BTO RESEARCH REPORT 746

Analysis of waterbird population trends for Northern Ireland's sea loughs: assessing the potential impacts of aquaculture and disturbance.

Part 2 – Belfast Lough and Lough Foyle

Katherine Booth Jones, Neil Calbrade & Graham Austin

BTO
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Part 2 – Belfast Lough and Lough Foyle

Authors

Katherine Booth Jones, Neil Calbrade, Graham Austin

Report of work carried out by the British Trust for Ornithology

on behalf of NIEA and the DAERA Marine and Fisheries Division

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Executive Summary

1. Belfast Lough and Lough Foyle are large sea loughs on the east and north coasts of Northern Ireland, respectively. Both hold Special Protection Area (SPA) and Ramsar Convention designations for their importance to wetland biodiversity and host nationally and internationally important populations of waterbirds. In particular, Belfast Lough is internationally important for Great Crested Grebe, Black-tailed & Bar-tailed Godwit and Redshank, while Lough Foyle is internationally important for Light-bellied Brent Goose.

2. The Wetland Bird Survey (WeBS) is a long-running survey recording numbers of all waterbird species on wetland sites throughout the UK. WeBS 'Core Counts' record waterbird numbers, monthly throughout the year, at high tide for seven and ten count sectors covering Belfast Lough and Lough Foyle, respectively. WeBS 'LowTide Counts' record waterbird numbers, monthly over the winter period (November to February) at low tide for 33 sectors for Belfast Lough. Belfast Lough is exceptional in that LowTide Counts are undertaken annually. These data can be used to assess population trends in different parts of the loughs. Lough Foyle is typical in that LowTide Counts are only undertaken intermittently (approximately every sixth winter).

3. This study is a follow-up to the first sector-level analysis of sea-lough WeBS data in Northern Ireland, on Carlingford Lough and Strangford Lough (Part 1), which were chosen as sites that host aquaculture activities. The report aims to improve understanding of the fluctuations in numbers of waterbirds within the sites and inform the consenting of operations and assessment of development plans on these SPAs and provide an initial insight into the potential impact of sub-tidal mussel aquaculture on trends in Belfast Lough (no aquaculture was present on the Northern Irish shore of Lough Foyle).

4. Smoothed population trends were generated using data from the period 2001/02 to 2018/19 and assessed for the most recent winter period for each of the 35 waterbird species, consisting of the internationally and nationally important waterbird species that are features of the Lough Foyle or Belfast Lough SPAs (20 and four, respectively), plus additional species that make up the 28 waterbird feature species of Strangford Lough, to facilitate comparisons with Part 1 of this report. For most species there were sufficient numbers recorded on at least some sectors to assess sector trends, relative importance in relation to the loughs' populations and whether the proportion of the entire loughs' populations supported by each sector had increased or decreased significantly. These trend analyses were undertaken for both high-tide and low tide counts for Belfast Lough. In the case of Lough Foyle trend analyses could only be undertaken using high-tide counts because the intermittent nature of low tide coverage is unsuitable for such an analysis.

5. To examine the potential impact of sub-tidal mussel cultivation on waterbird populations in Belfast Lough, waterbird population trends in sectors that overlapped with active licensed mussel beds were examined. Potential changes in population trends over time in relation to annual mussel yield as a measure of disturbance activity, and divergence from the trend of the overall lough were used to indicate potential impact of aquaculture on bird trends in the relevant sectors.

6. Sectors between Black Brae and Donnybrewer (04411) and Roe and Balls Point (04415) in Lough Foyle tended to be the most important for waterbirds in Lough Foyle, and trends were generally positive in this area for both waterfowl and waders, with the exception of Faughanvale to

Ballykelly (04413). This sector experienced declines in 10 of the 11 species for which trends could be generated, including Light-bellied Brent Goose which is a feature of the SPA and of international importance in Lough Foyle. This species generally increased in Northern Ireland during the same period, therefore declines at Lough Foyle may indicate a site-specific issue.

7. Sector-level trends for waterbirds in Belfast Lough Core Counts showed interesting patterns of increase and decrease between different species, which were largely consistent with Low Tide trends. Belfast Lough - BP Pools and Victoria Park (01223) and Belfast Lough - Whiteabbey to River Lagan (01422), contained the vast majority of dabbling ducks, shelduck, swans and geese.

8. Declines in Oystercatcher, Golden Plover, Lapwing, Turnstone, Curlew and Redshank across multiple sectors of Belfast Lough, paired with Northern Ireland-wide declines, suggested that there are widespread changes external to the lough that are impacting Belfast Lough's populations of wintering waders. This is of particular concern to numbers of Redshank, which are an SPA feature. Meanwhile, the proportion of Northern Irish wintering Eider found in Belfast Lough increased, and trends were generally positive, although Belfast Lough - Whiteabbey to River Lagan (01422) and Belfast Lough - Kinnegar to Greys Point (01424) showed evidence of decline. These sectors also showed declines in Red-breasted Merganser, although this species maintained a steady population in Belfast Lough over the study period, against Northern Ireland-wide declines.

9. The strong sector-level decline in Eider and Red-breasted Merganser numbers in the vicinity of areas of active mussel aquaculture in contrast to the overall site-level trend is of concern. Despite this, little convincing evidence of the impact of sub-tidal mussel aquaculture was observed on diving waterbird species in sectors that overlapped the licensed areas. However, areas of overlap were low and annual mussel yield may not be a good proxy for levels of activity in the count sectors.

10. To build on the initial findings of this report we recommend developing a more targeted field-based study to assess the potential impact of disturbance associated with aquaculture activity on waterbirds. Data collection describing how the numbers and behaviour (e.g. feeding, diving, resting) of waterbirds vary through the tidal cycle would be of particular importance, as the tide has a strong influence on both the behaviour of waterbirds in estuaries, and also influences the husbandry activity in intertidal oyster trestle areas.

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1. INTRODUCTION

1.1. Background

The five sea loughs of Northern Ireland (Carlingford, Strangford, Belfast, Larne and Lough Foyle) all hold Special Protection Area (SPA) and Ramsar Convention designations for their importance to wetland biodiversity. In addition, all the sea loughs also contain Areas of Special Scientific Interest (ASSIs), protected areas that aim to preserve the best of Northern Ireland's wildlife and geology and are safeguarded under The Environment (Northern Ireland) Order 2002 (Part IV). Belfast Lough is situated at the mouth of the River Lagan and hosts Belfast's busy port. It has two SPA designations, one for its coastline and another for its marine area below the mean low water mark. The lough is Northern Ireland's fourth most important site in terms of total wintering waterbird numbers, supporting approximately 16,000 individuals (Frost *et al.* 2021). The inner lough largely consists of tidal mudflats and lagoons, while its outer stretches are characterised by rocky shores and small sandy bays. Belfast Lough is particularly significant for its internationally important wintering populations of (Common) Redshank *Tringa totanus*, Bar-tailed *Limosa lapponica* and Black-tailed *L. limosa* Godwits. The open water SPA supports internationally important populations of Great Crested Grebe *Podiceps cristatus* and nationally important populations of (Great) Cormorant *Phalacrocorax carbo*, (Common) Shelduck *Tadorna tadorna*, (Greater) Scaup *Aythya marila*, (Common) Eider *Somateria mollissima*, (Common) Goldeneye *Bucephala clangula* and Red-breasted Merganser *Mergus serrator*. Situated between Co. Londonderry and Co. Donegal, Lough Foyle includes the estuaries of the River Foyle, Faughan and Roe. The lough is shallow and contains extensive intertidal mudflats and associated habitats that support approximately 33,000 individuals (five-year average of peak counts, Frost *et al*. 2020), making it Northern Ireland's third most important site for wintering waterbirds. The SPA is designated for internationally important populations of Whooper Swan *Cygnus cygnus*, Light-bellied Brent Goose *Branta bernicla hrota*, (European) Golden Plover *Pluvialis apricaria* and Bar-tailed Godwit, as well as supporting nationally important populations of 17 additional species (DAERA, 2015, Table 1).

