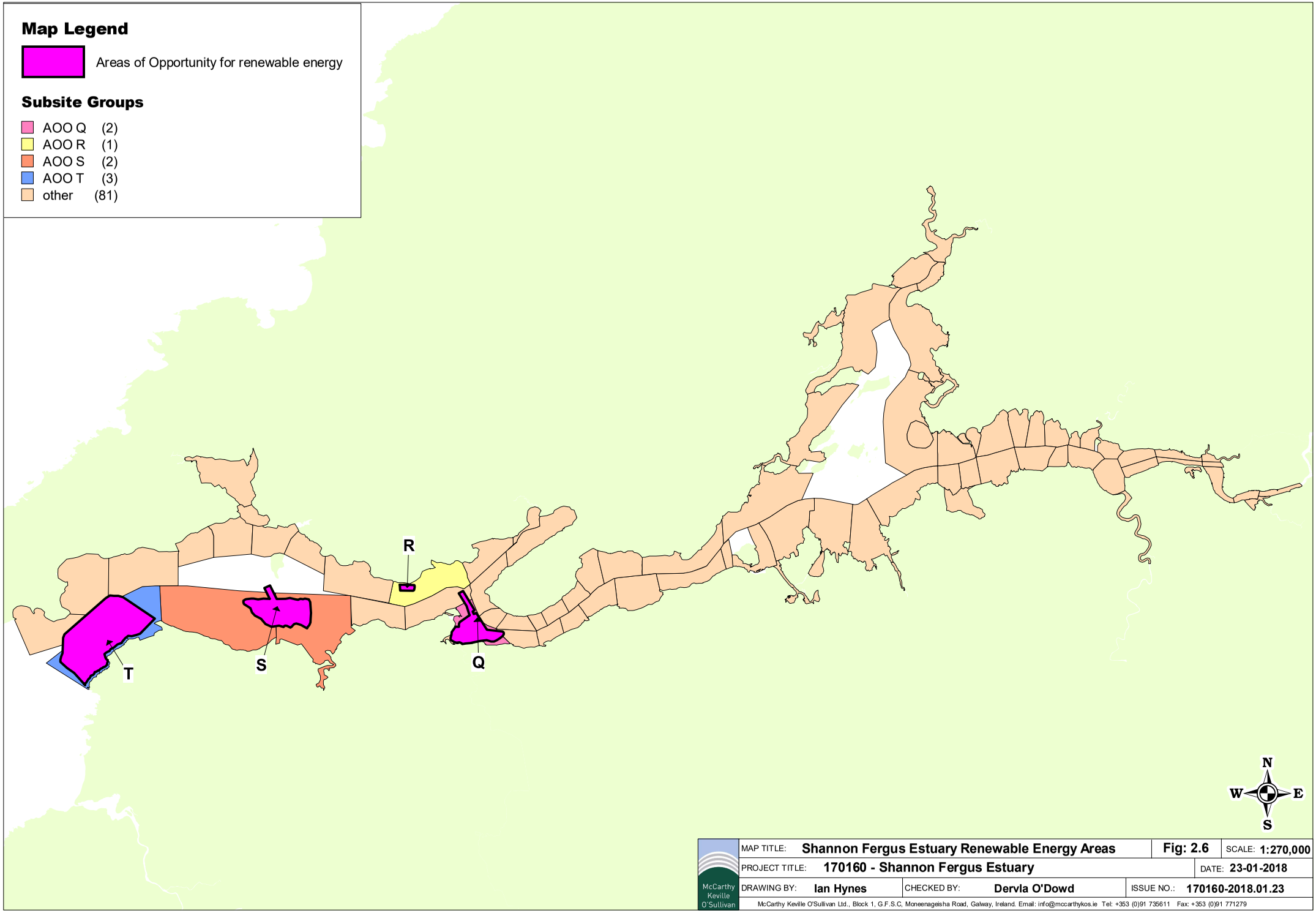
MAP TITLE:	Strategic Development Locations and subsite groups		Fig: 2.4	SCALE: 1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary			DATE: 23-01-2018
DRAWING BY:	Ian Hynes	CHECKED BY: Dervla O'Dowd		ISSUE NO.: 170160-2018.01.23

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



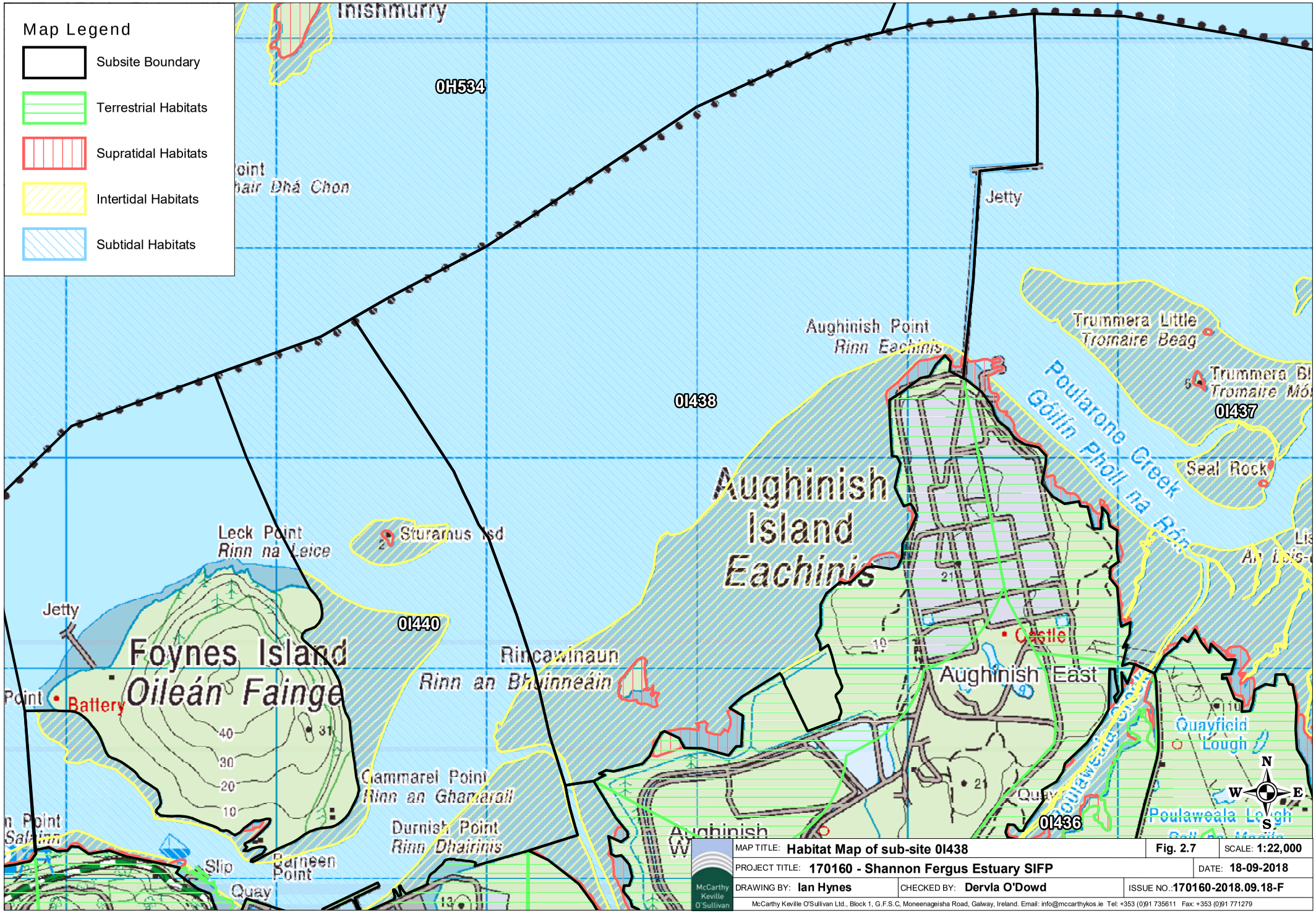
McCarthy Keville O'Sullivan	MAP TITLE: **Areas of Opportunity for aquaculture and subsite groups**		**Fig: 2.5**	SCALE: **1:270,000**
	PROJECT TITLE: **170160 - Shannon Fergus Estuary**			DATE: **23-01-2018**
	DRAWING BY: **Ian Hynes**	CHECKED BY: **Dervla O'Dowd**	ISSUE NO.: **170160-2018.01.23**	

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



McCarthy Keville O'Sullivan	MAP TITLE: Shannon Fergus Estuary Renewable Energy Areas		Fig: 2.6	SCALE: 1:270,000
	PROJECT TITLE: 170160 - Shannon Fergus Estuary			DATE: 23-01-2018
	DRAWING BY: Ian Hynes	CHECKED BY: Dervla O'Dowd		ISSUE NO.: 170160-2018.01.23

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE: **Habitat Map of sub-site 0I438**		Fig. 2.7	SCALE: **1:22,000**
PROJECT TITLE: **170160 - Shannon Fergus Estuary SIFP**			DATE: **18-09-2018**
DRAWING BY: **Ian Hynes**	CHECKED BY: **Dervla O'Dowd**	ISSUE NO.: **170160-2018.09.18-F**	

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

3 RESULTS

3.1 Habitat Zones

The distribution of the habitat zones in the subsites surveyed is shown in **Error! Reference source not found.**. The overall area surveyed is dominated by subtidal habitat (Table 3.1), but most of this occurs in the Lower Shannon and Mouth of the Shannon (Table 3.2). The largest areas of intertidal and supratidal habitat occur in the Fergus Estuary (Table 3.2). The largest area of terrestrial habitat surveyed was in the Lower Shannon (Table 3.2) reflecting the length of shoreline in this waterbody division.

Table 3.1: Total areas of the habitat zones in the subsites surveyed in the four waterbody divisions

Waterbody divisions	Total area (ha)			
	Subtidal	Intertidal	Supratidal	Terrestrial
Upper Shannon	1,639	1,971	450	2,952
Fergus Estuary	1,434	2,996	727	2,438
Lower Shannon	10,038	2,129	329	5,262
Mouth of the Shannon	7,375	867	225	2,182
Total area (ha)	20,486	7,885	1,731	12,834

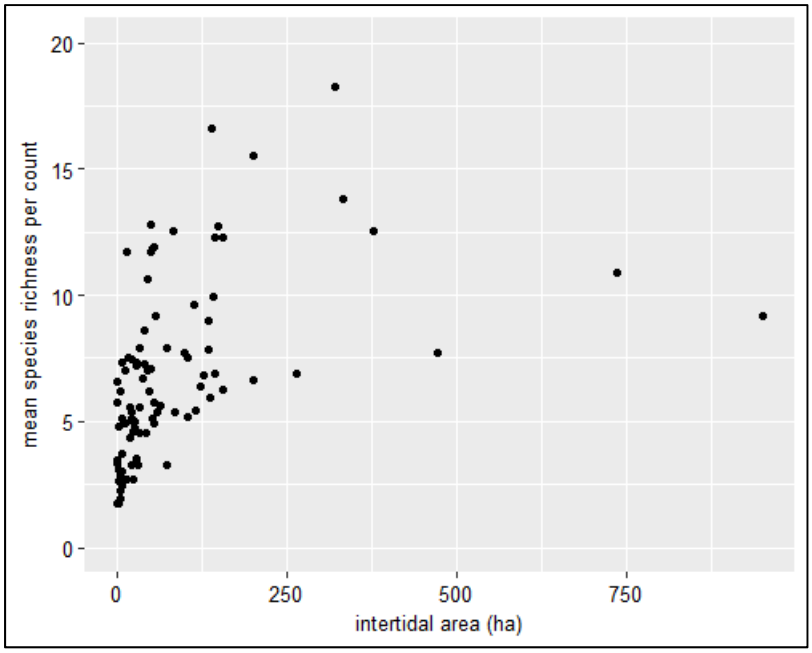
Table 3.2: Distribution of the habitat zones in the subsites surveyed between the four waterbody divisions

Waterbody divisions	% of total area of habitat zone in the waterbody divisions			
	Subtidal	Intertidal	Supratidal	Terrestrial
Upper Shannon	8%	25%	26%	23%
Fergus Estuary	7%	38%	42%	19%
Lower Shannon	49%	27%	19%	41%
Mouth of the Shannon	36%	11%	13%	17%

3.2 Waterbird Assemblage

3.2.1 Species richness

The total number of waterbird species recorded across all subsites ranged from 53 species in October to 28 species in June (Table 3.3). Most of the 21 SCI species were present in all the winter months (October-March) with Pintail and Scaup being the only missing SCI species during these months, while over half of the SCI species remained present during the summer (Table 3.3). The mean species richness per subsite varied from 1.7-18.3. The highest species richness occurred around Aughinish Island, in the Ballylongford area and in Poulnasherry Bay (**Error! Reference source not found.**). The Upper Shannon and the narrow section of the Lower Shannon between Foynes and Tarbert had generally low species richness, although the small size of the subsites in these areas will have affected the analyses. The subsite species richness was generally correlated with the subsite intertidal area although this was mainly due to low species richness in subsites with less than 50 ha of intertidal habitat (Text Figure 3.1). The subsite distribution of SCI species richness was strongly correlated with the subsite distribution of total species richness (Spearman's $r = 0.942$, one-side $p < 0.001$, $n = 89$).



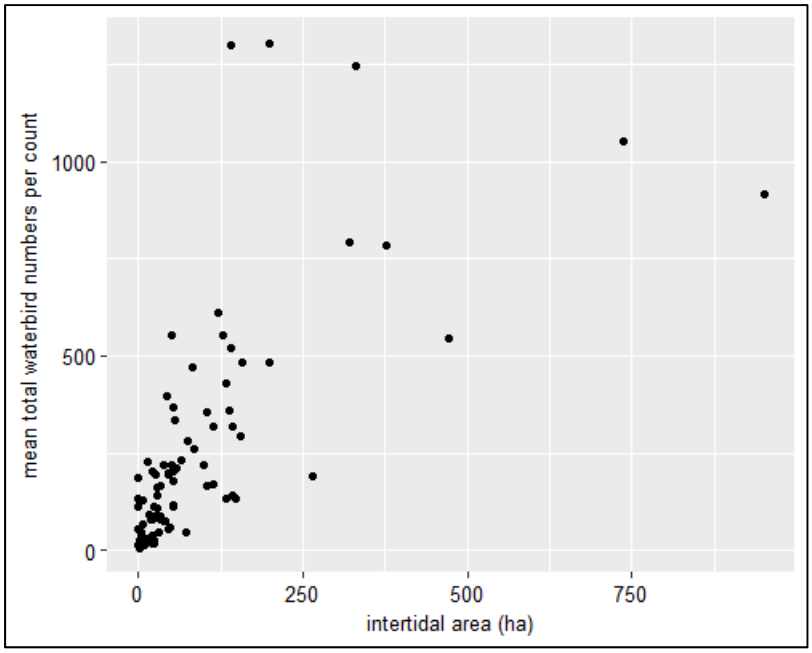
Text Figure 3.1: Relationship across subsites between mean species richness per count and intertidal area

Table 3.3: Monthly species richness

Month	Species richness	
	All species	SCI species
May	34	12
June	28	10
August	42	16
September	37	15
October	53	20
November	48	19
December	47	20
January	49	20
February	47	19
March	46	19
April	45	16

3.2.2 Total numbers

More than 20,000 waterbirds occurred in all the months across the traditional winter counting period (September-March) with the numbers peaking at nearly 44,000 in December (Table 3.4). The SCI species comprised an average of 85% of the total waterbird abundance with this percentage increasing as the total abundance increased (Spearman's r = 0.900, one-sided p < 0.001, n = 11). The subsites with the highest total abundances were the two subsites east of Aughinish Island and the subsite containing Ballylongford Creek, while the subsites in the Fergus Estuary waterbody division also generally had high abundances (**Error! Reference source not found.**). The subsite distribution of total abundances was generally correlated with the subsite intertidal areas (Text Figure 3.2). However, the two major subsites east of Aughinish Island (0I437, 0I491) and the Ballylongford Creek subsite (0K509), were outliers to this pattern with high total abundances relative to their intertidal areas. The subsite distribution of SCI waterbird abundances was strongly correlated with the subsite distribution of total waterbird abundances (Spearman's r = 0.992, one-side p < 0.001, n = 89).