In addition to their importance to wintering waterbirds, Northern Ireland's sea loughs are also important sites in terms of human use. Recreational activities such as boating, wildfowling and dog-walking have the potential to cause disturbance, particularly to winter birds feeding or roosting, while some activities may also modify the habitat or ecosystem, such as shellfish or seaweed harvesting and gravel extraction. One of the most commercially important and potentially impactful uses of the sea loughs is aquaculture.

Aquaculture is a growing industry in Northern Ireland; in 2018 the two key shellfish species (Blue Mussel *Mytilus edulis*, and Pacific Oysters *Crassostrea gigas*) were valued at over £11 million (DAERA, 2020). The five major sea loughs in Northern Ireland host aquaculture activities, cultivating predominantly mussels, but also oysters, scallops and clams. However, in the case of Lough Foyle licenced shellfish aquaculture sites occur only on the Republic of Ireland shore. Belfast Lough contains 21 licenced areas of bottom grown mussel aquaculture, of which six were active in 2018/19. The key responsibility of the Department of Agriculture, Environment and Rural Affairs' (DAERA's) Marine and Fisheries Division is to ensure the protection of Northern Ireland's marine and coastal areas while promoting their sustainable use in industries such as shellfish aquaculture.

The BTO have been requested to provide DAERA with an analysis of sector-level WeBS data for sea loughs in Northern Ireland. Work on this began in 2019 with Carlingford and Strangford Loughs (Part 1) and continues here for Belfast Lough and Lough Foyle (Part 2), with a following report documenting Larne Lough, Killough Harbour and Dundrum Bay (Part 3). The aim of these reports is to reveal how key species of waterbirds in the largest sea loughs are distributed within the SPAs, and to identity whether the populations are increasing or decreasing in the sectors relative to the SPAs as a whole. The methodology for this follows similar reports for Natural England for estuaries in Britain (Austin *et al.*, 2008; Ross-Smith *et al.*, 2013, 2015). We also examine the evidence for impacts of active bottom culture mussel aquaculture in Belfast Lough by comparing waterbird population trends in sectors with mussel aquaculture to trends at the site level. This will enable DAERA to more fully assess the potential impact of existing and future aquaculture (and other developments) on SPA populations.

1.2. Objectives

The aim of this project is to produce a sector-level analysis of WeBS data, for Belfast Lough and Lough Foyle. This will improve understanding of the fluctuations in numbers of waterbirds within the sites and inform the consenting of operations and assessment of development plans on these SPAs. The four main objectives of this work are to:

- Identify the abundance trends for the short (5 years), medium (10 years) and long (15 years) term for 35 waterbird species, consisting of the internationally and nationally waterbird species that are features of the Lough Foyle and Belfast Lough SPAs (20 and four, respectively, Table 1), plus additional species that make up the 28 waterbird feature species of Strangford Lough, to facilitate comparisons with Part 1 of this report. Trends will be calculated from high- and low tide counts for Belfast Lough, and high-tide counts for Lough Foyle. Sector-level trends will be compared with trends for the respective sites as a whole. The work will identify those WeBS sectors where large numbers of species are declining or increasing contrary to or more rapidly than on the site as a whole.

- Identify WeBS sectors that support important proportions of the species on the site.

- Where possible, identify potential drivers of change in the sectors where changes in waterbirds population are observed, such as changes in food supply/suitable roosting/feeding habitats.

- Identify sectors where changes in waterbird numbers overlap with shellfish aquaculture farms to infer whether there might be short, medium- or long-term impacts of aquaculture disturbance on waterbird trends.

Table 1 Species List: Species considered for sector-level analysis match those of Part 1 of this report, plus additional species that are features of Lough Foyle and Belfast Lough. Therefore, analysis will be carried out on up to 35 species, listed below, as the data allow. Blue ticks = internationally important populations, green ticks = populations important in all-Ireland context. ✓[a] = cited waterbird assemblage element.

	Lough Foyle			Belfast Lough				
Species	**SPA***	**ASSI***	**Number of sectors for which High Tide sector-level analysis is available**	**SPA Open Water***	**SPA***	**ASSI (Inner and Outer Belfast Lough)***	**Number of sectors for which Core sector-level analysis is available**	**Low tide sector-level analysis viable**
Mute Swan		✓	1				1	1
Whooper Swan	✓	✓	5				0	0
Bewick's Swan	✓		0				0	0
Greylag Goose	✓[a]	✓	2				0	0
Light-bellied Brent Goose	✓	✓	6				2	2
Common Shelduck	✓[a]	✓	3			✓	2	4
Eurasian Wigeon	✓[a]	✓	4				2	3
Eurasian Teal	✓[a]	✓	6				3	3
Mallard	✓[a]	✓	6			✓	4	8
Northern Pintail			1				0	0
Common Pochard			0				0	0
Common Eider	✓[a]	✓	2			✓	7	7
Red-breasted Merganser	✓[a]		0			✓	4	17
Greater Scaup			0			✓	3	3
Common Goldeneye			0			✓	4	4
Great Crested Grebe	✓[a]	✓	1	✓		✓	6	10
Eurasian Coot			0				1	1
Great Cormorant	✓[a]	✓	2			✓	6	5
Eurasian Oystercatcher	✓[a]	✓	10			✓	7	29

Common Ringed Plover			2			✓	5	5
Eurasian Golden Plover	✓	✓	5				1	0
Purple Sandpiper			0				0	0
Grey Plover			0				0	0
Northern Lapwing	✓[a]	✓	9			✓	5	9
Dunlin	✓[a]	✓	9			✓	6	10
Sanderling			4				0	0
Red Knot	✓[a]	✓	3			✓	2	1
Black-tailed Godwit			1		✓	✓	4	8
Bar-tailed Godwit	✓	✓	9		✓		4	2
Ruddy Turnstone			0			✓	7	12
Eurasian Curlew	✓[a]	✓	10			✓	6	11
Common Greenshank			0				0	0
Common Redshank	✓[a]	✓	7		✓	✓	7	20
Slavonian Grebe			0				0	0
Red-throated Diver			0				0	0

* 'All ornithological SPA features_finalised_Oct 2014.xslx' obtained from NIEA, 10th February 2020.

2. Methodology

2.1. Waterbird data

WeBS is responsible for a number of monthly or periodic monitoring schemes including the WeBS Core Counts, the WeBS LowTide Counts and the Non-Estuarine Waterbird Survey. This report is based on data collected by the Core Count and LowTide Count surveys.

The WeBS Core Count scheme is a long-running survey that monitors waterbird numbers on sites throughout the UK via monthly site visits, when numbers of all waterbird species are recorded (Frost *et al.,* 2020). The primary aim of the Core Count scheme is to provide abundance estimate for whole sites which then feed into population estimates, species indices and multispecies indicators. On coastal sites, WeBS Core Count visits are normally undertaken over high tide, the nominal date for survey visits chosen to correspond with spring high-tides when waterbirds are concentrated near the high-water mark or concentrated into high-tide roosts facilitating accurate counting. On large sites, such as Belfast Lough and Lough Foyle, where it is not feasible, or indeed desirable, to make a single count for the entire site, synchronous counts of smaller count sectors are undertaken by teams of volunteer counters. These sector counts are routinely summed to give the overall site total, and during this process the completeness of the overall count assessed. This is required because all sectors are not necessarily counted on all occasions. This completeness assessment is species-specific because the absence of data from a given sector would not be expected to affect the overall total equally for all species. Furthermore, completeness is assessed on a month by month, year by year basis using algorithms that allow for both seasonal and long-term trends in site usage. Thus a consolidated count for a site composed of multiple sectors is considered complete when those sectors counted on the month in question would be expected to hold at least 75% of the site total for the species in question for the season and year in question. Whilst the division of large sites into sectors has evolved principally in response to the practicality of undertaking counts, the divisions between sectors typically follow distinctive features of the environment. Thus, an analysis of waterbird trends on the individual sectors can inform in a biologically meaningful manner.

Seven constituent and extant WeBS Core Count sectors of Belfast Lough (Figures 2.1.i and 2.1.ii) and ten sectors of Lough Foyle (Figures 2.1.iii & 2.1.iv) were considered in this report. However, it must be noted that the sectors north of Roe and Ball's Point in Lough Foyle were only added to the site in 2007/08 and, before that, this area was not covered. Resulting long-term trends for these sectors should therefore be viewed with caution. This has particular relevance for the trends of Sanderling *Calidris alba* (section 4.3.21) and Bar-tailed Godwit (section 4.3.24) in the site.

The WeBS LowTide scheme has been running since the winter of 1992/93 and as the name indicates, counts are undertaken over low tide. The objective of the LowTide Count scheme is to quantify the within-site distribution of species over the low tide period as so identify important habitat/areas for feeding waterbirds. Counts are organised in a similar manner to those undertaken for the Core Count scheme other than that monthly counts are restricted to the main winter period (November to February inclusive). Unlike Core Counts there is less emphasis on synchronicity of counts across a site as these counts are not typically summed to derive abundance estimates for the overall site. Indeed, if a given flock of waterbirds is recorded on several sectors during the course of a visit this

does not compromise the principal aims of the LowTide Counts indicating as it does that all those sectors are important to the birds. It is not feasible to count all sites in all winters and typically the LowTide Count scheme aims to cover about 10 to 20 estuaries UK-wide each winter and ensure any given site is included at least once every five to ten years. Unfortunately, this means that LowTide Counts cannot normally be used to derive sector level trends for the type of analysis being undertaken here. However, exceptionally, the LowTide Count scheme has run annually across the full time period in Belfast Lough. Consequently, for Belfast Lough we are able to consider waterbird trends at the sector level for both high-tide and low tide. There have been a number of occasions when LowTide Count sections for Belfast Lough have been redefined and this adds complexity to the interpretation of trends as unlike Core Count sectors these changes have not resulted from direct splitting or combining of previous sections while honouring existing boundaries. Fortunately, the majority of these changes occurred prior to the period being considered by this report. There are, however, a number of sectors included where a full time-series of counts is not available.

Thirty-three constituent and extant WeBS LowTide Count sectors of Belfast Lough (Figure 2.1.iv) were considered in this report.

Figure 2.1.i: Structural hierarchy of WeBS Core Count sectors in Belfast Lough.

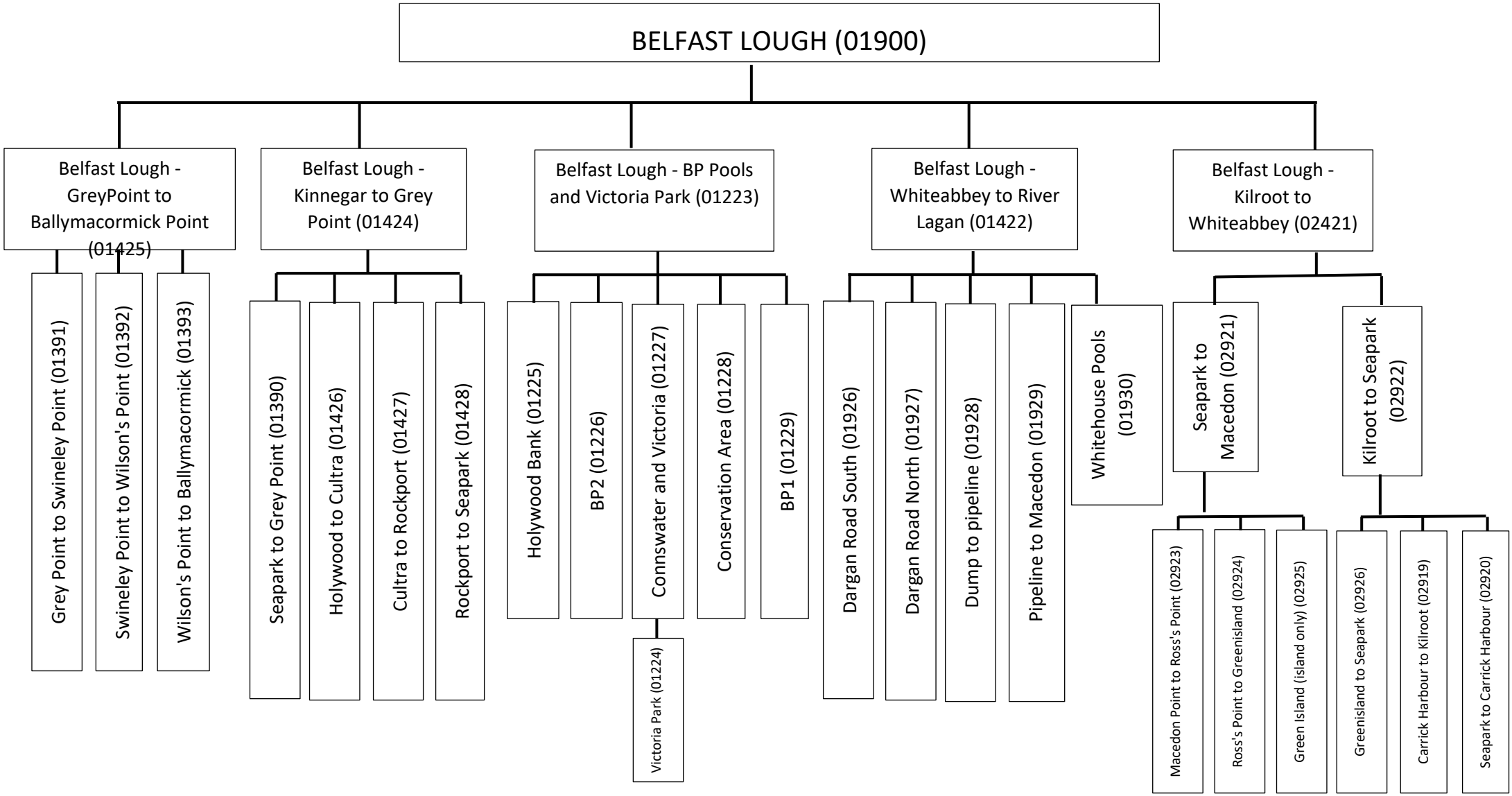


Figure 2.1.ii: Locations of each Core Count sector in Belfast Lough. These WeBS sectors represent the finest spatial scale over which data are currently collected (see Figure 2.1 i).