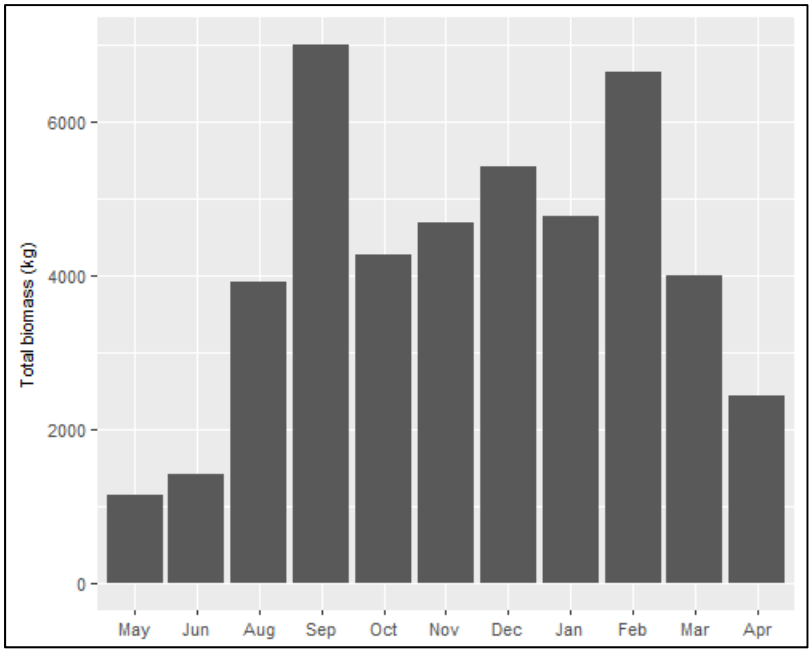
Text Figure 3.2: Relationship across subsites between mean waterbird abundance per count and intertidal area

Table 3.4: Monthly waterbird abundance

Month	Total numbers of waterbirds	
	All species	SCI species
May	3,474	2,493
June	4,002	2,625
August	15,694	12,943
September	22,029	18,335
October	21,382	18,472
November	30,827	28,455
December	43,903	41,081
January	33,663	30,964
February	35,849	33,647
March	22,639	20,947
April	5,302	4,437

3.2.3 Biomass

The overall numbers and biomasses of waterbirds feeding on benthic invertebrates in the intertidal zone in the four waterbody divisions are shown in Table 3.5. The highest numbers occurred in the Lower Shannon. The Upper Shannon and the Fergus Estuary supported only around 50% of the densities of birds and biomass that occurred in the Lower Shannon and Mouth of the Shannon. Mean subsite abundances and biomasses were strongly correlated (Spearman's $r = 0.873$, one-sided $p < 0.001$, $n = 85$). The highest subsite densities mainly occurred in a group of subsites with very narrow intertidal zones along the northern shore of the Lower Shannon (**Error! Reference source not found.**). Relatively high densities also occurred in subsites in the Foynes/Aughinish area, which had larger intertidal zones (**Error! Reference source not found.**). The peak biomass of waterbirds feeding on benthic invertebrates occurred in autumn (September) and late winter (February) with very low biomass in spring/early summer (Text Figure 3.3).



Text Figure 3.3: Monthly total biomasses of waterbirds feeding on benthic invertebrates

Table 3.5: Overall numbers and biomass of intertidal waterbirds in the four waterbody divisions.

Waterbody	Bird numbers		Biomass	
	mean	density (birds/ha)	mean (kg)	density (kg/ha)
Upper Shannon	2894	1.5	813	0.43
Fergus Estuary	3510	1.2	1035	0.36
Lower Shannon	4543	2.3	1799	0.92
Mouth of the Shannon	1271	2.2	506	0.87

Intertidal waterbirds are defined as waterbirds that predominantly feed on benthic invertebrates in the intertidal zone (see text).

3.3 Species Analyses

3.3.1 Species abundances and seasonal occurrence patterns

A total of 70 waterbird species were recorded during the survey. The monthly count totals for all the waterbird species recorded are shown in Appendix 7. All 21 SCI species of the River Shannon and River Fergus SPA were recorded. Table 3.6 summarises the occurrence patterns of the SCI species, while Table 3.7 summarises the occurrence patterns of 14 regularly occurring non-SCI species. The monthly distribution of the total counts of the SCI species, and of 14 regularly occurring non-SCI species, are shown in Text Figure 3.4 and Text Figure 3.5. Other regularly occurring non-SCI species included Gadwall, Great Northern Diver, Shag, Little Grebe, Water Rail, Coot, Whimbrel, Common Sandpiper, Spotted Redshank, Common Tern and Mediterranean Gull. These mainly occurred in very low numbers (maximum count < 50). The exception was Whimbrel, for which a count of 2310 was recorded in April during their concentrated spring migration period through Ireland. Scarce/rare non-SCI species recorded were: Greenland White-fronted Goose, Canada Goose, Pochard, Tufted Duck, Long-tailed Duck, Common Scoter, Red-breasted Merganser, Red-throated Diver, Black-throated Diver, American Golden Plover, Ruff, Curlew Sandpiper, Little Stint,

Green Sandpiper, Jack Snipe, Long-billed Dowitcher, Sandwich Tern, Arctic Tern, Ring-billed Gull, Yellow-legged Gull, Iceland Gull and Kingfisher.

Table 3.6: Summary of total numbers and seasonal occurrence patterns of the SCI species

SCI species	Occurrence	Main	Peak month	Peak count	Mean count
Whooper Swan	Oct-Apr	Nov-Mar	Mar	522	401
Light-bellied Brent Goose	Oct-Apr	Nov-Apr	Apr	289	211
Shelduck	All year	Nov-Jun	Feb	713	425
Wigeon	Jun-Mar	Oct-Mar	Jan	3215	2350
Teal	Jun-Apr	Oct-Mar	Dec	2888	2438
Pintail	Dec	-	Dec	2	2
Shoveler	May, Oct-Mar	Dec-Feb	Dec	74	47
Scaup	Oct, Jan	-	Jan	2	2
Cormorant	All year	All year	May	494	300
Golden Plover	Aug, Oct-Apr	Oct-Mar	Dec	8321	5035
Grey Plover	Aug-May	Oct-Mar	Jan	208	128
Lapwing	Aug-Feb	Nov-Feb	Dec	7131	5435
Ringed Plover	All year	Sep-Mar	Oct	446	270
Curlew	All year	Aug-Mar	Sep	2913	2317
Black-tailed Godwit	All year	Aug-Nov, Mar-May	Sep	3359	1687
Bar-tailed Godwit	May, Aug-Apr	Aug-Nov, Jan	Aug	213	143
Knot	Aug-Apr	Dec, Feb-Mar	Feb	1167	844
Dunlin	May, Aug-Apr	Nov-Mar	Dec	6253	4821
Greenshank	Jun-Apr	Aug-Mar	Aug	205	145
Redshank	All year	Aug-Mar	Dec	2747	2036
Black-headed Gull	All year	Aug-Mar	Sep	8268	5079

The main occurrence period is defined as the months in which 20% or more of the peak count occurred and the mean count is the mean across the main occurrence period.

Table 3.7: Summary of total numbers and seasonal occurrence patterns of regularly occurring non-SCI species.

SCI species	Occurrence	Main	Peak month	Peak count	Mean count
Mute Swan	All year	All year	Mar	105	60
Greylag Goose	May-Jun, Oct-Apr	May-Jun, Oct-Nov, Jan-Mar	Mar	115	71
Mallard	All year	May-Jan	Sep	1031	576
Little Egret	All year	Aug-Dec, Feb	Sep	219	147
Grey Heron	All year	May-Mar	Sep	109	64
Great Crested Grebe	All year	Aug-Apr	Dec	84	53
Oystercatcher	All year	Aug-Apr	Nov	778	541
Turnstone	Aug, Oct-Apr	Oct-Feb	Jan	252	114
Sanderling	Aug-Apr	Oct-Mar	Feb	78	59
Snipe	Aug-Apr	Nov-Jan	Jan	913	632
Common Gull	All year	Sep-Mar	Feb	639	297
Lesser Black-backed Gull	All year	Aug-Oct, May	Sep	421	278
Herring Gull	All year	Jun-Mar	Sep	476	215
Great Black-backed Gull	All year	Jun-Nov, Feb	Sep	320	170

The main occurrence period is defined as the months in which 20% or more of the peak count occurred and the mean count is the mean across the main occurrence period.

Compared to the 2010/11 WSP counts, there were much higher mean numbers of Whooper Swan, Wigeon, Ringed Plover, Curlew and Redshank, and much lower mean numbers of Pintail, Cormorant, Black-tailed Godwit, Bar-tailed Godwit and Dunlin, recorded across the winter (October-February) period (Table 3.8). For most of these species, except Curlew and Redshank, the differences between the winters were broadly consistent across the winter period, suggesting that these reflect real changes in abundances (Text Figure 3.6). However, the differences in Whooper Swan numbers are likely to reflect differences in coverage of terrestrial habitats. Also, while Black-tailed Godwit numbers were consistently higher in 2010/11, the scale of the difference is probably exaggerated by an exceptional count of over 9000 birds in October 2010.

For the non-SCI species, there were much higher mean numbers of Mute Swan, Little Egret, Oystercatcher, Sanderling, Snipe and Lesser Black-backed Gull, and much lower mean numbers of Herring Gull, recorded across the winter (October-February) period (Table 3.9). For Mute Swan, Little Egret, Sanderling and Snipe, the differences between the winters were broadly consistent across the winter period (Text Figure 3.6-Text Figure 3.7). However, the differences in Snipe numbers are likely to reflect differences in coverage of terrestrial habitats.

Table 3.8: Comparison of the overall numbers of SCI species recorded in the 2010/11 WSP counts and the 2017/18 MKO counts.

SCI species	2010/11 (WSP)		2017/18 (MKO)	
	mean	range	mean	range
Whooper Swan	14	0-52	149	24-260
Light-bellied Brent Goose	84	12-214	123	18-266
Shelduck	421	167-857	407	54-713
Wigeon	1459	927-2061	2341	1229-3120
Teal	2267	1569-3267	1969	656-2782
Pintail	54	3-94	0	0-2
Shoveler	36	15-68	26	4-74
Scaup	0	-	2	1-2
Cormorant	406	144-749	106	49-156
Golden Plover	4557	249-11576	5232	4026-8314
Grey Plover	121	30-206	119	37-208
Lapwing	4192	851-10960	4339	831-6850
Ringed Plover	123	53-223	226	102-418
Curlew	1683	501-2653	2209	1736-2612
Black-tailed Godwit	2668	683-9052	681	144-1473
Bar-tailed Godwit	439	239-885	85	15-133
Knot	440	198-621	489	27-1167
Dunlin	11547	6691-14799	3943	726-6175
Greenshank	92	43-157	125	87-191
Redshank	1782	1015-2442	2303	1911-2656
Black-headed Gull	3281	920-8540	3560	1621-5889

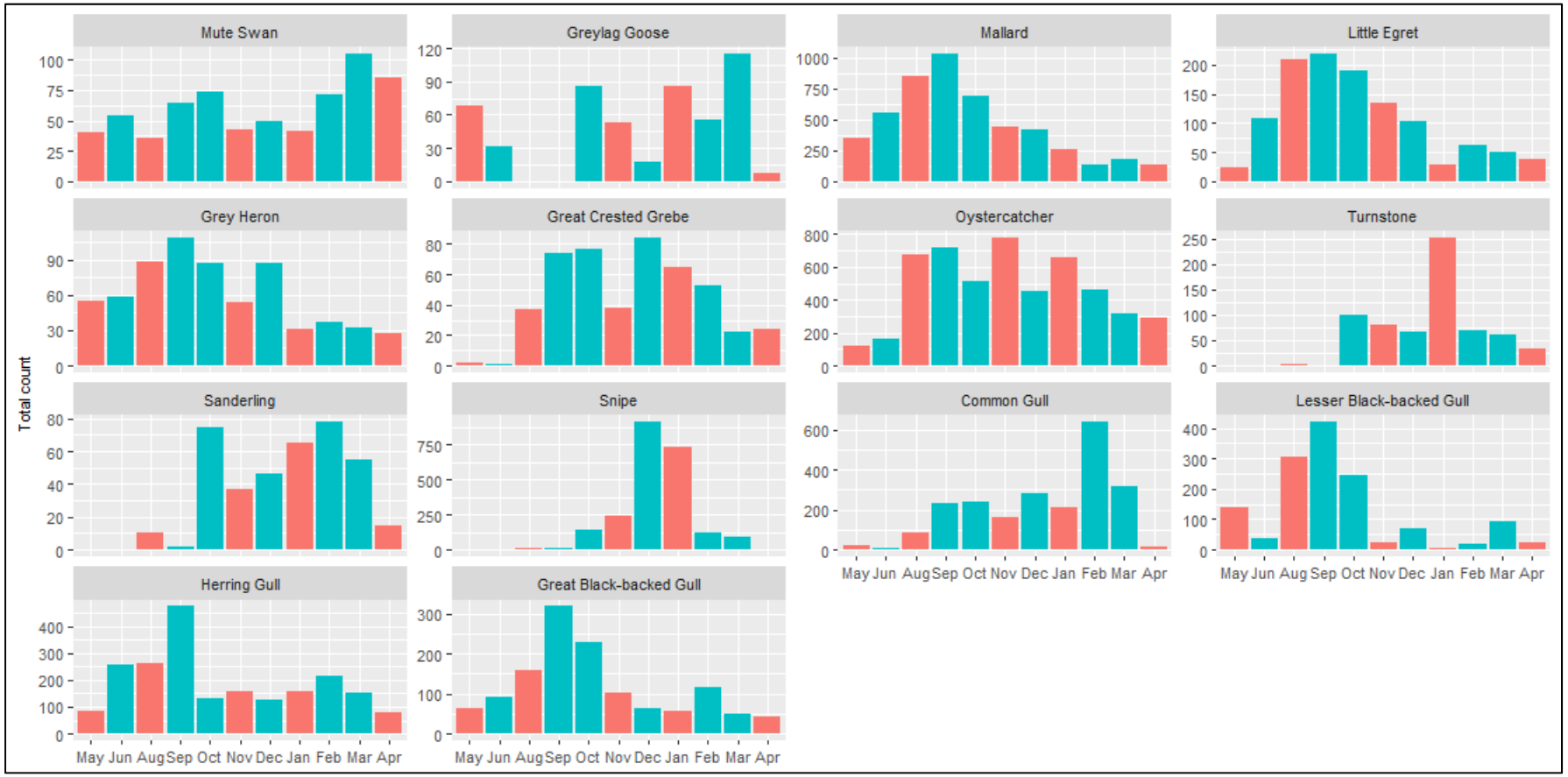
Totals only included counts from subsites that were covered in both surveys and the 2017/18 totals only include the October-February counts.

Table 3.9: Comparison of the overall numbers of regularly occurring non-SCI species recorded in the 2010/11 WSP counts and the 2017/18 MKO counts.