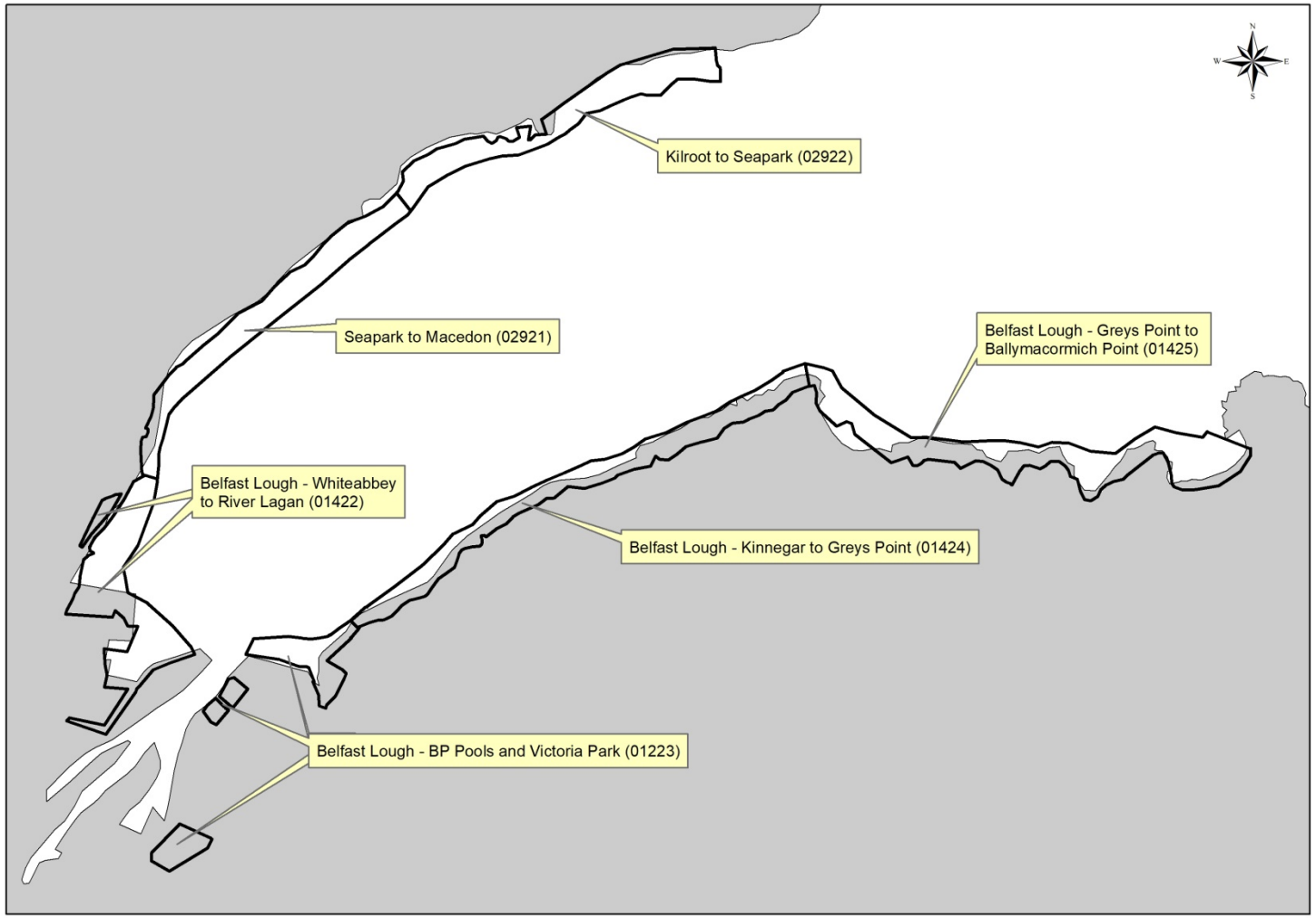


Figure 2.1.iii: Structural hierarchy of WeBS LowTide count sectors on Belfast Lough. Sectors at the finest spatial scale are primarily considered for this report. Sectors in grey are no longer counted.

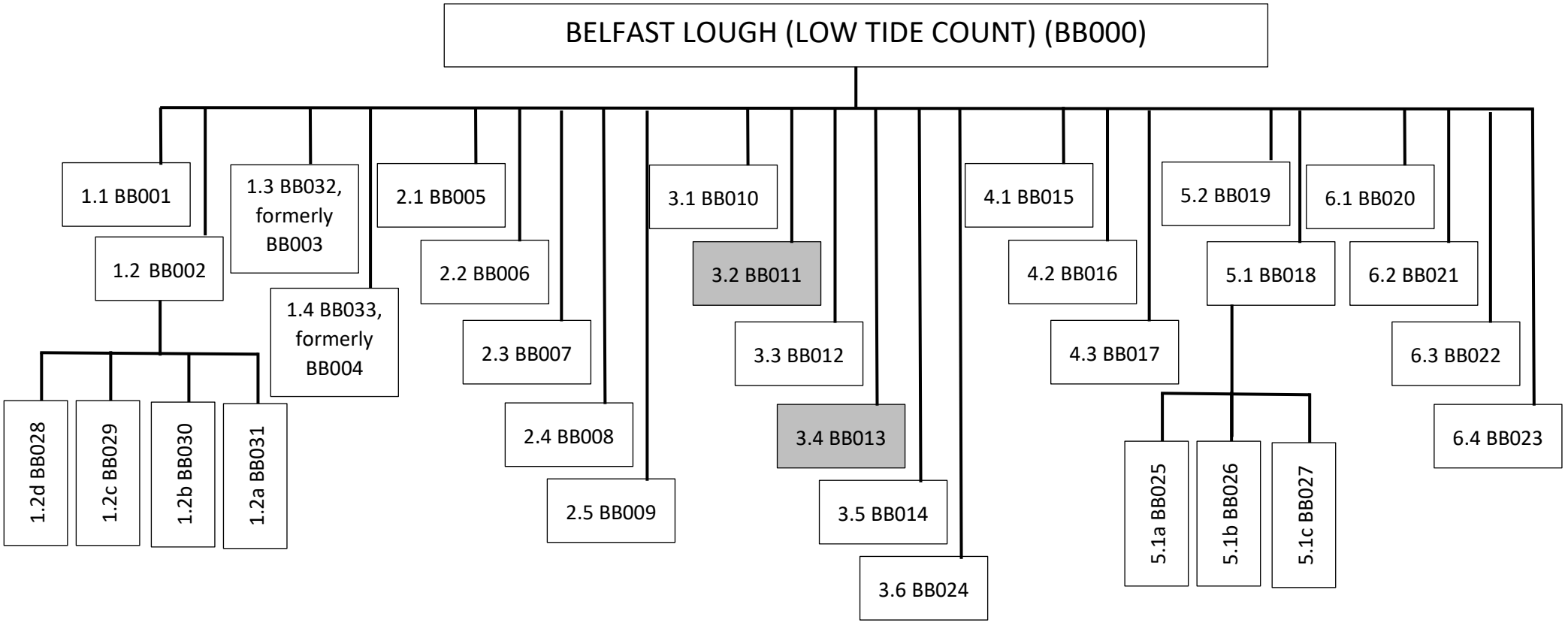


Figure 2.1 iv: Locations of each Low Tide Count sector in Belfast Lough. These WeBS sectors are the most recent subdivisions for WeBS counts in Belfast Lough, and represent the finest spatial scale over which data are collected (see Figure 2.1 iii).