SCI species	2010/11 (WSP)		2017/18 (MKO)	
	mean	range	mean	range
Mute Swan	10	6-13	43	28-58
Greylag Goose	31	0-112	31	0-86
Mallard	431	219-763	379	129-677
Little Egret	36	6-93	83	22-179
Grey Heron	62	13-125	50	26-78
Great Crested Grebe	75	43-123	54	37-71
Oystercatcher	302	181-483	434	332-626
Turnstone	66	27-95	89	48-214
Sanderling	17	0-68	55	36-68
Snipe	30	3-64	327	67-689
Common Gull	287	161-420	274	159-547
Lesser Black-backed Gull	13	3-23	63	5-241
Herring Gull	328	52-908	98	60-144
Great Black-backed Gull	127	5-376	98	42-206

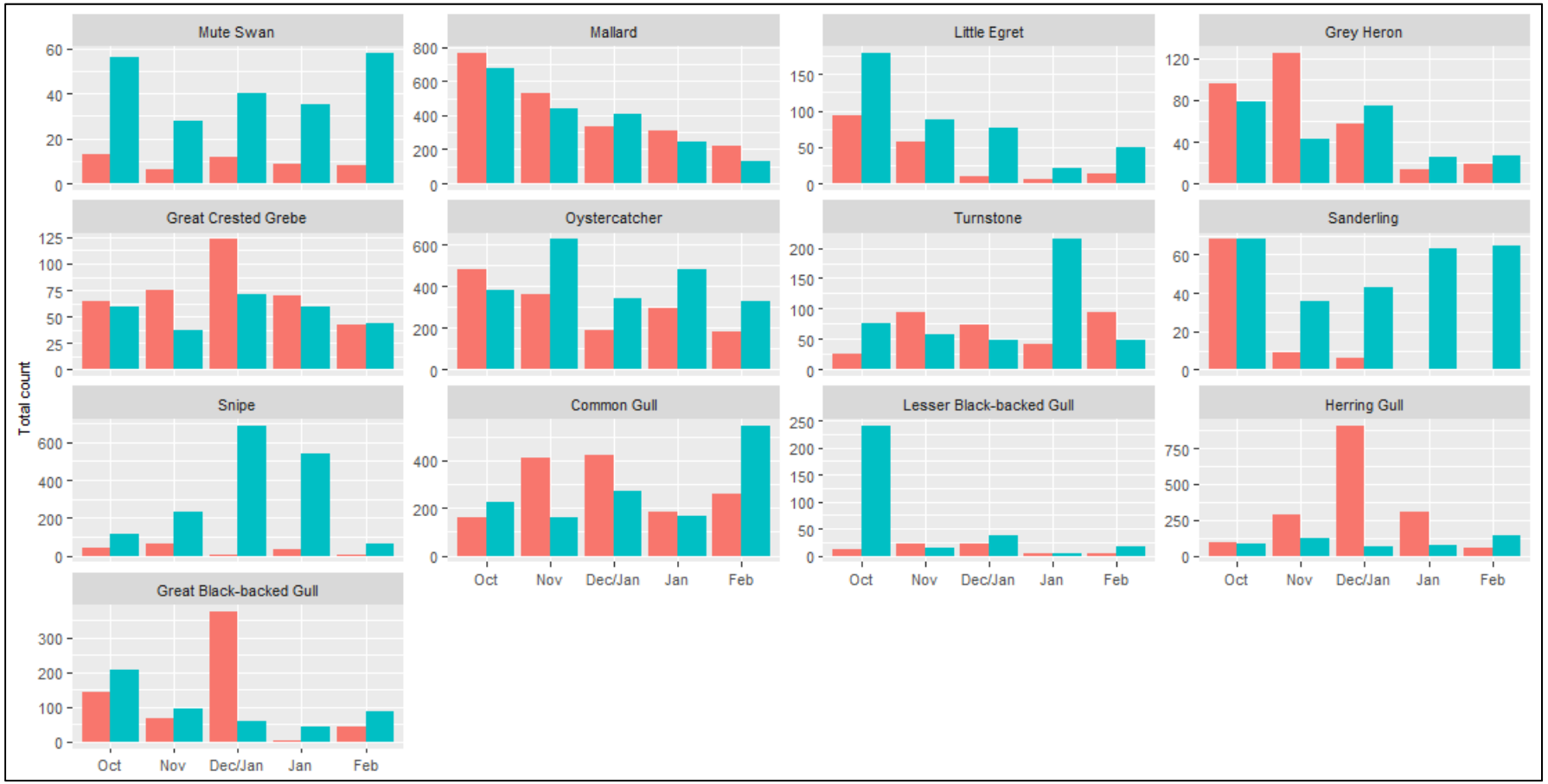
Totals only included counts from subsites that were covered in both surveys and the 2017/18 totals only include the October-February counts.

Text Figure 3.4: Monthly total counts of the SCI species in in May 2017 - April 2018, with high tide counts shown as red bars and low tide counts shown as blue bars



Text Figure 3.5: Monthly total counts of regularly occurring non-SCI species in May 2017 - April 2018, with high tide counts shown as red bars and low tide counts shown as blue bars

Text Figure 3.6: Comparison of the monthly total counts of the SCI species in October-February 2010/11 (red bars) and 2017/18 (blue bars)



Text Figure 3.7: Comparison of the monthly total counts of regularly occurring non-SCI species in October-February 2010/11 (red bars) and 2017/18 (blue bars)

The additional subsites included in the present survey did not hold high numbers of most SCI species, but they did hold around 50% of the total Whooper Swan and Cormorant numbers and 20% of the total Light-bellied Brent Goose and Ringed Plover numbers (Table 3.10). However, these additional subsites held larger numbers of most of the regularly occurring non-SCI species, including nearly 70% of the total Greylag Goose numbers and around 20-35% of the total Mute Swan, Grey Heron, Oystercatcher, Turnstone, Great Crested Grebe and Herring Gull numbers (Table 3.11).

Table 3.10: Mean percentage of the total count of the SCI species recorded in additional subsites that were not covered in the 2010/11 WSP surveys

Species	Mean percentage of total count in additional subsites	
	entire survey area	SPA
Whooper Swan	52%	52%
Light-bellied Brent Goose	23%	8%
Shelduck	2%	1%
Wigeon	3%	3%
Teal	5%	4%
Shoveler	0%	0%
Cormorant	45%	43%
Golden Plover	3%	3%
Grey Plover	1%	0%
Lapwing	4%	4%
Ringed Plover	20%	9%
Curlew	10%	9%
Black-tailed Godwit	1%	1%
Bar-tailed Godwit	1%	0%
Knot	0%	0%
Dunlin	7%	6%
Greenshank	4%	3%
Redshank	5%	4%
Black-headed Gull	11%	11%

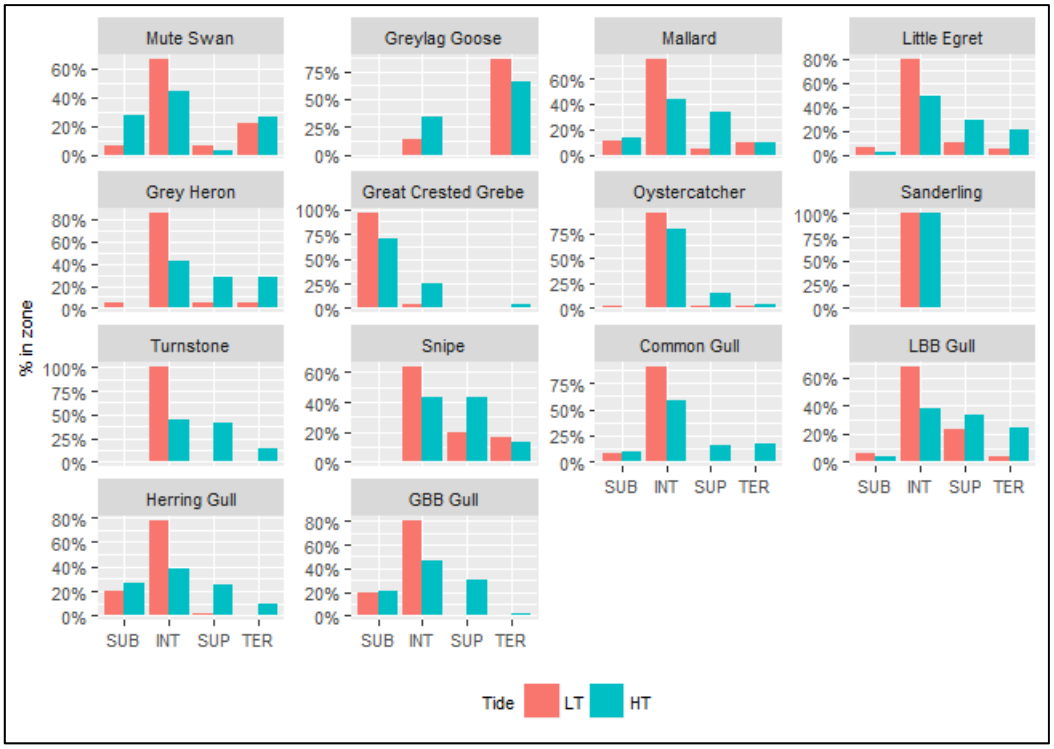
Table 3.11: Mean percentage of the total count of regularly occurring non-SCI species recorded in additional subsites that were not covered in the 2010/11 WSP surveys

Species	Mean percentage of total count in additional subsites	
	entire survey area	SPA
Mute Swan	20%	15%
Greylag Goose	68%	68%
Mallard	4%	3%
Little Egret	16%	15%
Grey Heron	19%	14%
Great Crested Grebe	12%	11%
Oystercatcher	23%	13%
Turnstone	25%	16%
Sanderling	6%	4%
Snipe	19%	19%
Common Gull	10%	7%
Lesser Black-backed Gull	4%	4%
Herring Gull	34%	24%
Great Black-backed Gull	14%	7%

3.3.2 Habitat use

The broad patterns of habitat use recorded during the survey are summarised in Text Figure 3.8 and Text Figure 3.9.

Text Figure 3.8: Habitat use of SCI waterbird species at low tide and high tide



Text Figure 3.9: Habitat use of regularly occurring non-SCI waterbird species at low tide and high tide

As would be expected, at low tide most wader species occurred almost exclusively in the intertidal zone. At high tide waders also occurred in the supratidal and terrestrial zones, presumably reflecting the use of these areas for high tide roosts. There was little evidence of significant levels of field feeding at low tide. At high tide quite high numbers of Golden Plover, Lapwing and Curlew occurred in the terrestrial zone indicating field feeding birds.

At low tide, most Mute Swan, Light-bellied Brent Goose and dabbling ducks occurred in the intertidal zone. Somewhat surprisingly, this was also the case (but to a slightly lesser extent) at high tide. However, the latter may have been due to surveyors recording the habitat zone based on the mapped extent of intertidal habitat, rather than the actual tidal exposure at the time of the count. Unlike, the other dabbling ducks, Shoveler mainly occurred in the terrestrial zone reflecting the occurrence of birds in the Shannon Airport Lagoon. Whooper Swan and Greylag Goose also occurred mainly in the terrestrial zone. This presumably reflected the occurrence of field-feeding Whooper Swan, while Greylag Goose were mainly recorded in lagoons in the Upper Shannon zone.

The gulls also mainly occurred in the intertidal zone at low tide. Black-headed Gull and Common Gull also remained concentrated in the intertidal zone at high tide, but the larger gulls (Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull) showed a more even distribution across the habitat zones at high tide. As with the Light-bellied Brent Goose and dabbling ducks, the relatively high numbers recorded in the intertidal zone at high tide may have been due to the recording protocol.

Not surprisingly, most Great Crested Grebe were recorded in the subtidal zone and the small numbers of birds apparently recorded in the intertidal zone will have been on flooded areas within the mapped zones. Cormorant, which is also a bird typically associated with subtidal habitat, was only recorded in relatively low numbers in the subtidal zone. This is largely due to the very large numbers recorded at the Bunlicky Lake breeding colony in the terrestrial zone, as well as probably reflecting the occurrence of daytime roosts in the intertidal and supratidal zone, as well as the recording issues discussed above.

3.3.3 Subsite occupancy

The subsite occupancy of the SCI species ranged from 2%-73%, while the area occupancy ranged from 2-83% (Table 3.12). Two SCI species are not included in Table 3.12: Pintail and Scaup were only recorded from one subsite on one count (Pintail) or two counts (Scaup). The subsite occupancy of regularly occurring non-SCI species ranged from 2%-44%, while the area occupancy ranged from 1-60% (Table 3.13).

Table 3.12: Mean subsite and area occupancy of the SCI species

Species	Mean % subsite occupancy	Mean % area occupancy
Whooper Swan	9% (0.8%)	16% (2.4%)
Light-bellied Brent Goose	8% (1.2%)	11% (0.6%)
Shelduck	30% (3.7%)	54% (4.1%)
Wigeon	40% (4.5%)	58% (7.1%)
Teal	40% (4.2%)	58% (6.5%)
Shoveler	2% (0.6%)	2% (0.5%)
Cormorant	45% (3.1%)	49% (3.8%)
Golden Plover	13% (0.7%)	23% (1.5%)
Grey Plover	8% (1.2%)	18% (2.8%)
Lapwing	40% (3.3%)	60% (5.2%)
Ringed Plover	10% (1.1%)	10% (1.4%)
Curlew	73% (2.9%)	83% (2.4%)
Black-tailed Godwit	20% (4.5%)	36% (5.7%)

Species	Mean % subsite occupancy	Mean % area occupancy
Bar-tailed Godwit	7% (1.8%)	13% (0.9%)
Knot	7% (2.8%)	15% (2.3%)
Dunlin	29% (1.2%)	58% (1.8%)
Greenshank	26% (1.8%)	39% (3.1%)
Redshank	55% (3.5%)	74% (5.2%)
Black-headed Gull	63% (5%)	71% (4.9%)

Table 3.13: Mean subsite and area occupancy of regularly occurring non-SCI species

Species	Mean % subsite occupancy	Mean % area occupancy
Mute Swan	13% (1.2%)	11% (1.5%)
Greylag Goose	2% (0.5%)	1% (0.3%)
Mallard	40% (3.5%)	54% (5.3%)
Little Egret	40% (5%)	60% (3.9%)
Grey Heron	32% (4.1%)	40% (5.6%)
Great Crested Grebe	15% (1.7%)	21% (3%)
Oystercatcher	44% (2.8%)	56% (2.5%)
Turnstone	10% (2.6%)	13% (3.6%)
Sanderling	4% (0.7%)	4% (1.5%)
Snipe	32% (8.4%)	44% (11.1%)
Common Gull	19% (2.5%)	23% (2.8%)
Lesser Black-backed Gull	23% (5.4%)	27% (6.1%)
Herring Gull	32% (3.7%)	37% (5%)
Great Black-backed Gull	32% (3.4%)	44% (4.8%)

3.3.4 Species distribution

The distribution patterns of the SCI species between the four waterbody divisions are summarised in Table 3.14, and those of the non-SCI species are summarised in Table 3.15. The standard errors for most species are relatively low indicating that the distribution patterns were fairly constant across the counts.

The Lower Shannon generally held high numbers of most of the estuarine species (Light-bellied Brent Goose, Shelduck, dabbling ducks, waders and Black-headed Gull). For many of these species, numbers in the Fergus Estuary were relatively low even though this zone has the largest area of intertidal habitat. Oystercatcher, Ringed Plover, Turnstone and Sanderling were all largely confined to the Lower Shannon and Mouth of the Shannon reflecting the association of these species with sandy and/or hard substrates. Conversely, several other species were largely absent from the Mouth of the Shannon reflecting their association with muddier and/or more sheltered habitats. Great Crested Grebe, which occurs exclusively in subtidal habitat was largely absent from the Fergus Estuary and Upper Shannon, while Common Gull and Herring Gull also showed a similar pattern.

Whooper Swan, which occurred almost exclusively in the terrestrial zone, mainly occurred in the Upper Shannon and Fergus Estuary. The overall numbers were higher in the Upper Shannon but this was due to the large numbers that occurred at one site (Bunlicky Lake). The other concentration of birds was along the northern and eastern shore of the Fergus Estuary (**Error! Reference source not found.**).

Cormorant showed variable distribution patterns across the survey period, with high numbers in the Upper Shannon in the summer reflecting the presence of the breeding colony at Bunlicky Lake. The numbers at Bunlicky Lake peaked in May and over 90% of the total Cormorant count in that month was in subsites within the likely foraging range of birds from that colony (Table 3.16). Numbers in the Upper Shannon gradually decreased across the autumn/early winter period, with very low numbers at Bunlicky

Lake, while numbers in the Lower Shannon increased. However, the numbers in the Upper Shannon were high again from January.

For most species, the distribution patterns across the winter period (October-February) between the waterbody divisions were broadly similar between the 2010/11 and 2017/18 surveys (Text Figure 3.10 and Text Figure 3.11).

Table 3.14: Mean percentage of the total count of the SCI species occurring in the four waterbody divisions, 2017/18.

Species	Parameter	Upper Shannon	Fergus	Lower Shannon	Mouth of the Shannon
Whooper Swan	mean	60%	39%	1%	0%
	s.e.	*6%*	*6%*	*1%*	*0%*
Light-bellied Brent Goose	mean	1%	0%	13%	86%
	s.e.	*1%*	*0%*	*8%*	*8%*
Shelduck	mean	12%	31%	37%	20%
	s.e.	*3%*	*3%*	*4%*	*6%*
Wigeon	mean	14%	17%	64%	4%
	s.e.	*5%*	*3%*	*6%*	*1%*
Teal	mean	16%	25%	57%	2%
	s.e.	*3%*	*3%*	*4%*	*1%*
Shoveler	mean	76%	0%	24%	0%
	s.e.	*14%*	*0%*	*14%*	*0%*
Cormorant	mean	58%	4%	27%	11%
	s.e.	*6%*	*1%*	*6%*	*2%*
Golden Plover	mean	38%	22%	35%	5%
	s.e.	*12%*	*8%*	*9%*	*2%*
Grey Plover	mean	9%	16%	67%	8%
	s.e.	*4%*	*9%*	*13%*	*3%*
Lapwing	mean	36%	21%	40%	4%
	s.e.	*2%*	*3%*	*3%*	*1%*
Ringed Plover	mean	0%	0%	35%	65%
	s.e.	*0%*	*0%*	*10%*	*10%*
Curlew	mean	17%	16%	53%	14%
	s.e.	*2%*	*2%*	*3%*	*2%*
Black-tailed Godwit	mean	23%	37%	40%	0%
	s.e.	*10%*	*9%*	*13%*	*0%*
Bar-tailed Godwit	mean	39%	22%	12%	27%
	s.e.	*19%*	*17%*	*7%*	*16%*
Knot	mean	46%	14%	1%	38%
	s.e.	*23%*	*8%*	*1%*	*17%*
Dunlin	mean	24%	37%	28%	10%
	s.e.	*6%*	*9%*	*4%*	*2%*
Greenshank	mean	4%	9%	74%	14%
	s.e.	*1%*	*3%*	*3%*	*3%*
Redshank	mean	30%	30%	34%	7%
	s.e.	*3%*	*3%*	*2%*	*1%*
Black-headed Gull	mean	24%	23%	49%	4%
	s.e.	*4%*	*4%*	*6%*	*1%*

Calculated using data from the main periods of occurrence for each species. Sample sizes: n = 11 (Cormorant); n = 8 (Shelduck, Curlew, Greenshank, Redshank and Black-headed Gull); n = 7 (Ringed Plover and Black-tailed Godwit); n = 6 (Light-bellied Brent Goose, Wigeon, Teal, Golden Plover and Grey Plover); n= 5 (Whooper Swan, Bar-tailed Godwit and Dunlin); n = 4 (Lapwing); n =3 (Shoveler and Knot).

Table 3.15: Mean percentage of the total count of regularly occurring non-SCI species occurring in the four waterbody divisions, 2017/18.

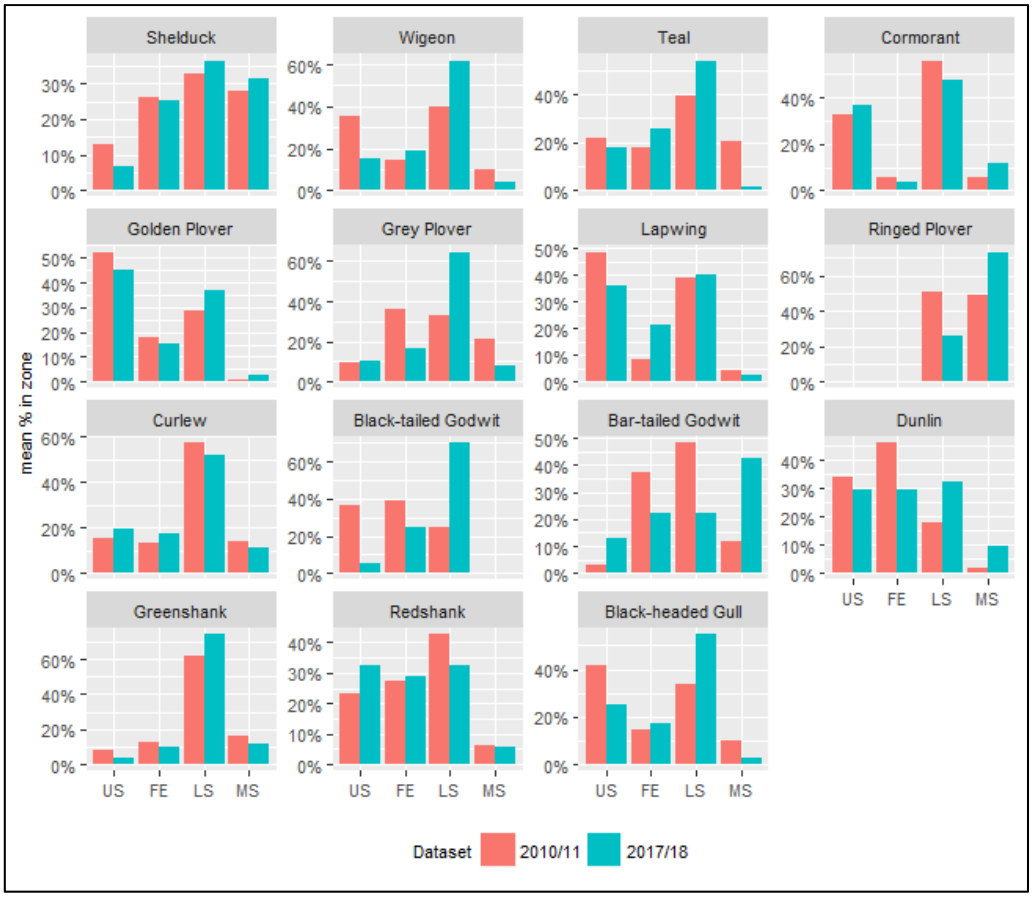
Species	Parameter	Upper Shannon	Fergus	Lower Shannon	Mouth of the Shannon
Mute Swan	mean	74%	5%	15%	6%
	s.e.	*4%*	*2%*	*4%*	*1%*
Greylag Goose	mean	100%	0%	0%	0%
	s.e.	*0%*	*0%*	*0%*	*0%*
Mallard	mean	31%	9%	52%	8%
	s.e.	*3%*	*2%*	*4%*	*1%*
Little Egret	mean	13%	16%	60%	11%
	s.e.	*4%*	*3%*	*4%*	*3%*
Grey Heron	mean	23%	15%	47%	14%
	s.e.	*3%*	*3%*	*3%*	*3%*
Great Crested Grebe	mean	7%	3%	78%	12%
	s.e.	*4%*	*2%*	*3%*	*2%*
Oystercatcher	mean	8%	17%	41%	34%
	s.e.	*2%*	*2%*	*3%*	*3%*
Turnstone	mean	1%	0%	49%	50%
	s.e.	*1%*	*0%*	*11%*	*12%*
Sanderling	mean	0%	0%	2%	98%
	s.e.	*0%*	*0%*	*2%*	*2%*
Snipe	mean	23%	6%	67%	4%
	s.e.	*10%*	*2%*	*9%*	*2%*
Common Gull	mean	8%	0%	77%	14%
	s.e.	*3%*	*0%*	*4%*	*4%*
Lesser Black-backed Gull	mean	43%	1%	52%	4%
	s.e.	*19%*	*1%*	*19%*	*1%*
Herring Gull	mean	3%	3%	64%	30%
	s.e.	*1%*	*1%*	*5%*	*5%*
Great Black-backed Gull	mean	16%	22%	47%	16%
	s.e.	*8%*	*6%*	*6%*	*3%*

Calculated using data from the main periods of occurrence for each species. Sample sizes: n = 11 (Cormorant); n = 8 (Shelduck, Curlew, Greenshank, Redshank and Black-headed Gull); n = 7 (Ringed Plover and Black-tailed Godwit); n = 6 (Light-bellied Brent Goose, Wigeon, Teal, Golden Plover and Grey Plover); n= 5 (Whooper Swan, Bar-tailed Godwit and Dunlin); n = 4 (Lapwing); n =3 (Shoveler and Knot).

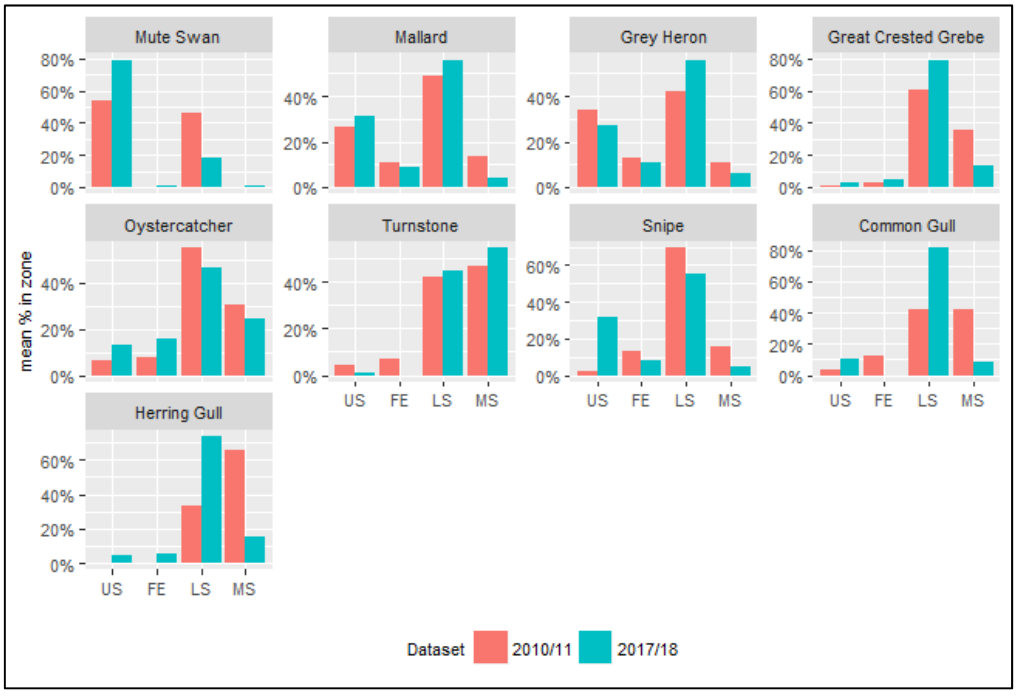
Table 3.16: Cormorant numbers recorded at the Bunlicky Lake breeding colony and in the likely core and mean maximum foraging ranges of birds from that colony.

Month	Numbers in			% of total count in	
	Bunlicky Lake	core	mean maximum	core	mean maximum
Jan	171	175	231	57%	76%
Feb	116	132	143	69%	75%
Mar	254	262	268	84%	86%
Apr	219	258	303	71%	83%
May	282	330	449	67%	91%
Jul	137	191	303	50%	79%
Aug	28	145	295	32%	66%
Sep	7	107	218	33%	68%
Oct	0	44	108	23%	56%
Nov	3	15	33	9%	20%
Dec	11	28	36	22%	29%

The core and mean maximum foraging ranges are defined as including subsites within 5.2 and 25 km, respectively, of the Bunlicky Lake breeding colony, following Thaxter et al. (2012). Subsites that overlap these distances are included if more than 50% of the subsite is within the distance.



Text Figure 3.10: Comparison of the mean percentage distribution of SCI species in qualifying counts between the four waterbody divisions in October-February 2010/11 and 2017/18



Text Figure 3.11: Comparison of the mean percentage distribution of regularly occurring non-SCI species in qualifying counts between the four waterbody divisions in October-February 2010/11 and 2017/18

3.3.5 Strategic Integrated Framework Plan subsite groups

3.3.5.1 Strategic development locations

The Strategic Development Locations are all located in the terrestrial zone but are adjacent to tidal habitats. The 500m terrestrial zone counted within each subsite covered 50-87% of the total area of each Strategic Development Location (Table 3.17). The Strategic Development Locations included 12-37% of the total area of the terrestrial zones within the subsite groups (Table 3.17). Most of the Strategic Development Locations are in areas where the terrestrial zones of the subsites held very low numbers of SCI species (Table 3.18). The terrestrial zones of the subsites containing Strategic Development Location F, which covers Aughinish Island and hinterland, held higher numbers of SCI species, including a mean of 5-10% of the total count of Shoveler, Golden Plover, Lapwing and Black-tailed Godwit (Table 3.18). However, only 37% of the terrestrial zones of these subsites are within the Strategic Development Location (Table 3.17).

Table 3.17: Total areas of the Strategic Development Locations and representation within the terrestrial zones of the subsites containing the Strategic Development Locations.

SDL	Area (ha)	Terrestrial zones of subsite groups	
		% of SDL within	% within SDL
A	106	83%	31%
B	256	60%	31%
D	203	72%	25%
E	107	50%	12%
F	515	61%	37%
G	557	60%	20%
H	70	85%	37%
I	50	87%	20%

Table 3.18: Mean percentages of the total count of SCI species occurring in the terrestrial zone within subsite groups containing Strategic Development Locations.

Species	Subsite group									Total
	A	B	C	D	E	F	G	H	I	
Whooper Swan	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Light-bellied Brent Goose	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shelduck	0%	0%	0%	0%	0%	4%	0%	0%	0%	4%
Wigeon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Teal	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Shoveler	0%	0%	0%	0%	0%	7%	0%	0%	0%	7%
Cormorant	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Golden Plover	0%	0%	0%	0%	0%	10%	0%	2%	0%	10%
Grey Plover	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Lapwing	0%	0%	0%	4%	0%	6%	0%	1%	0%	10%
Ringed Plover	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Curlew	0%	0%	0%	1%	0%	2%	0%	1%	0%	4%
Black-tailed Godwit	0%	0%	0%	0%	0%	5%	0%	0%	0%	5%
Bar-tailed Godwit	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Knot	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Dunlin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Greenshank	0%	0%	0%	1%	0%	1%	0%	0%	0%	2%
Redshank	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%
Black-headed Gull	0%	0%	0%	2%	0%	0%	0%	0%	0%	3%

While the Strategic Development Locations do not contain significant areas of tidal habitat, development within the Strategic Development Locations could potentially cause disturbance to waterbirds using the adjacent tidal habitats. Buffers of 300 m around the Strategic Development Locations include 9-64% of the subtidal zones, 0-

62% of the intertidal zones, and 1-67% of supratidal zones, within the subsite groups (Table 3.19). The highest numbers of SCI species occurred in the subsite groups containing Strategic Development Locations F and H. The subsite group containing Strategic Development Location F held 5-40% of the total counts of Shelduck, Wigeon, Teal, Shoveler, Lapwing, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Greenshank, Redshank and Black-headed Gull (Table 3.20). The subsite group containing Strategic Development Location H held 5-15% of the total counts of Light-bellied Brent Goose, Wigeon, Golden Plover, Grey Plover, Lapwing, Ringed Plover, Curlew and Dunlin (Table 3.20). These species are all mainly associated with intertidal and/or shallow subtidal habitat and 33% of the intertidal zones within the subsite group containing Strategic Development Location F, and 47% of the intertidal zones within the subsite group containing Strategic Development Location G are within the 300 m buffers around the Strategic Development Locations.