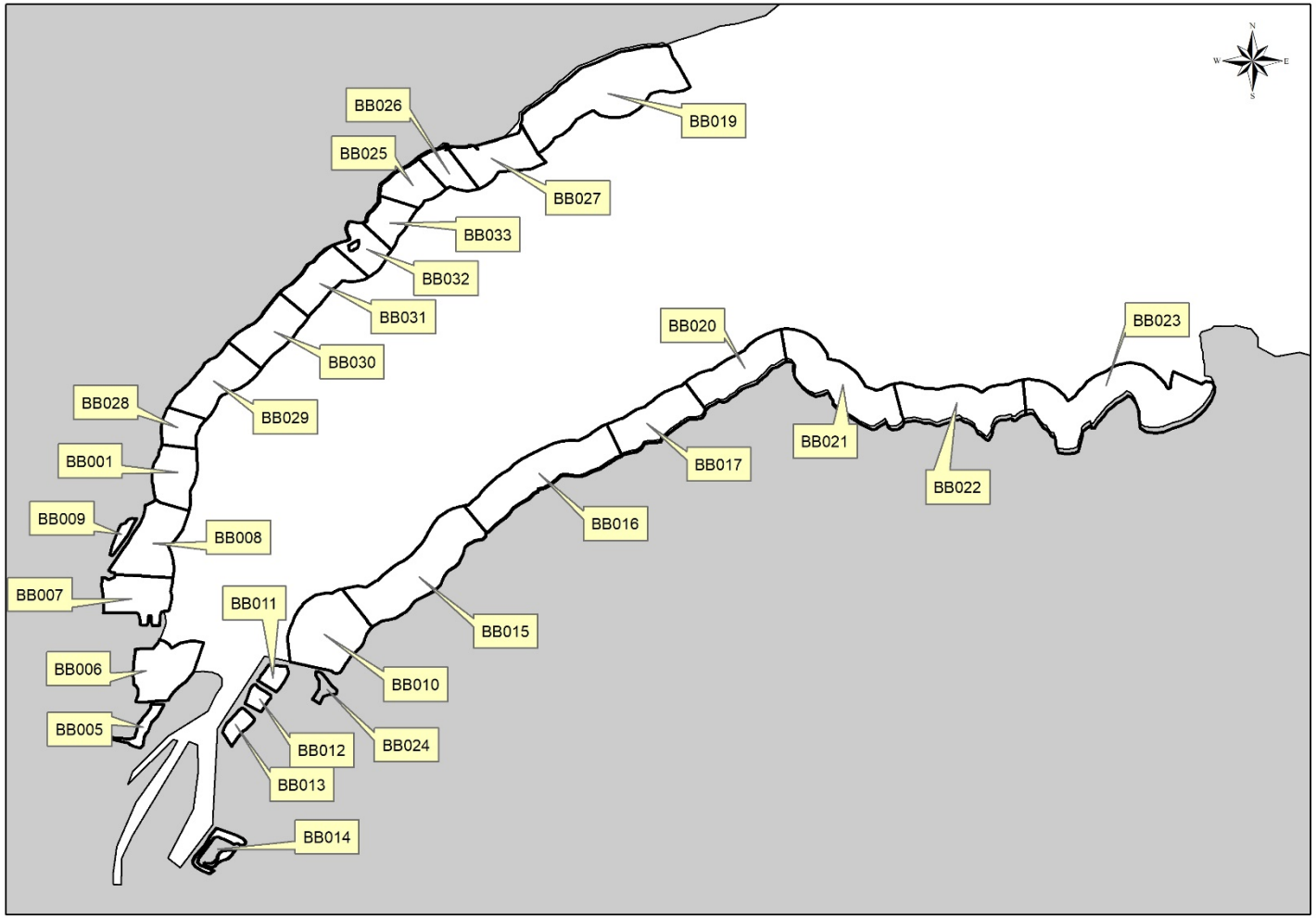


Figure 2.1.v: Structural hierarchy of WeBS Core Count sectors on Lough Foyle. Sectors at the finest spatial scale are primarily considered for this report.

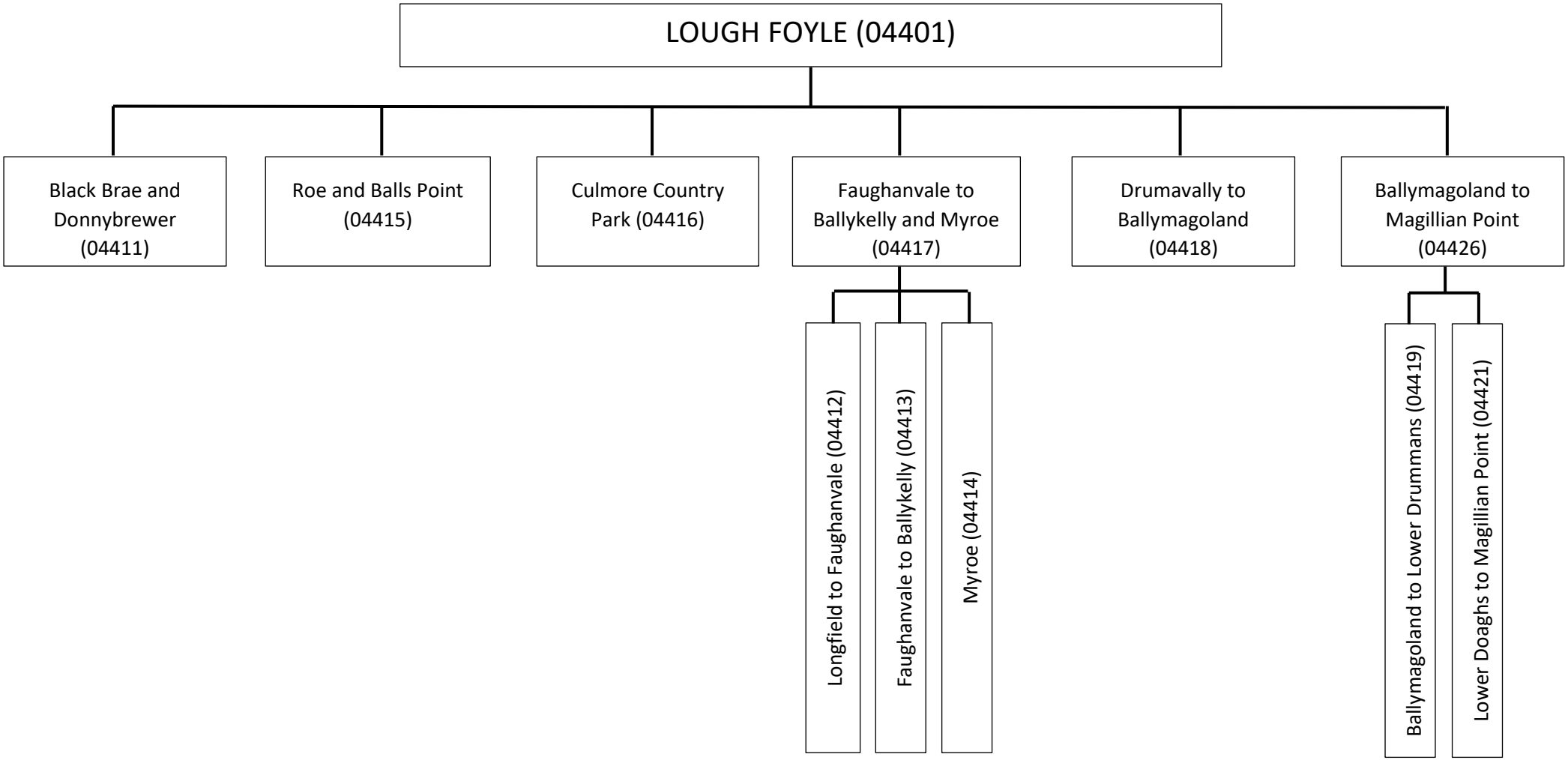
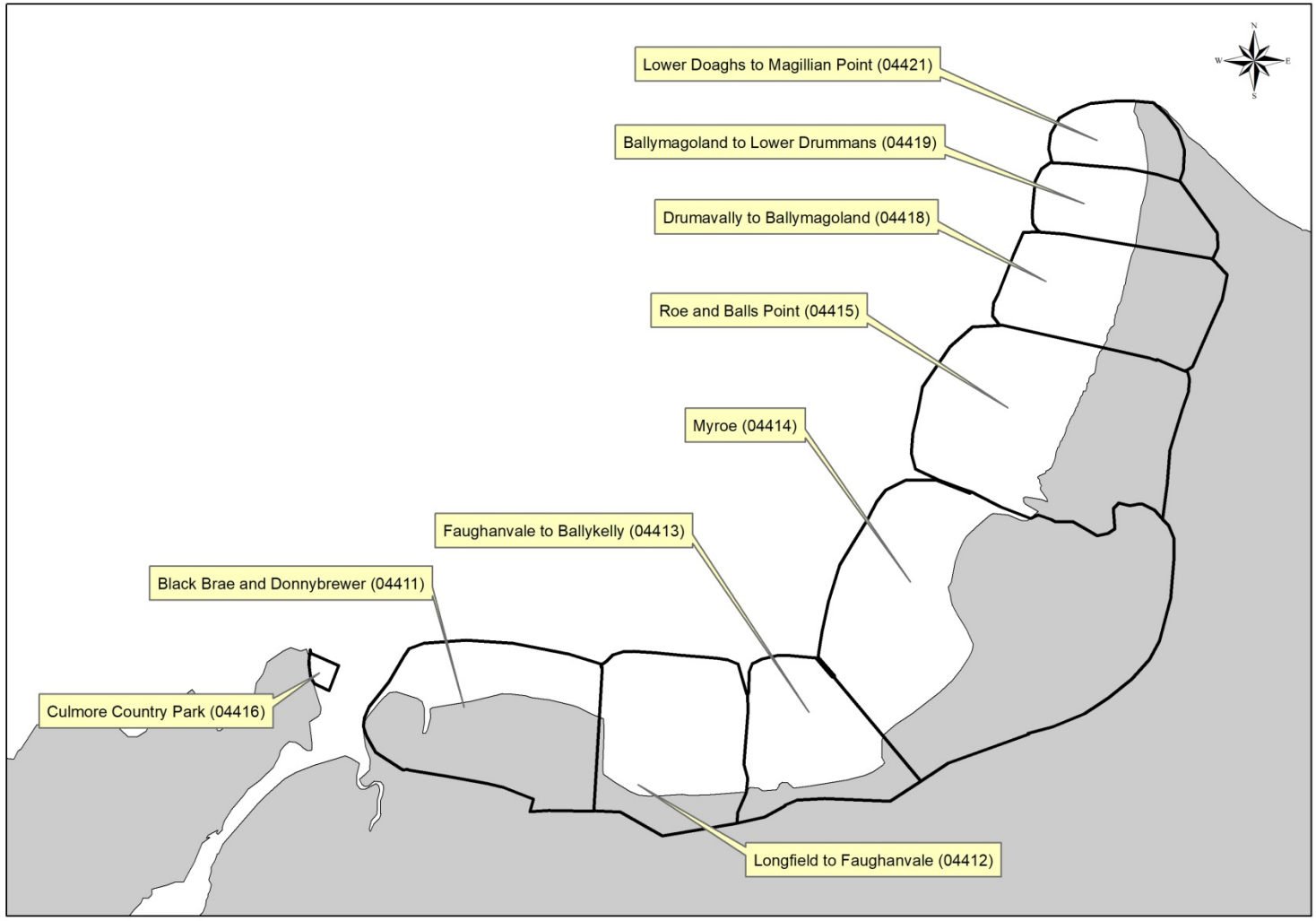