Table 3.19: Percentages of total areas counted within subsite groups containing Strategic Development Locations

SDL	% of subsite group			
	within SDL	within 300 m buffer		
	terrestrial zone	subtidal zone	intertidal zone	supratidal zone
A	31%	5%	21%	66%
B	31%	9%	31%	38%
C	0%	16%	21%	63%
D	25%	16%	31%	23%
E	37%	2%	0%	1%
F	8%	5%	33%	60%
G	37%	12%	47%	67%
H	20%	9%	20%	6%
I	20%	64%	62%	39%

Table 3.20: Mean percentages of the total count of SCI species occurring within subsite groups containing Strategic Development Locations

Species	Subsite groups									Total
	A	B	C	D	E	F	G	H	I	
Whooper Swan	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Light-bellied Brent Goose	0%	1%	0%	0%	0%	0%	0%	11%	0%	13%
Shelduck	1%	0%	2%	1%	0%	9%	3%	3%	0%	19%
Wigeon	0%	2%	5%	1%	0%	17%	1%	9%	0%	35%
Teal	1%	2%	3%	1%	1%	16%	3%	4%	0%	31%
Shoveler	0%	0%	16%	0%	0%	8%	0%	0%	0%	24%
Cormorant	0%	1%	1%	0%	0%	4%	1%	2%	0%	9%
Golden Plover	0%	0%	0%	1%	0%	10%	0%	12%	0%	24%
Grey Plover	1%	0%	0%	0%	0%	36%	0%	7%	0%	45%
Lapwing	0%	1%	0%	6%	0%	8%	0%	7%	0%	23%
Ringed Plover	0%	5%	9%	1%	0%	0%	0%	12%	0%	28%
Curlew	2%	1%	1%	4%	1%	11%	0%	6%	0%	27%
Black-tailed Godwit	0%	0%	2%	0%	9%	9%	1%	2%	0%	24%
Bar-tailed Godwit	0%	0%	0%	0%	0%	10%	0%	0%	0%	11%
Knot	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%
Dunlin	0%	1%	0%	2%	0%	6%	0%	9%	0%	18%
Greenshank	1%	0%	0%	6%	0%	14%	2%	4%	0%	29%
Redshank	1%	1%	1%	2%	1%	5%	1%	4%	0%	16%
Black-headed Gull	1%	3%	5%	4%	1%	8%	0%	2%	1%	26%

3.3.6 Areas of Opportunity for aquaculture

The Areas of Opportunity for aquaculture include six large sites covering areas of 63-797 ha, as well as two small sites with areas of 2-6 ha (Table 3.21). These Areas of Opportunity occur in most of the significant bays/estuaries in the Lower Shannon and

Mouth of the Shannon. Therefore, the subsite groups containing the Areas of Opportunity hold high percentages (69-100%) of the total counts of Light-bellied Brent Goose, Grey Plover and Ringed Plover (Table 3.22), as these species mainly occurred in these waterbody divisions. In fact, apart from Whooper Swan and Shoveler, the subsite groups containing the Areas of Opportunity for aquaculture held 19% or more of the total count of all the SCI species (Table 3.22). The subsite groups with the highest numbers of SCI species were subsite groups J (Ballylongford area), K (Poulnasherry Bay) and N (Aughinish Island - River Deel). Most of Poulnasherry Bay is within Area of Opportunity K, while around half of the intertidal habitat within the subsite group N is within Area of Opportunity N. However, only around 20% of the intertidal habitat within the subsite group J is within Area of Opportunity J.

Table 3.21: Total areas of the Areas of Opportunity for aquaculture and the percentages occupied by the Areas of Opportunity of the total areas within the subsites groups

AAO	Area (ha)	% occupied by the AOO of the total area within the subsite group		
		subtidal zone	intertidal zone	supratidal zone
J	541	11%	20%	10%
K	797	25%	85%	61%
L	476	50%	90%	15%
M	63	5%	43%	0%
N	344	17%	45%	4%
O	2	0%	3%	1%
P	6	1%	9%	3%
U	541	68%	14%	44%

Table 3.22: Mean percentages of the total count of SCI species occurring within subsites groups containing Areas of Opportunity for aquaculture

Species	Subsite group								Total
	J	K	L	M	N	O	P	U	
Whooper Swan	1%	0%	1%	0%	4%	0%	0%	0%	6%
Light-bellied Brent Goose	18%	62%	9%	10%	1%	0%	0%	0%	100%
Shelduck	5%	20%	0%	0%	9%	1%	1%	5%	41%
Wigeon	9%	4%	0%	0%	24%	1%	2%	4%	44%
Teal	4%	2%	0%	0%	21%	1%	2%	3%	33%
Shoveler	0%	0%	0%	0%	4%	0%	0%	0%	4%
Cormorant	3%	4%	1%	1%	4%	0%	1%	7%	22%
Golden Plover	15%	2%	0%	0%	26%	2%	2%	4%	50%
Grey Plover	11%	6%	0%	2%	49%	0%	0%	0%	69%
Lapwing	7%	2%	0%	0%	13%	1%	1%	5%	30%
Ringed Plover	25%	19%	8%	6%	2%	7%	4%	3%	74%
Curlew	7%	10%	0%	1%	16%	1%	1%	5%	40%
Black-tailed Godwit	4%	1%	0%	0%	21%	0%	2%	2%	29%
Bar-tailed Godwit	4%	38%	0%	5%	25%	0%	2%	0%	73%
Knot	2%	38%	0%	0%	0%	0%	0%	0%	40%
Dunlin	10%	6%	0%	1%	9%	2%	1%	2%	31%
Greenshank	7%	8%	0%	1%	12%	1%	1%	28%	58%
Redshank	4%	5%	0%	0%	10%	1%	1%	5%	26%
Black-headed Gull	3%	2%	0%	0%	7%	1%	1%	5%	19%

3.3.7 Areas of Opportunity for renewable energy generation

The Areas of Opportunity for renewable energy generation include three large Areas of Opportunity occupying areas of 358-1386 ha and one small Area of Opportunity with an area of 27 ha (Table 3.23). Three of the Areas of Opportunity are mainly/entirely within the subtidal zone while the Area of Opportunity S in Tarbert Bay includes a significant area of intertidal habitat (Table 3.23). The subsite group containing Area of Opportunity S held 5-15% of the total count of Light-bellied Brent Goose, Wigeon, Grey Plover,

Lapwing, Ringed Plover, Curlew, Black-tailed Godwit, Greenshank and Redshank (Table 3.24).

Table 3.23: Total areas of the Areas of Opportunity for renewable energy generation and the percentages occupied by the Areas of Opportunity of the total areas within the subsite groups

AOO	Area (ha)	% occupied by the AOO of the total area within the subsite group		
		subtidal zone	intertidal zone	supratidal zone
Q	358	4%	0%	0%
R	27	18%	4%	0%
S	558	69%	71%	21%
T	1386	53%	17%	0%

Table 3.24: Mean percentages of the total count of SCI species occurring within subsite groups containing Areas of Opportunity for renewable energy generation

Species	% of total count in subsite group				Total
	Q	R	S	T	
Whooper Swan	0%	0%	0%	0%	0%
Light-bellied Brent Goose	1%	0%	15%	4%	20%
Shelduck	8%	0%	3%	0%	12%
Wigeon	8%	2%	9%	0%	19%
Teal	10%	2%	4%	0%	15%
Shoveler	0%	0%	0%	0%	0%
Cormorant	0%	1%	3%	3%	7%
Golden Plover	0%	0%	12%	0%	13%
Grey Plover	0%	0%	9%	2%	11%
Lapwing	1%	1%	7%	0%	9%
Ringed Plover	1%	2%	25%	19%	46%
Curlew	2%	1%	7%	1%	11%
Black-tailed Godwit	1%	0%	2%	0%	4%
Bar-tailed Godwit	0%	0%	2%	2%	4%
Knot	0%	0%	1%	0%	1%
Dunlin	2%	1%	10%	2%	15%
Greenshank	7%	0%	7%	3%	17%
Redshank	3%	1%	4%	1%	9%
Black-headed Gull	1%	1%	3%	1%	6%

3.3.8 Disturbance events and raptor observations

Overall, 95 disturbance events and 68 raptor observations were recorded during the survey, but over 70% of each did not cause any observable disturbance responses (Table 3.25). The most frequent disturbance pressure recorded was pedestrian activity along the shoreline and around 40% of these incidences were observed to cause disturbance responses (Table 3.26). Sparrowhawk and Peregrine were the most frequently recorded raptor species and disturbance impacts were recorded during around half of the observations of these species (Table 3.27). Kestrel and Hen Harrier were also frequently recorded but were rarely observed to cause disturbance impacts.

The Lower Shannon had the highest number of disturbance incidences and the highest overall disturbance score, while the Fergus Estuary had a high overall disturbance score despite a low number of incidences. The Upper Shannon had the highest number of raptor observations, but these did not cause high levels of disturbance as indicated by the disturbance score (Table 3.28). The Lower Shannon also had high numbers of raptor observations but these caused higher levels of disturbance as indicated by the disturbance score (Table 3.28). The areas with highest levels of disturbance incidences were Foynes/Aughinish, Tarbert and Poulnasherry Bay, reflecting concentrations of industrial, port and aquaculture activity. The Foynes/Aughinish area also had high

levels of raptor activity). High levels of disturbance events and impacts were recorded in January and February, but otherwise there was little seasonal variation in disturbance levels (Table 3.29). The highest levels of raptor observations and impacts occurred in August with low levels in spring/early summer (Table 3.29). The numbers of disturbance events recorded during October-February were lower than the number recorded during the same period in the 2010/11 survey, but the latter showed a similar pattern of peak disturbance levels occurring in January and February (Table 3.30). The numbers of raptor observations recorded during October-February were slightly higher than the number recorded during the same period in the 2010/11 survey (Table 3.30).

Table 3.25: Disturbance results summary

Impact score	Disturbance events	Raptor observations
High	0	0
Moderate	3	0
Low	23	20
None	69	48

Table 3.26: Summary of disturbance events and impacts

Type of disturbance	Event	Impacts	Impact score
Human on foot - shoreline	39	16	58
Powered watercraft	18	0	0
Winkle pickers	9	0	0
Other vehicles	9	1	1
Dogs	5	3	9
Human on foot - intertidal aquaculture	5	2	2
Aircraft	4	0	0
Non-powered watercraft	2	1	2
Bait diggers	2	2	6
Aquaculture machinery	1	0	0
Unknown	1	1	1

Table 3.27: Summary of raptor observations and impacts

Species	Observations	Impacts	Impact score
Sparrowhawk	16	8	11
Peregrine	15	6	12
Kestrel	14	2	2
Hen Harrier	14	1	1
Merlin	4	2	4
Buzzard	3	0	0
Osprey	1	1	0
Short-eared Owl	1	0	2

The total for Hen Harrier in this table includes one observation of a bird identified as a Marsh / Hen Harrier.

Table 3.28: Distribution of disturbance events and raptor observations between the waterbody divisions

Waterbody division	Disturbance		Raptors	
	events	score	observations	score
Upper Shannon	12	7	28	5
Fergus Estuary	5	24	5	0
Lower Shannon	56	39	26	25
Mouth of the Shannon	22	9	9	2

Table 3.29: Monthly occurrence of disturbance events and raptor observations

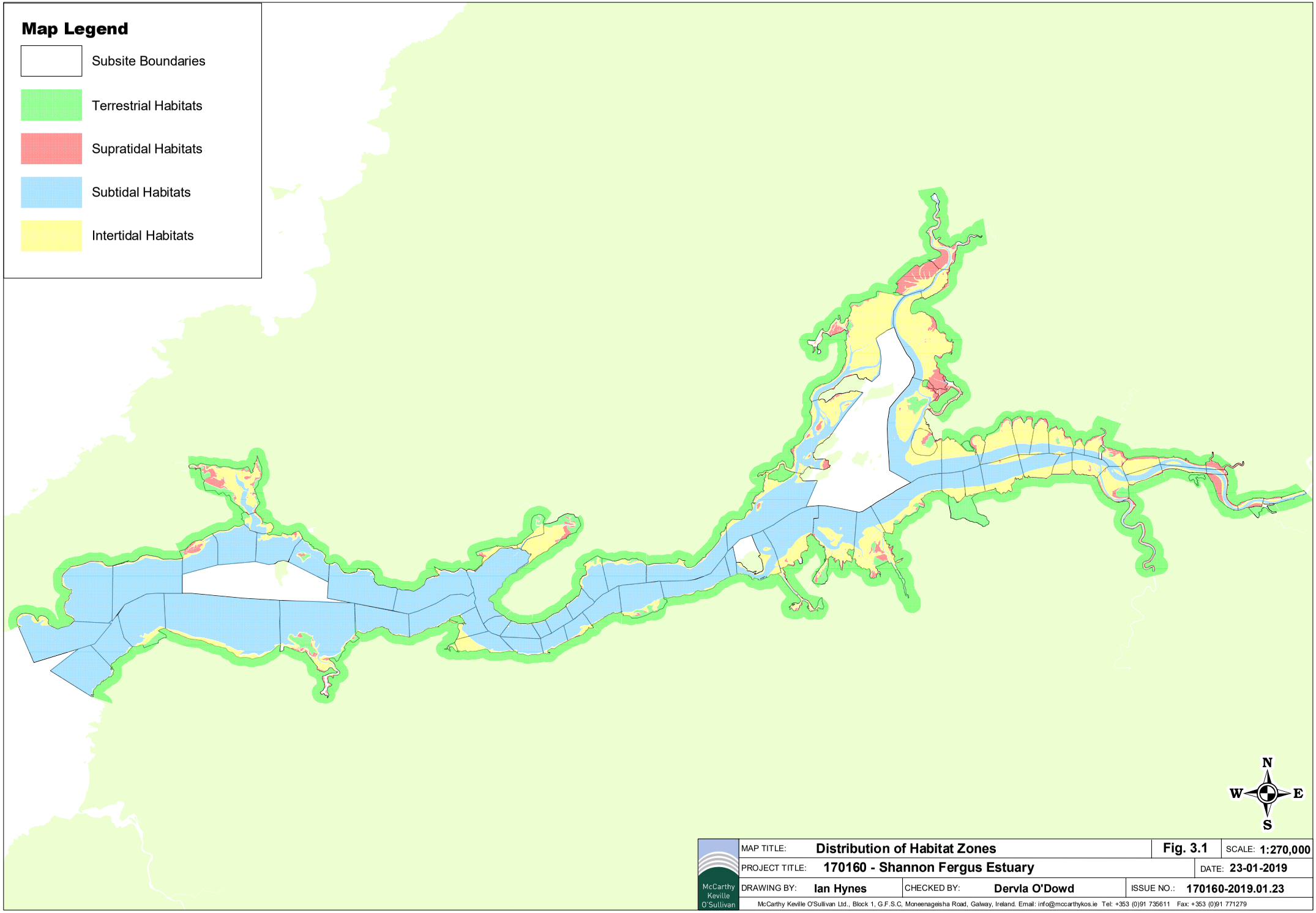
Month	Disturbance		Raptor	
	events	score	observations	score
May	4	0	2	0
Jun	7	4	1	0
Aug	8	3	22	12
Sep	6	0	7	2
Oct	9	5	9	1
Nov	8	2	6	2
Dec	6	8	5	2
Jan	13	32	5	7
Feb	20	23	4	5
Mar	8	2	4	1
Apr	6	0	3	0

Table 3.30: Comparison of the number of disturbance events and raptor observations recorded in 2010/11 and 2017/18

Month	Disturbance events		Raptor observations	
	2010/11	2017/18	2010/11	2017/18
Oct	7	7	2	7
Nov	17	7	4	5
Dec/Jan	15	6	3	5
Jan	47	9	6	5
Feb	21	15	0	4

3.4 Additional Results Included in Appendices

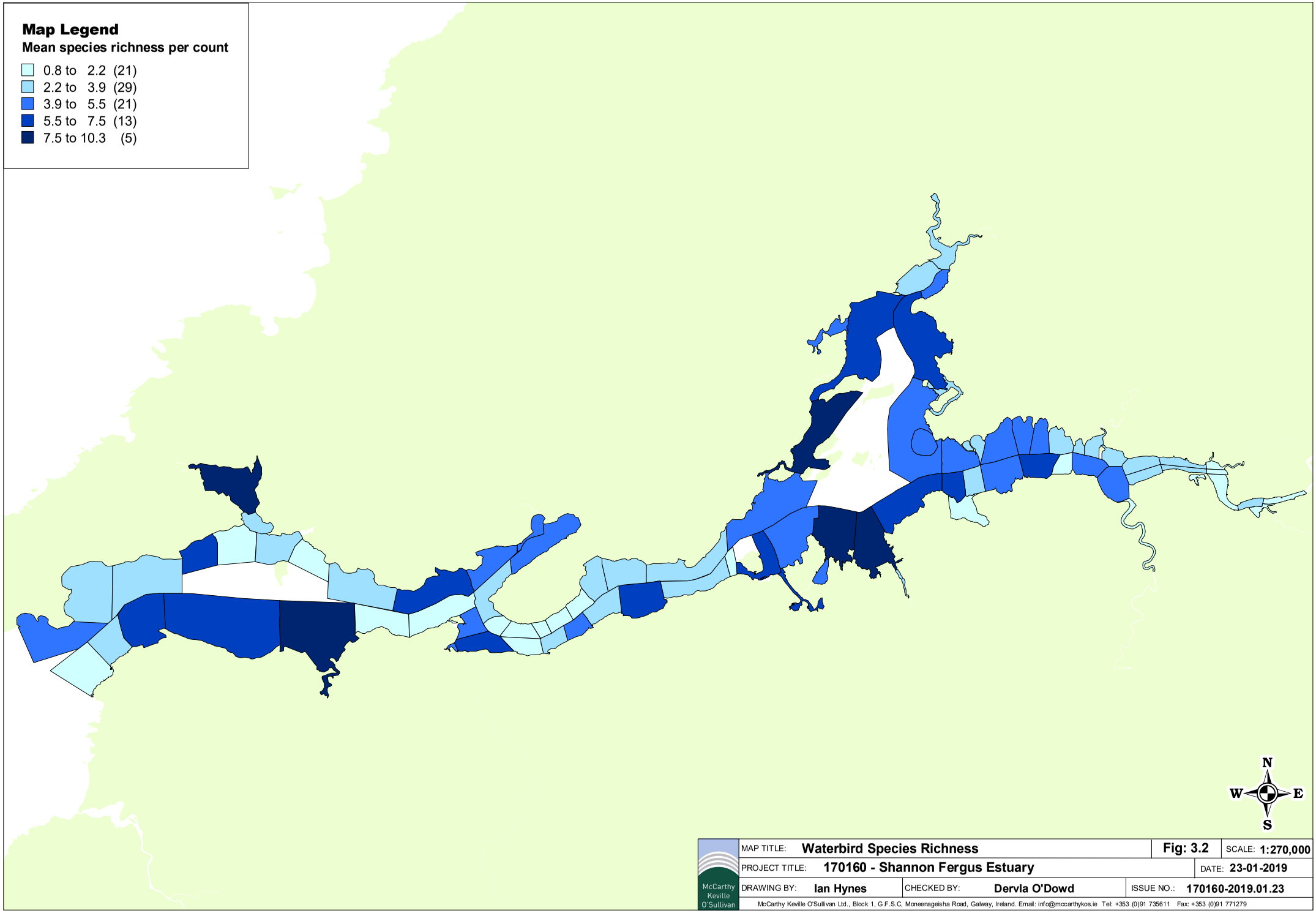
The appendices include the results of more detailed analyses at the subsite scale. Appendix 5 shows the mean and peak waterbird species richness for each subsite. Appendix 6 presents rankings for all the subsites based on the total waterbird numbers and densities recorded across all the high tide and low tide counts. These rankings can be compared with similar rankings that were presented for the 2010/11 survey results in NPWS (2014). Appendix 7 shows the monthly count totals for all the waterbird species recorded and compares them to the international and national importance thresholds. Appendix 8 presents species accounts for all the SCI species. These summarise the numbers and subsite distribution of the species using the same format as used for the 2010/11 survey results in NPWS (2014). Appendix 9 presents subsite accounts. These include a map of the subsite and show the peak count for each SCI species recorded in the subsite and the SCI species for which the subsite was ranked as of very high or high importance in Appendix 6. Appendix 10 presents dot density maps for each SCI species. Separate maps are presented for each count on which the species was recorded. The density of dots represent the relative density in each habitat zone of each subsite. Note that the individual dots do not represent the position of birds within the subsite.



MAP TITLE:	Distribution of Habitat Zones		Fig. 3.1	SCALE: 1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary			DATE: 23-01-2019
DRAWING BY:	Ian Hynes	CHECKED BY:	Dervla O'Dowd	ISSUE NO.: 170160-2019.01.23

McCarthy Keville O'Sullivan

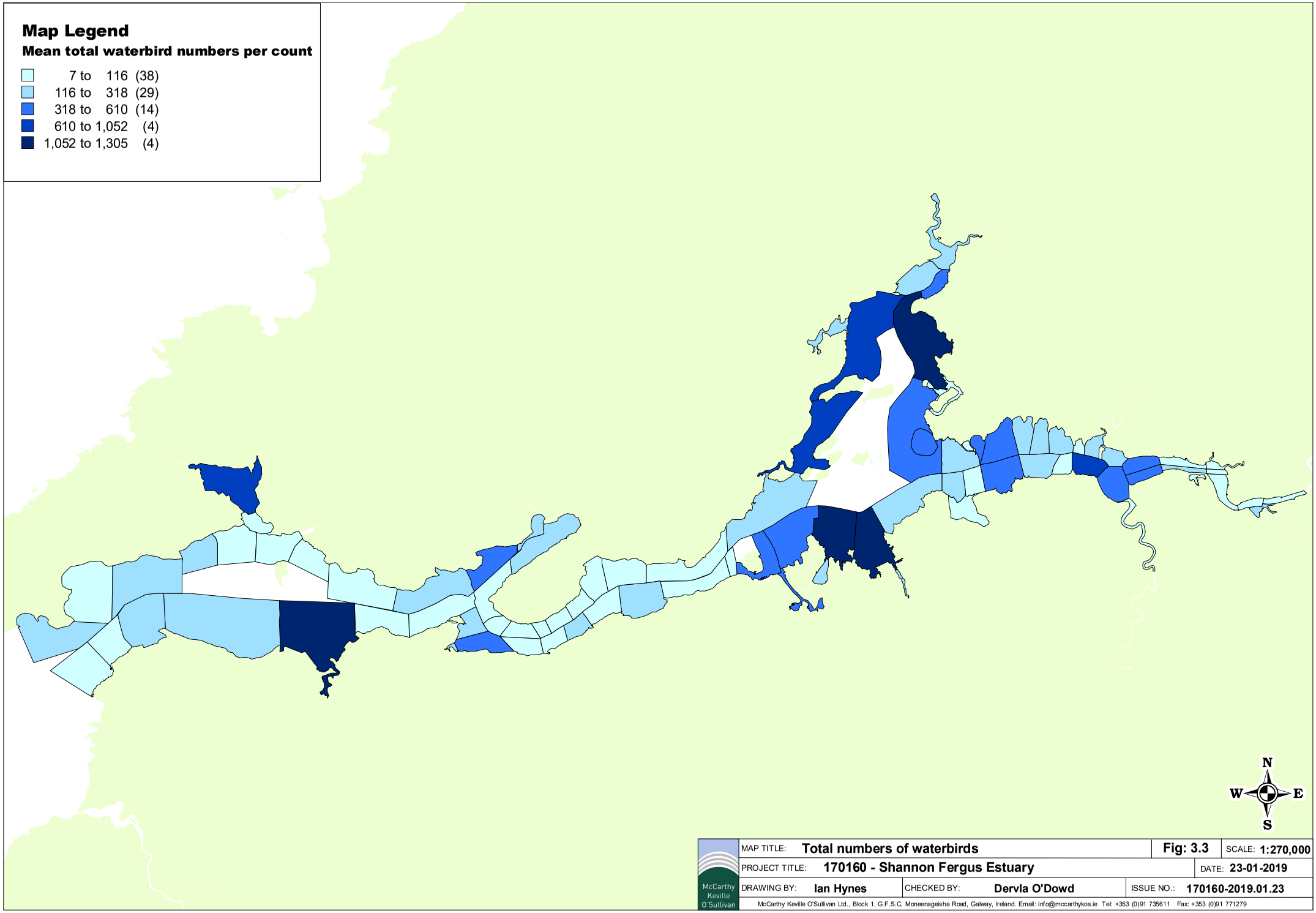
McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE:	Waterbird Species Richness	Fig: 3.2	SCALE:	1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary		DATE:	23-01-2019
DRAWING BY:	Ian Hynes	CHECKED BY: Dervla O'Dowd	ISSUE NO.:	170160-2019.01.23

McCarthy Keville O'Sullivan

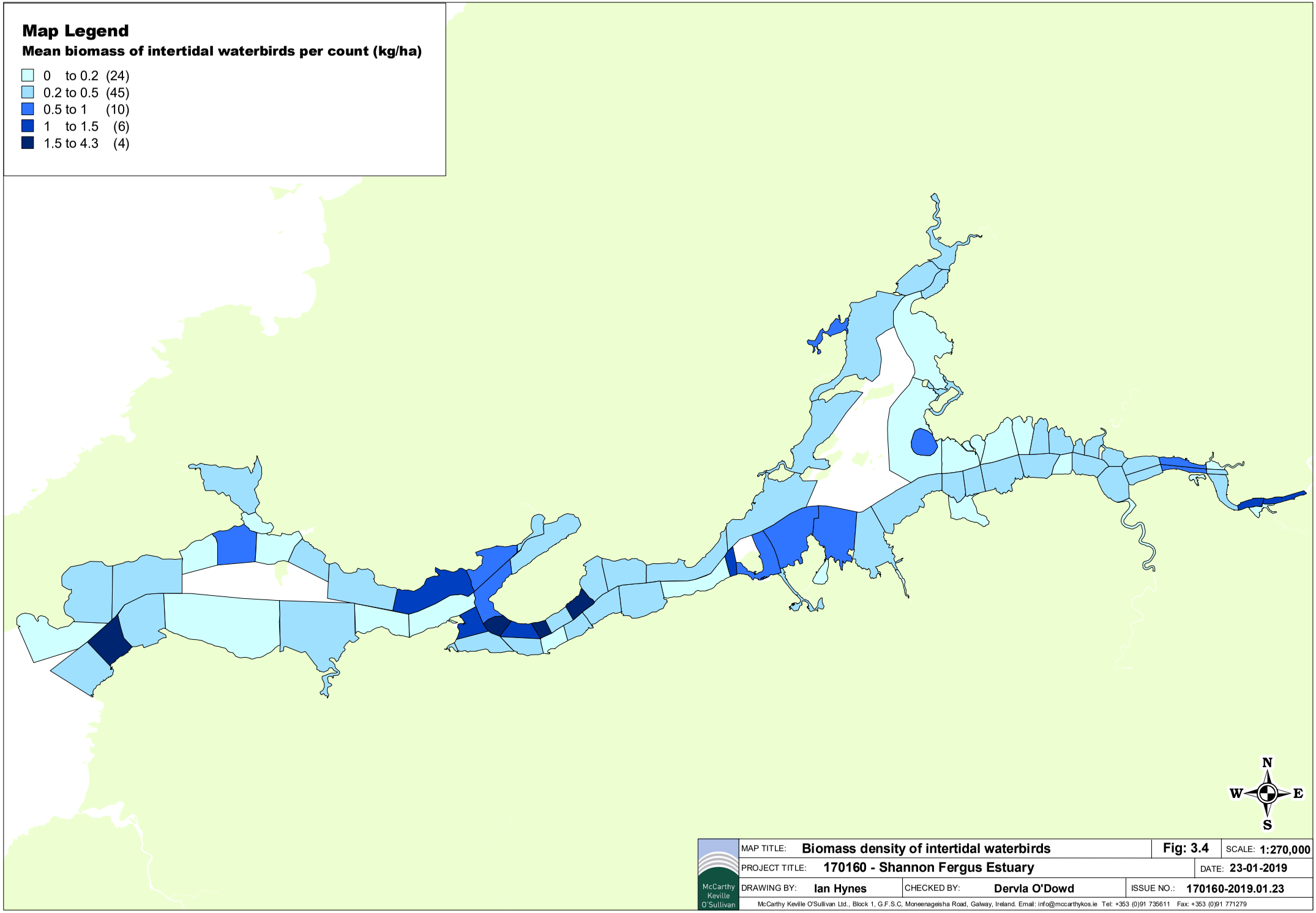
McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE:	Total numbers of waterbirds		Fig: 3.3	SCALE: 1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary			DATE: 23-01-2019
DRAWING BY:	Ian Hynes	CHECKED BY:	Dervla O'Dowd	ISSUE NO.: 170160-2019.01.23

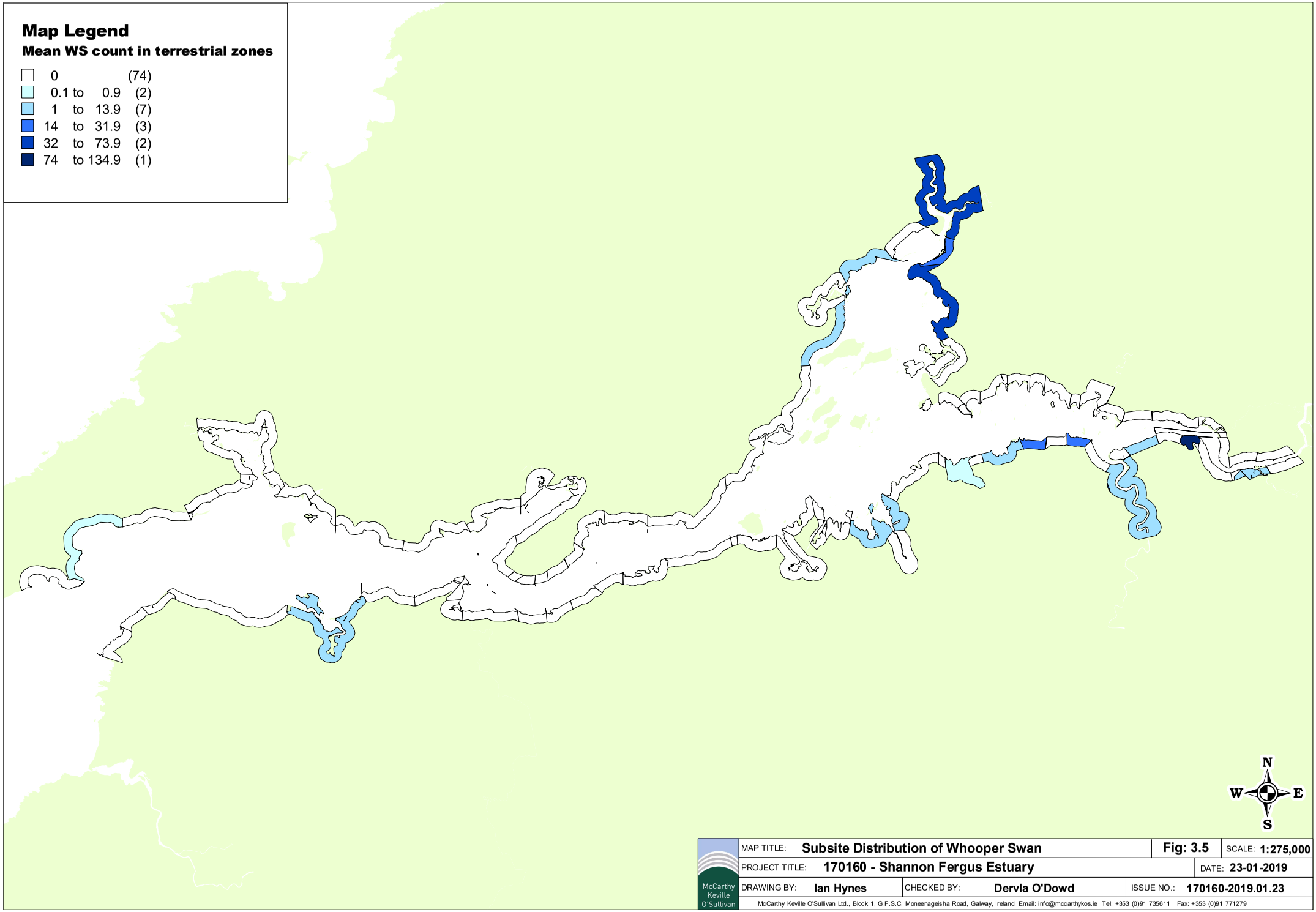
McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



McCarthy Keville O'Sullivan	MAP TITLE: Biomass density of intertidal waterbirds		Fig: 3.4	SCALE: 1:270,000
	PROJECT TITLE: 170160 - Shannon Fergus Estuary			DATE: 23-01-2019
	DRAWING BY: Ian Hynes	CHECKED BY: Dervla O'Dowd		ISSUE NO.: 170160-2019.01.23