Figure 2.1 vi: Locations of each Core Count (high tide) count sector in Lough Foyle. These WeBS sectors are the most recent subdivisions for WeBS counts in Lough Foyle, and represent the finest spatial scale over which data are collected (see Figure 2.1 v).



2.1.1. Smoothed waterbird trends and percentage change

The methodology used to produce smoothed site, regional and national trends as reported by WeBS Alerts (Woodward *et al.* 2019) can be usefully extended to generate trends on smaller areas of interest such as single or appropriately grouped WeBS count sectors. It is, however, important to recognise that the numbers of birds underlying the observed trend on sectors are generally much lower than those underlying site trends reported by WeBS Alerts which, by definition, are at least equal to the national qualifying threshold for the site as a whole. Consequently, individual trends should not be 'over-interpreted'. For example, a 50% decline from 30 birds to 15 birds would give much less cause for concern than a 50% decline from 1,000 to 500 birds the latter being much more likely to reflect a real and substantial loss of birds from an area than the former. However, whilst acknowledging this, a consistent pattern of decline across multiple species, even when the numbers involved for some of them are comparatively low, is strongly indicative of adverse factors affecting the sector in question, and the particular suite of species showing a decline in numbers can guide us in where to look for problems (for example, does the suite of species represent those known to be particularly sensitive to disturbance or those with similar ecological requirements).

Thus, using validated WeBS data to winter 2018/19 inclusive, following (Atkinson *et al*. 2000, 2006), smoothed trends were fitted using Generalized Additive Models (GAMs) for the relevant species. The smoothing is to ensure that year-specific factors, such as poor conditions on the breeding grounds or particularly harsh weather on the wintering grounds, that are not related to changes in the quality of the loughs themselves, do not contribute overly to the trend. Percentage change has been calculated for short- (5 year) medium- (10 year) and long-term (15 year). To ensure statistical robustness, percentage change is calculated with reference to the penultimate winter in the time series available to avoid referring to the end points of the smoothed trend (which are less robust). Consequently, percentage change to winter 2017/18 is reported. By way of analogy with the WeBS Alerts system, declines of at least 25% but below 50% are flagged as medium-declines (or moderate declines), and declines of 50% or greater are flagged as high-declines (or steep declines). We specifically do not use the terms medium- and high-Alerts because unlike the percentage change reported by WeBS Alerts, medium and high declines reported at the sector level do not constitute a formal WeBS Alert. The corresponding percentage change required to balance the numbers to their former level following a decline are likewise termed medium- or moderate (at least 33% but below 100%) and high- or sharp (100% or greater) increases.

Trends can only be produced for species where sufficient data exist across the years being considered, and cannot be produced for species which are recorded irregularly and/or in very low numbers in Belfast or Lough Foyle in winter (Belfast Lough: Whooper Swan, Bewick's Swan *Cygnus columbianus bewickii*, Greylag Goose *Anser anser*, (Northern) Pintail *Anas acuta*, (Common) Pochard *Aythya ferina*, Purple Sandpiper *Calidris maritima*, Grey Plover *Pluvialis squatorola*, Sanderling, (Common) Greenshank *Tringa nebularia*, Slavonian Grebe *Podiceps auritus*, Red-throated Diver *Gavia stellata*; Lough Foyle: Bewick's Swan, Pochard, Scaup, (Eurasian) Coot *Fulica atra*, Purple Sandpiper, Grey Plover, Slavonian Grebe, Red-throated Diver). In addition, trends are for the winter period only, and robust WeBS trends cannot be produced for species which are almost entirely recorded on passage (Greenshank). Wintering trends rely on the assumption that the number of individuals present at a site usually remains relatively stable for several weeks at a time (or longer) and hence monthly WeBS counts are representative of the wintering population. This is not the case

during passage months: numbers can fluctuate on a daily basis as birds arrive and depart, so counts may vary by chance from year to year according to whether or not the count date happens to coincide with a peak in passage. In addition, passage birds are present for a relatively short but unknown length of time, which may also vary from year to year. For both these reasons, numbers counted during passage months cannot be considered representative of the passage population in a particular year, and hence trends are not produced.