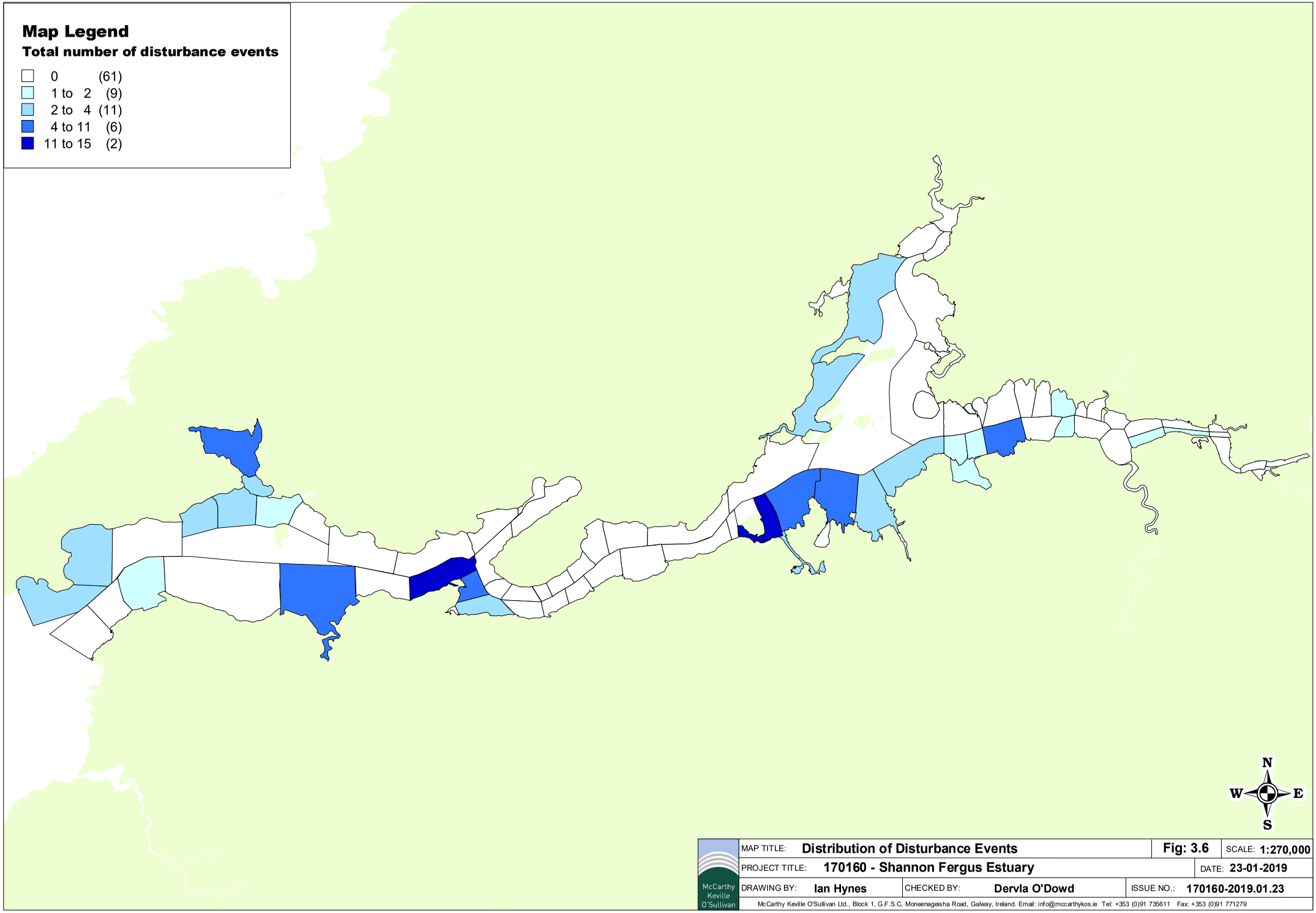
McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE: Subsite Distribution of Whooper Swan		Fig: 3.5	SCALE: 1:275,000
PROJECT TITLE: 170160 - Shannon Fergus Estuary			DATE: 23-01-2019
DRAWING BY: Ian Hynes	CHECKED BY: Dervla O'Dowd		ISSUE NO.: 170160-2019.01.23

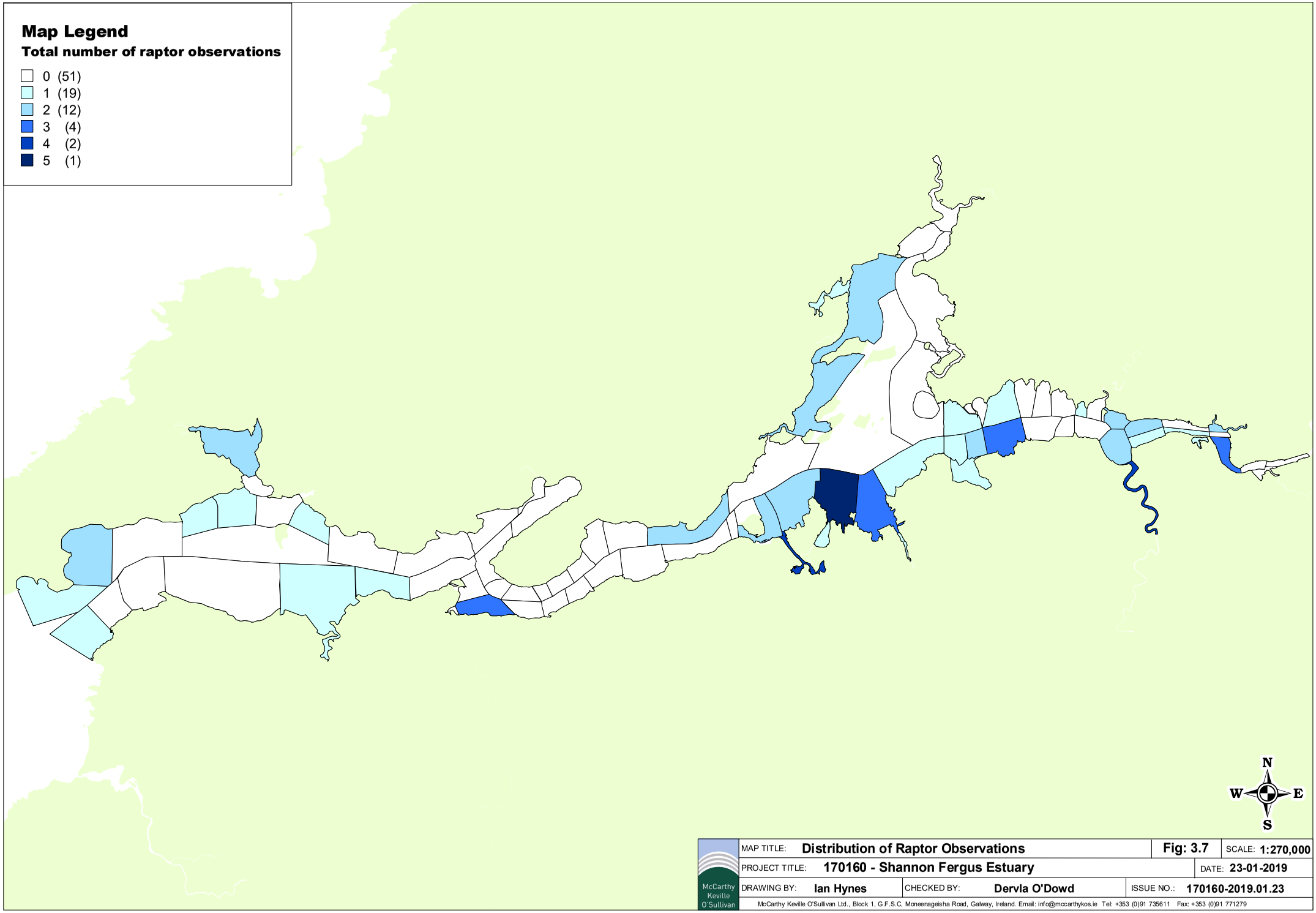
McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



McCarthy Keville O'Sullivan	MAP TITLE: **Distribution of Disturbance Events**		**Fig: 3.6**	SCALE: **1:270,000**
	PROJECT TITLE: **170160 - Shannon Fergus Estuary**			DATE: **23-01-2019**
	DRAWING BY: **Ian Hynes**	CHECKED BY: **Dervla O'Dowd**	ISSUE NO.: **170160-2019.01.23**	

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279



MAP TITLE:	Distribution of Raptor Observations		Fig: 3.7	SCALE: 1:270,000
PROJECT TITLE:	170160 - Shannon Fergus Estuary			DATE: 23-01-2019
DRAWING BY:	Ian Hynes	CHECKED BY:	Dervla O'Dowd	ISSUE NO.: 170160-2019.01.23

McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

4 DISCUSSION

4.1 Coverage

This survey is the most comprehensive waterbird survey of the River Shannon and Fergus Estuaries that has ever been undertaken. Ground-based I-WeBS surveys have only covered a limited number of subsites, while aerial I-WeBS surveys have major limitations in detecting waterbirds. The 2010/11 WSP counts were a major improvement on coverage compared to the I-WeBS counts and included the first low tide counts of the River Shannon and Fergus Estuaries. However, the WSP counts only covered around 70% of the SPA and only covered the October-February period. The present survey included year-round counts, and covered around 85% of the SPA, including more or less full coverage of all the intertidal habitat apart from in the Fergus Estuary.

This survey used a team of 14 counters, compared to the eight counters used for the WSP counts. The additional numbers of birds recorded due to this increased coverage was relatively modest for most of the SCI species. The exceptions were Whooper Swan, Light-bellied Brent Goose, Cormorant and Ringed Plover. The additional Whooper Swan and Cormorant numbers were mainly due to coverage of the lagoon at Muckinish Point and the uppermost section of the Fergus Estuary[1] (Whooper Swan) and Bunlicky Lake (Cormorant). The additional Light-bellied Brent Goose and Ringed Plover numbers were more widely distributed across a number of subsites in the Lower Shannon and Mouth of the Shannon. The additional numbers of regularly occurring non-SCI species recorded were generally higher.

The WSP counts covered the October-February period, which includes the months with the highest overall waterbird abundances (November-February). However, in the present survey, several of the SCI species, occurred in high numbers in August and September with these months holding the peak numbers of Curlew, Black-tailed Godwit, Bar-tailed Godwit, Greenshank and Black-headed Gull as well as several of the regularly occurring non-SCI species. Waterbird numbers remained high into March, when the peak numbers of Light-bellied Brent Goose occurred. They decreased rapidly in April, although peak numbers of Whooper Swan occurred in this month. Numbers were generally very low in May and June, although peak numbers of Cormorant occurred in May.

Overall comparison of the effects of reducing coverage to the WSP levels, indicates that most of the SCI species could be adequately covered by the WSP subsites with targeted additional coverage for Whooper Swan and Cormorant. However, regularly occurring non-SCI species would be less well covered. Counts in September, at least, would be required to pick up the autumn peaks in abundances of several of the SCI species.

4.2 Waterbird numbers and population trends

During the 2017/18 surveys, internationally important numbers of two SCI species (Whooper Swan and Black-tailed Godwit) were recorded, and nationally important numbers of another 15 SCI species were recorded (Table 4.1). The peak Light-bellied Brent Goose count was below the national importance threshold, while Pintail and

[1] This subsite (0H535) has the same code as a WSP subsite but the area covered by the WSP was limited to a short section of Latoon Creek adjacent to the M18 and only comprises around 2% of the total area of the subsite covered in the present surveys. During the WSP counts, no WS were recorded in the limited area of this subsite that was covered.

Scaup were very rare (Table 4.1). There are striking apparent declines in numbers of Light-bellied Brent Goose, Shelduck, Pintail, Scaup, Lapwing, Bar-tailed Godwit, Knot, Dunlin, compared with the mean annual peak counts from the baseline period of 1995/96-1999/00 used for the SPA designation, particularly so given that the latter are based on more limited survey coverage (Table 4.1). For other species, showing little decline, or apparent increases, it is hard to know to what extent the coverage issues affect the comparisons. Also, more than one winter's data would be needed for full assessment of current population levels. In the assessment of population trends over the period 1996/97-2010/11 carried out by NPWS (2014), most of the SCI species were assessed as being declining although there was limited confidence in these trends for most of these species due to the data quality. Comparison of the 2010/11 and 2017/18 counts shows consistent patterns of increases in Wigeon and Greenshank and decreases in Pintail, Cormorant, Black-tailed Godwit, Bar-tailed Godwit and Dunlin. The decreases in Pintail, Bar-tailed Godwit and Dunlin reflect national trends over a similar period (2011/12-2015/16), while Greenshank has shown large increases in Cork Harbour over a similar period (Gittings, 2018).

Table 4.1: Summary of population trend information for the SCI species of the River Shannon and Fergus Estuaries SPA

Species	Peak counts		Importance ratings		Site trends		National trends
	2017/18	1995/96-1999/00	2017/18	1995/96-1999/00	1996/97 - 2010/11	2010/11-2017/18	2011/12-2015/16
Whooper Swan	522	118	N	I	Increase		-6%
Brent Goose	289	494	I		Decline2		-29%
Shelduck	713	1,025	N	N	Decline2		-10%
Wigeon	3,215	3,761	N	N	Decline2	Increase	5%
Teal	2,888	2,260	N	N	Decline2		-6%
Pintail	2	62	N			Decrease	-32%
Shoveler	74	107	N	N			-38%
Scaup	2	102	N				-82%
Cormorant	321	245	N	N	Decline1	Decrease	-5%
Golden Plover	8,321	5,664	N	N	Decline2		-10%
Grey Plover	208	558	N	N	Decline2		-42%
Lapwing	7131	15,126	N	N	Decline2		-14%
Ringed Plover	446	223	N	N	Decline2		-18%
Curlew	2,913	2,396	N	N	Decline2		-2%
Black-tailed Godwit	3,359	2,035	I	I	Decline2	Decrease	3%
Bar-tailed Godwit	213	460	N	N		Decrease	-18%
Knot	1,167	2,015	N	N	Decline2		-49%
Dunlin	6,253	15,131	I	N	Decline2	Decrease	-23%
Greenshank	205	61	N	N	Decline1	Increase	-2%
Redshank	2,747	2,645	N	N	Decline2		-2%
Black-headed Gull	8,268	2,681					

Peak counts and importance ratings for 1995/96-1999/00 and the site trends for 1996/97-2010/11 are taken from NPWS (2014). Note that these 1995/96-1999/00 peak counts are mean annual peak counts across the five winters. The national trends are taken from the online trend summaries (www.birdwatchireland.ie/?tabid=111; accessed 19/12/2018). The site trends for 2010/11-2017/18 are

derived from comparison of the 2010/11 and 2017/18 count data (see text). The 2017/18 peak count for Cormorant shown is the peak for the September-March period to represent the wintering population.

The SPA is also designated for its breeding Cormorant population. The Cormorant breeding colony is located at Bunlicky Lake and the size of the colony was estimated as 93 occupied nests in 2010 (NPWS, unpublished data). The peak count of Cormorant in the 2017/18 survey was in May and this included 282 birds at Bunlicky Lake, while counts in March and April recorded 254 and 219 birds at Bunlicky Lake, respectively. While these numbers will have included some non-breeding birds, these counts suggest that there has been a substantial increase in the breeding population since 2010.

4.3 Seasonal occurrence patterns

Overall waterbird numbers were highest in mid-winter (November-February) and this was reflected in the patterns of occurrence for some of the waterbird species (Wigeon, Teal, Shoveler, Great Crested Grebe, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin and Redshank). However, other species showed different patterns of occurrence. Several species showed peaks in spring and/or autumn, including Whooper Swan (October/November and March), Light-bellied Brent Goose (October and March/April), Mallard (August-October), Ringed Plover (August/September), Black-tailed Godwit (August-October and March-May) and Black-headed Gull (August-September).

Many of these patterns are typical of the species occurrence patterns in Ireland (Crowe, 2005). The late summer/autumn peak in Mallard numbers is considered to represent birds congregating on major wetlands after the breeding season, with the subsequent decline in numbers coinciding with the start of the hunting season (Crowe, 2005). The almost mirror opposite phenology of Shelduck reflects the moult migration of this species to the Waddensee (Wernham et al., 2002), with numbers building up in late winter and with some birds remaining to breed. The spring/autumn peaks of some of the other species may represent passage migration through the River Shannon and Fergus Estuaries. The spring and autumn peaks of Black-tailed Godwit in the River Shannon and Fergus Estuaries have been previously noted by Hutchinson (1979) and may also reflect dispersal of birds inland to feed on fields in mid-winter. A large spring peak of Black-tailed Godwit also occurs in Cork Harbour, although the exact timing varies from year to year (T. Gittings, unpublished data).