2.1.2. Placing the smoothed waterbird indices into context

Once the smoothed sector indices have been produced the observed trends are placed in context of the site trends. Following (Banks and Austin 2004), the standard WeBS methodology as used to compare site trends with regional and national trends when reporting WeBS Alerts (Woodward *et al.* 2019) is extended here to compare counts sector trends with site trends. Where waterbird numbers of a given species on a given count sector follow those of the species across the site as a whole then the proportion of site numbers on the sector will remain constant. Any significant deviation from this gradient of zero would indicate that the waterbird populations on the relevant count sector are doing either better or less well than would be expected from the site trend. Consequently:

- where a decline on a sector reflects a decline across the site as a whole, without that sector being disproportionately important to the site-level numbers of that species, it is unlikely that the observed site trend is being driven by factors affecting that sector. If this is true of the majority of sectors, then this may indicate that the observed site decline in the species in question is due to factors external to the site and are thus not due to site management issues *per se*;

- where a decline on a sector is more pronounced than that across the site as a whole, this may suggest that factors affecting that sector could be contributing to the overall decline;

- where a decline on a sector is less pronounced than the decline across the site as a whole, this suggests that relatively favourable conditions on that sector are helping buffer site declines;

- where an increase on a sector is less pronounced than that across the site as a whole, this suggests that the sector is already at carrying capacity for the species in question or, if historically it supported greater numbers, that the quality of the sector to that species has diminished;

- where an increase on a sector is greater than that across the whole site, this suggests that trends on that sector are driving the increase across the site or that the sector in question is relatively attractive compared to the site as a whole when increased numbers arrive at the site due to external factors.

The comparisons between sectors and site are derived from a logistic regression model with a binomial error term. The resulting plots depict the percentage contribution of the sector to the site as a whole and the associated confidence limits represent both variation in this proportion between months in a given year and the underlying sample size (for example, we would be more confident of

our estimate that a sector contributed 10% of the site total if 100 birds out of 1000 on the site were counted there than we would be if this was 10 out of 100). This is based on the winter period as routinely used for all WeBS reporting (Nov-Mar for waders and Sep-Mar for other species). Only data from months where counts consolidated across the site as a whole had been assessed as complete were used - following standard WeBS protocol described above.

Having considered the trends on the sectors, each in the context of trends across the site as a whole, it is important to consider the site trends in a broader context – here the whole of Northern Ireland (following standard WeBS Alerts reporting), as this can modify our interpretation of the pattern of change across sectors. This is especially important where there has been an increase or decline at the broader scale. Consequently:

- where there has been an apparent re-distribution of a species within the site (that is, declines on some sectors appear to be balanced by increases on other sectors), but the proportional contribution of the site to increasing regional numbers is declining, then this implies that those sectors with static or declining numbers are actually of concern because we would expect them to be increasing in parallel with the other sectors. Thus, in such cases, the apparent redistribution within the site is misleading and the species in question may be facing problems on those sectors not supporting an increase in numbers;

- where a species is in decline at the broader scale we would expect declines on at least some of the sectors of the site regardless of whether birds are being affected by adverse factors locally. Thus, we would expect those sectors of least suitable habitat to a given species to be the first to show a decline in numbers.

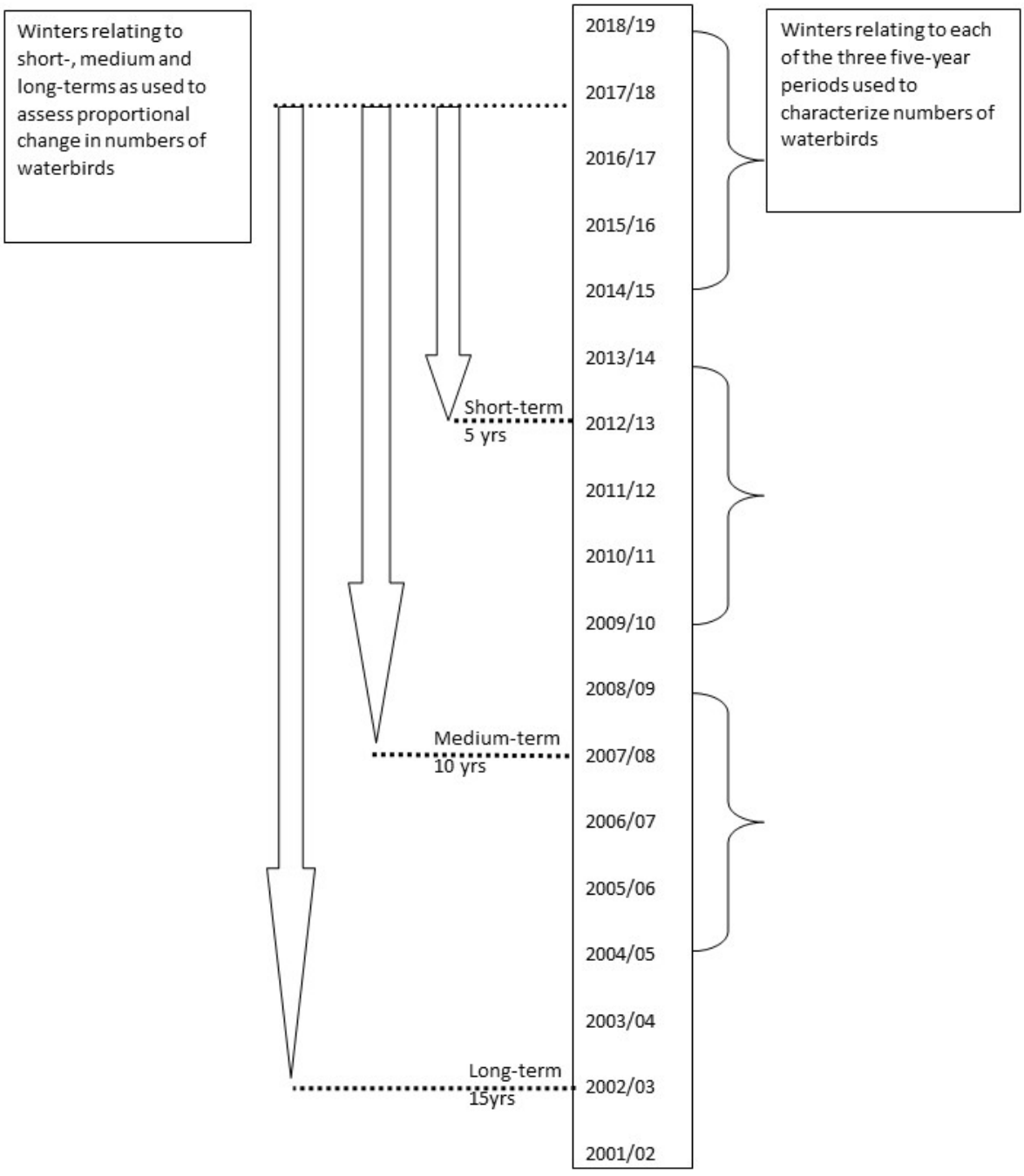


Figure 2.1.2.v Schematic of reference winters used for reported waterbird numbers and change.

2.1.3. Comparing figures and tables with previous reports

The BTO has prepared a guidance document 'Guidance to interpretation of Wetland Bird Survey within-site trends' (Austin and Ross-Smith 2014) to aid the interpretation of WeBS sector trend analyses. This document is also provided in the supplementary material accompanying this report. These guidelines give full details of analyses included in this report and the rationale behind them as an aid to the interpretations of numbers and trends on WeBS count sectors. In summary these include:

- proportional change in the numbers of each species assessed over the long-, medium- and short-terms (Overview: Tables 2 and for underlying values see sheet 'TableOfChange' in 'Belfast Lough Core Result Matrices.xls' and 'Lough Foyle Result Matrices.xls', supplied to NIEA digitally).

- underlying linear trend across the 15-winter period and the significance of this trend from zero (for underlying values see sheet 'TableOfProportions' in 'Belfast Lough Core Result Matrices.xls' and 'Lough Foyle Result Matrices.xls', supplied to NIEA digitally).