The I-WeBS count season from September-March is often used to define the period of interest for wintering waterbirds (e.g., in specifying timing constraints for development work). This has long been known to be an over-simplification. For example, a recent study found that seven wader species occurred in nationally important numbers at the North Bull Island in the summer of 2017 (Cooney, 2017). In the River Shannon and Fergus Estuaries, the present study indicates that the main period of seasonal occurrence (the period in which at least 20% of the annual peak count occurs) extends outside the I-WeBS season for nine SCI species (Light-bellied Brent Goose, Shelduck, Cormorant, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Greenshank, Redshank and Black-headed Gull). In most cases, the only additional month was August and two SCI species (Bar-tailed Godwit and Greenshank) had their peak count in that month. Therefore, it would be advisable to include August in any future monitoring programme. It should also be noted that the present study did not include any counts in July and experience elsewhere suggests that relatively high numbers of many of the SCI species are also likely to occur in this month.

Numbers of most species were low in spring and early summer (April-June). Apart from Light-bellied Brent Goose, which had its peak count in April (see above), the only

SCI species whose main periods of seasonal occurrence extended into these months were Shelduck and Cormorant. In both cases, these occurrence patterns reflect the presence of local breeding populations. Breeding Shelduck are widely distributed throughout the River Shannon and Fergus Estuaries (Balmer et al., 2013) while a large Cormorant breeding colony occurs at Bunlicky Lake in the Upper Shannon. The Cormorant breeding population is listed as a SCI of the River Shannon and Fergus Estuaries SPA, distinct from the Cormorant wintering population. Apart from their annual moult migration, Shelduck populations in Ireland are largely resident (Wenham et al., 2002), so, while the Shelduck SCI of the River Shannon and Fergus Estuaries SPA is listed as a wintering population, the Shelduck present in spring and early summer are effectively part of the same population. Therefore, the occurrences of both Cormorant and Shelduck in spring and summer must be considered in any assessments of these SCI populations. Apart from Light-bellied Brent Goose, Shelduck and Cormorant, most of the other SCI species occurred in very low numbers in spring and early summer. However, Black-tailed Godwit still occurred in nationally important numbers in all three months and Curlew occurred in nationally important numbers in June. Black-tailed Godwit has long been known to have sizeable summering populations on estuaries in southern Ireland and these two species were also the most abundant summering waders on the North Bull Island in 2017 (Cooney, 2017).

The seasonal occurrence patterns of some of the other waterbird species may also be affected by local breeding populations. For example, there are breeding colonies of Common Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull in the outer part of the Shannon Estuary and adjacent coastline (Balmer et al., 2013). The seasonal occurrence patterns of these species may reflect the combined patterns of distinct breeding and wintering populations.

4.4 Distribution patterns

The River Shannon and Fergus Estuaries is a very large site and this is reflected in the numbers of subsites required to cover it fully. Due to the size of the site and the number of subsites, analyses of waterbird distribution at the subsite scale can be difficult to interpret. Groupings of subsites can be used to reduce the numbers of analytical units to manageable sizes and, by having larger units, the effects of stochastic variability in waterbird distribution will be reduced. These groupings can also be designed to reflect features of specific interest for the analysis. In this report, distribution patterns have been analysed at two scales: groupings of sites into waterbody divisions have been used to analyse broad patterns of distribution across the entire site, while Strategic Integrated Framework Plan subsite groups have been used to analyse waterbird distribution in relation to Strategic Development Locations and Areas of Opportunity identified in the Strategic Integrated Framework Plan.

4.4.1 Broad distribution patterns

The four waterbody divisions used for the analysis of broad patterns of distribution reflect variation in the character of the River Shannon and Fergus Estuaries. The Fergus Estuary is a wide estuary with extensive mudflats extending across the full width of the estuary and relatively narrow tidal channels. The Upper Shannon also has extensive mudflats, but has a wide central tidal channel. In the Lower Shannon, the mudflats are mainly limited to discrete bays, with long sections occupied by deep subtidal habitat with very narrow hard substrate intertidal zones. The Mouth of the Shannon is similar to the Lower Shannon but the estuary is much wider and more exposed. These differences are reflected in the percentage of the tidal habitat that is intertidal or supratidal in the four waterbody divisions: 72% in the Fergus Estuary, 60%

in the Lower Shannon, 20% in the Lower Shannon and 13% in the Upper Shannon (note, these percentages do not include tidal habitat outside the subsites).

Total waterbird numbers were highest in the Lower Shannon, but this waterbody division also had the largest total area and shoreline length. At the subsite scale, total waterbird numbers were strongly correlated with intertidal area reflecting the fact that most of the abundant species are strongly associated with intertidal and/or shallow subtidal habitat. Shallow subtidal habitat is the zone immediately below the tideline in which geese and dabbling ducks can feed. It is difficult to map, and was not mapped in this survey, but the relative frequency of intertidal habitat is a good proxy for comparing shallow subtidal habitat between subsites and other groupings.

Perhaps somewhat surprisingly, for many of the estuarine species, numbers in the Fergus Estuary were relatively low even though this zone has the largest area of intertidal habitat. Similarly, the highest densities of intertidal waterbirds and intertidal waterbird biomass occurred in the Lower Shannon and Mouth of the Shannon and were roughly twice as high as the densities in the Upper Shannon and Fergus Estuary. The Fergus Estuary includes a large central area of intertidal habitat and islands that was not covered by the survey, due to the distance from shoreline vantage points. It is possible that this could have affected density estimates if waterbirds tended to feed in this area at low tide, and/or roosted on islands in this area at high tide. However, the fact that the density estimates for the Upper Shannon, which was fully covered by the survey, were very similar, suggests that the differences in density estimates between the upper areas (the Fergus Estuary and Upper Shannon) and lower areas (the Lower Shannon and Mouth of the Shannon) reflect real differences in waterbird distribution patterns. The generally narrower intertidal zones in the Lower Shannon and Mouth of the Shannon would have a higher proportion of tideline edge habitat at low tide and, as many intertidal waterbirds tend to feed close to the tideline, this could be a factor explaining the higher densities in these waterbody divisions.

At the subsite scale, the highest densities of intertidal waterbirds and intertidal biomass occurred in subsites with very small areas of intertidal habitat (< 10 ha). This may be an extreme example of the effect of a high proportion of tideline edge in small areas of intertidal habitat, while there may also be artefacts involved as errors in classifying and mapping intertidal habitat (see Methods) and/or stochastic variation in waterbird occurrences, would have disproportionately large effects on density estimates in these subsites.

4.4.2 Strategic Integrated Framework Plan subsite groups

The Strategic Integrated Framework Plan subsite groups with the highest numbers of SCI waterbirds were those associated with the major areas of intertidal habitat in the Lower Shannon and Mouth of the Shannon (there was only one Strategic Integrated Framework Plan subsite group in the Upper Shannon and none in the Fergus Estuary). These included the subsite groups containing Strategic Development Location F and Area of Opportunity N (Aughinish Island), Strategic Development Location H and Area of Opportunity J (Ballylongford area), Area of Opportunity K (Poulnasherry Bay) and Area of Opportunity S (Tarbert Bay).

The Strategic Development Locations are all located in the terrestrial zone. Therefore, development of these sites will only cause direct waterbird habitat loss where these zones contain fields or other habitats used by waterbirds. The only Strategic Development Location subsite group in which large numbers of waterbirds were recorded in the terrestrial zone was the Strategic Development Location F subsite group. However, only 37% of the terrestrial zone of the subsite group is within the

Strategic Development Location. Development of the Strategic Development Locations could also potentially cause disturbance to waterbirds using adjacent tidal habitats within up to 300 m of the Strategic Development Location. However, disturbance impacts can often be largely eliminated by appropriate design of the development and mitigation of the construction work.

The Areas of Opportunity for aquaculture are all located in tidal habitats. Development of the aquaculture Areas of Opportunity will cause changes to the physical structure of the habitat (such as placement of trestles in the intertidal zone) and these changes, as well as disturbance from husbandry activity, may cause negative impacts to waterbirds (Gittings and O'Donoghue, 2016). There are already varying levels of aquaculture activity in five of the six Areas of Opportunity, with the most extensive development in Poulnasherry Bay (Area of Opportunity K). The only Area of Opportunity with no existing licensed activity is Area U (Clonderlaw Bay). A recent assessment has found potentially significant impacts to some of the SCI species from some of this existing aquaculture activity (Gittings and O'Donoghue, 2017), so further Appropriate Assessment will probably be required for any expansion of aquaculture activity.

The Areas of Opportunity for renewable energy generation are also all located in tidal habitats. Three of these Areas of Opportunity are largely occupied by deep subtidal habitat. As there is only one SCI species dependent on this habitat (Cormorant) and this species does not occur in large numbers in the relevant subsite groups, the potential for impacts on the integrity of the SPA from renewable energy development in these Areas of Opportunity may be limited. However, depending on the type of renewable energy generation proposed, there may be additional species to consider (e.g., from collision risk to waterbird movements through offshore wind turbine developments). Area of Opportunity S is located in Tarbert Bay and contains a high proportion of the intertidal habitat in the relevant subsite group.

A crude assessment of the potential impact from development of the Strategic Development Locations and Areas of Opportunity can be obtained by multiplying the percentages of the River Shannon and Fergus Estuaries populations occurring within the relevant Strategic Development Location or Area of Opportunity subsite groups by the percentage of the relevant habitat zone in the subsite group that occurs within the Strategic Development Location or Area of Opportunity. For example, the Area of Opportunity K subsite group holds 38% of the River Shannon and Fergus Estuaries Knot population, and 85% of the intertidal habitat in the subsite group is within the Area of Opportunity. This suggests that 32% of the River Shannon and Fergus Estuaries Knot population could potentially be affected by development of this Area of Opportunity. However, this is only a very simple preliminary screening analysis and more detailed assessment would be required to take account of the distribution of the species and its habitat within the subsite group (as it is unlikely to be uniformly distributed throughout the relevant habitat zones(s)), the extent of the area to be developed, and the likely response of the species to the development.

4.5 Disturbance

The overall level of disturbance by human activity recorded in the survey was relatively low, given the size of the area surveyed, with a mean of 8.6 disturbance events per count and a mean of 2.4 disturbance events causing an observable impact per count. This may reflect the limited access to the shoreline over large areas of the River Shannon and Fergus Estuaries. The most frequently recorded activity, and the activity with the greatest observed impact, was pedestrian activity along the shoreline. However, the low levels of observed impact associated with more stationary activities

(such as winkle pickers) may not reflect the full disturbance impacts of these activities as birds may have already have been displaced before the activity was observed. The frequency of activities associated with the intertidal zone (winkle picking, bait digging and most aquaculture-related activities) will be underestimated in the dataset as these activities generally only occur at low tide and will not, therefore, have been recorded in the counts carried out at high tide. Recorded disturbance levels were also lower than those recorded in the 2010/11 survey. However, this difference may simply be a statistical artefact (due to sampling effects), and/or may also reflect differences in the interpretation of the disturbance recording instructions by individual surveyors.

Observed disturbance impacts by raptors were slightly less frequent than observed disturbance impacts from human activities (a total of 21 observed disturbance impacts from raptors, compared to 27 observed disturbance impacts from human activities). However, the impact scores indicated that human activities tended to have much larger disturbance effects than raptors (a total score of 79 for human activities compared to 32 for raptors). This partly reflects the generally longer duration of human activities compared to raptor observations (mean duration ratings of 2.8 for human activities, compared to 1.0 for raptor observations). It is also likely that disturbance impacts of human activities were under-recorded (due to displacement of birds before the activity was observed; see above), but this is less likely to be the case for raptor observations. The raptor species observed, and their relative frequency, are typical for a coastal wetland in Ireland. The much higher levels of impact recorded for Sparrowhawk and Peregrine, compared to Hen Harrier and Kestrel, despite similar numbers of observations, reflect differences in their hunting behaviour and prey species.

5 CONCLUSIONS

This survey is the most comprehensive waterbird survey of the River Shannon and Fergus Estuaries that has ever been undertaken, with year-round coverage of around 85% of the SPA. The only previous reasonably comprehensive survey was the WSP in 2010/11, which covered around 70% of the SPA and was limited to the October-February period. Overall comparison of the effects of reducing coverage to the WSP levels, indicates that most of the SCI species could be adequately covered by the WSP subsites with targeted additional coverage for Whooper Swan and Cormorant. Counts in September, at least, would be required to pick up the autumn peaks in abundances of several of the SCI species. However, coverage of regularly occurring non-SCI species would be more significantly affected.

During the survey, internationally important numbers of two SCI species (Whooper Swan and Black-tailed Godwit) were recorded. However, there are striking apparent declines in numbers of Light-bellied Brent Goose, Shelduck, Pintail, Scaup, Lapwing, Bar-tailed Godwit, Knot, Dunlin, compared with the mean annual peak counts from the baseline period of 1995/96-1999/00 used for the SPA designation, particularly so given that the latter are based on more limited survey coverage. Comparison of the 2010/11 and 2017/18 counts shows consistent patterns of increases in Wigeon and Greenshank and decreases in Pintail, Cormorant, Black-tailed Godwit, Bar-tailed Godwit and Dunlin. However, the counts of Cormorant at Bunlicky Lake during this survey suggest that there has been a substantial increase in the Cormorant breeding population since 2010.

Overall seasonal occurrences and broad patterns of distribution for most species were in line with previous surveys of the River Shannon and Fergus Estuaries and general patterns of seasonal occurrence and habitat associations in Ireland. However, somewhat surprisingly, the lower sections of the River Shannon and Fergus Estuaries held much higher densities of intertidal waterbirds than the Fergus Estuary and Upper Shannon, despite the latter having the most extensive areas of intertidal habitat. The Strategic Integrated Framework Plan areas with the highest concentrations of SCI species included Strategic Development Location F and Areas of Opportunity J, K, N and S.

6 REFERENCES

Balmer, D.E., Gillings, S., Caffrey, B.J., Swann, R.L., Downie, I.S. & Fuller, R.J. (2013). Bird Atlas 2007-11: The Breeding and Wintering Birds of Britain and Ireland. BTO, Thetford.

Bibby, C.J., Burgess, N.D., Hill, D.A. & Mustoe, S. (2000). Bird Census Techniques. Academic Press, London.

Cooney, T. (2017). Occurrences of non-breeding waders in summer on the east coast of Ireland. Irish Birds, 10, 475–482.

Crowe, O. (2005). Ireland's Wetlands and Their Waterbirds: Status and Distribution. BirdWatch Ireland, Newcastle, Co. Wicklow.

Cummins, S. & Crowe, O. (2011). Collection of Baseline Waterbird Data for Irish Coastal Special Protection Areas 2010/2011. A report commissioned by the National Parks and Wildlife Service, and prepared by BirdWatch Ireland.

Cutts, N., Hemmingway, K. & Spencer, J. (2013). Waterbird Disturbance Mitigation Toolkit: Informing Estuarine Planning & Construction Projects. Version 3.2, March 2013.

Gittings, T. & O'Donoghue, P.D. (2016). The effects of intertidal oyster culture on the spatial distribution of waterbirds. Wader Study, 123, 226–239.

Gittings, T. & O'Donoghue, P.D. (2018). River Shannon and Fergus Estuaries SPA: Appropriate Assessment of Aquaculture.

Gittings, T. (2018). Cork Harbour I-Webs Counts: Summary Report for the winter of 2017/18. Unpublished report (www.gittings.ie/downloads).

Hutchinson, C.D. (1979). Ireland's Wetlands and Their Birds. Irish Wildbird Conservancy, Dublin.

Lewis, L., Burke, B. & Crowe, O. (2016). Irish Wetland Bird Survey: Results of Waterbird Monitoring in Ireland in 2014/15.

Lewis, L.J. & Tierney, T.D. (2014). Low Tide Waterbird Surveys: Survey Methods and Guidance Notes. Irish Wildlife Manuals, No. 80. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langston, R.H.W. & Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation, 156, 53–61.

Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (2002). The Migration Atlas: Movements of the Birds of Britain and Ireland. A&C Black.