- means of peak counts of each species for the most recent five-winter period (Overview: Tables 3 and 7 for underlying values together with equivalent values for the previous two five-winter periods and the peak value in the most recent winter, see sheet 'TableOf5yePeaks' in 'Belfast Lough Core Result Matrices.xls' and 'Lough Foyle Result Matrices.xls', supplied to NIEA digitally).

- Peak counts of each species for the most recent winter period available (2018/19) (Overview: Tables 4 and 8 for underlying values see sheet 'TableOfPeaks' in 'Belfast Lough Core Result Matrices.xls' and 'Lough Foyle Result Matrices.xls', supplied to NIEA digitally).

- the proportion of species assessed as falling into each of the five categories from high decline through to high increase (mapped pie-charts: Figures 3.1.i to 3.1.ii).

- for each species for each sector, graphs depicting both annual mean and annual peak numbers together with, where there is sufficient data, the smoothed trends through each. Accompanying each of these is a graph showing the proportional contribution of each sector to the overall numbers across the whole site. The equivalent graphs are also available for the whole sites relative to Northern Ireland (supplied to NIEA digitally).

- density plots for each species across all sectors which focus attention on the most important areas for each species (supplied to NIEA digitally).

2.2. Relating trends to aquaculture activity

While there were no DAERA licensed aquaculture areas in Lough Foyle, Belfast Lough supported 12 licensed bottom-culture Blue Mussel *Mytilus edulis* (hereafter 'mussel') beds (Figures 2.2.i and 2.2.ii.). Although there were four active areas that overlapped WeBS sectors; two overlapping Core Count sectors, and these two plus an additional two overlapping Low Tide sectors (Table 2, Figures 2.2.i and 2.2.ii.), for both Core Counts and Low Tide sectors, the effective extent was much larger than that shown in Figures 2.2.i and 2.2.ii because counters record to the approximate mid-point of the lough. Therefore, in practice all active aquaculture sites were covered by WeBS in Belfast Lough. However, in this analysis we chose to limit the focus to the licenced sites overlapping the WeBS sector delineations as shown in Figures 2.2.i and 2.2.ii, to account for decreasing detectability with increasing distance from the shore (Graham and Thompson 2021), which may reduce the ability to detect trend differences related to aquaculture activity in more distant aquaculture sites.

It is also important to note that the aquaculture polygons shown in Figures 2.2.i and ii represent the total licenced area of each operator, which is not necessarily concurrent with the total active mussel bed area, nor an indicator of the yield or activity of the area. Husbandry activity, such as thinning or predator control, is not measured for bottom-culture mussel beds (NIEA staff, *pers. comm.*) and therefore the quantity of disturbance potentially caused by mussel aquaculture in Belfast Lough can only be estimated by examining yield per area (tonnage) as a proxy for activity (Figure 2.2.iii.). Available records of bottom-culture mussel tonnage begin in 2010 for Belfast Lough, when tonnage was at a peak across all licensed areas. Across the licensed areas that overlapped with WeBS sectors, peak tonnage occurred in 2012 (Figure 2.2.iii). Yield of mussels from areas overlapping WeBS sectors, and more generally in the lough, declined since 2010 (Figure 2.2.iii).

Although tonnage data were only available from 2010, bottom-culture mussel aquaculture had been licensed in Belfast Lough for a long time previous to this. The oldest licenced area was B10, which was established in 1997, but all sites in Belfast Lough were granted licences between 1997 and 2002, and therefore had been in place between 18 – 23 years. Because tonnage data prior to 2010 were not available, only short- (2012/13 - 2017/18) and medium-term (2007/08 - 2017/18) trends were examined in terms of the potential impact of aquaculture, and only for sectors which intersected with licensed areas (Table 2, Figures 2.2.i and 2.2.ii.), for reasons previously outlined.

Table 2 Active mussel bed areas in Belfast Lough and the WeBS sectors they overlap with.

Belfast Lough Core Count Sector	Overlapping aquaculture licence areas
Core Counts	
Belfast Lough - Whiteabbey to River Lagan (01422)	B7
Seapark to Macedon (02921)	B7, B10
LowTide counts	
BB008 (Belfast Lough LTC 2.4)	B3, B7
BB001 (Belfast Lough LTC 1.1)	B3, B7
BB028 (Belfast Lough LTC 1.2d)	B7, B10
BB029 (Belfast Lough LTC 1.2c)	B7, B10, B11
BB030 (Belfast Lough LTC 1.2b)	B10, B11

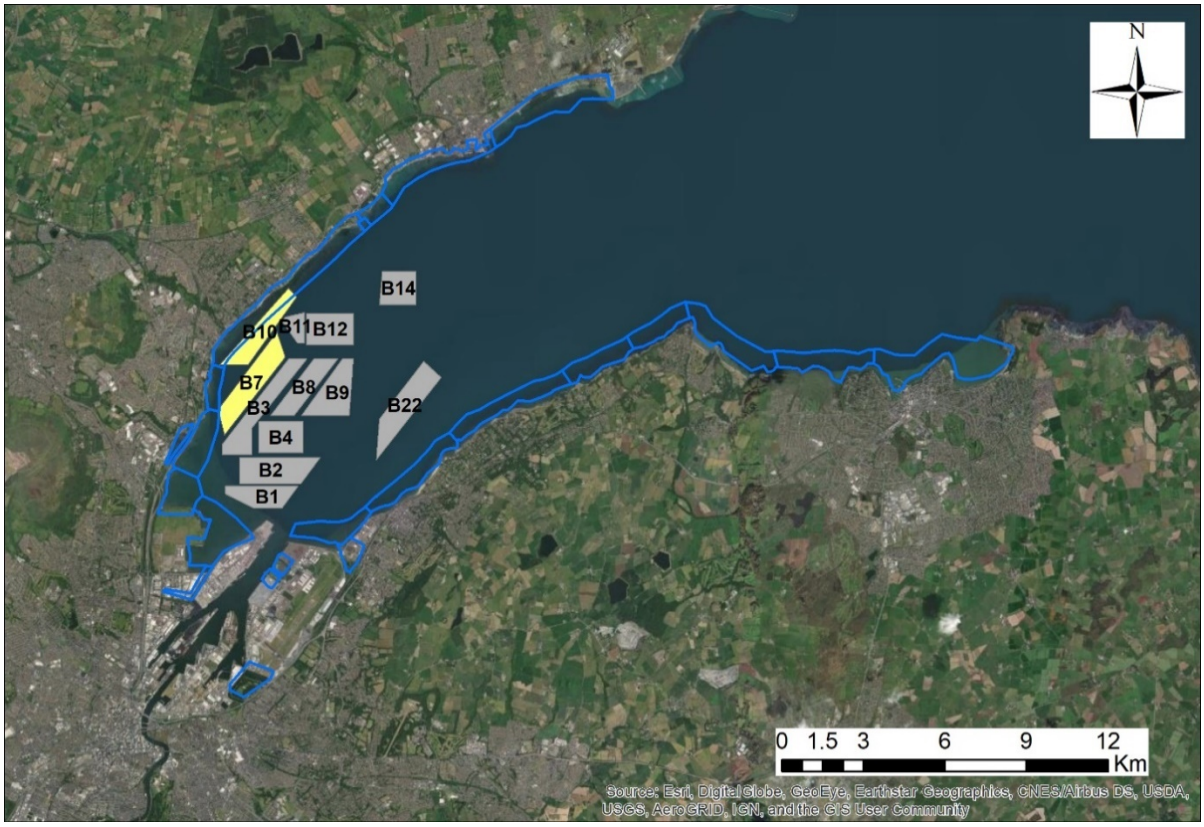


Figure 2.2.i: Map of licenced, active bottom mussel beds in Belfast Lough. Licenced areas in yellow overlap Core Count WeBS sectors, which are outlined in blue.

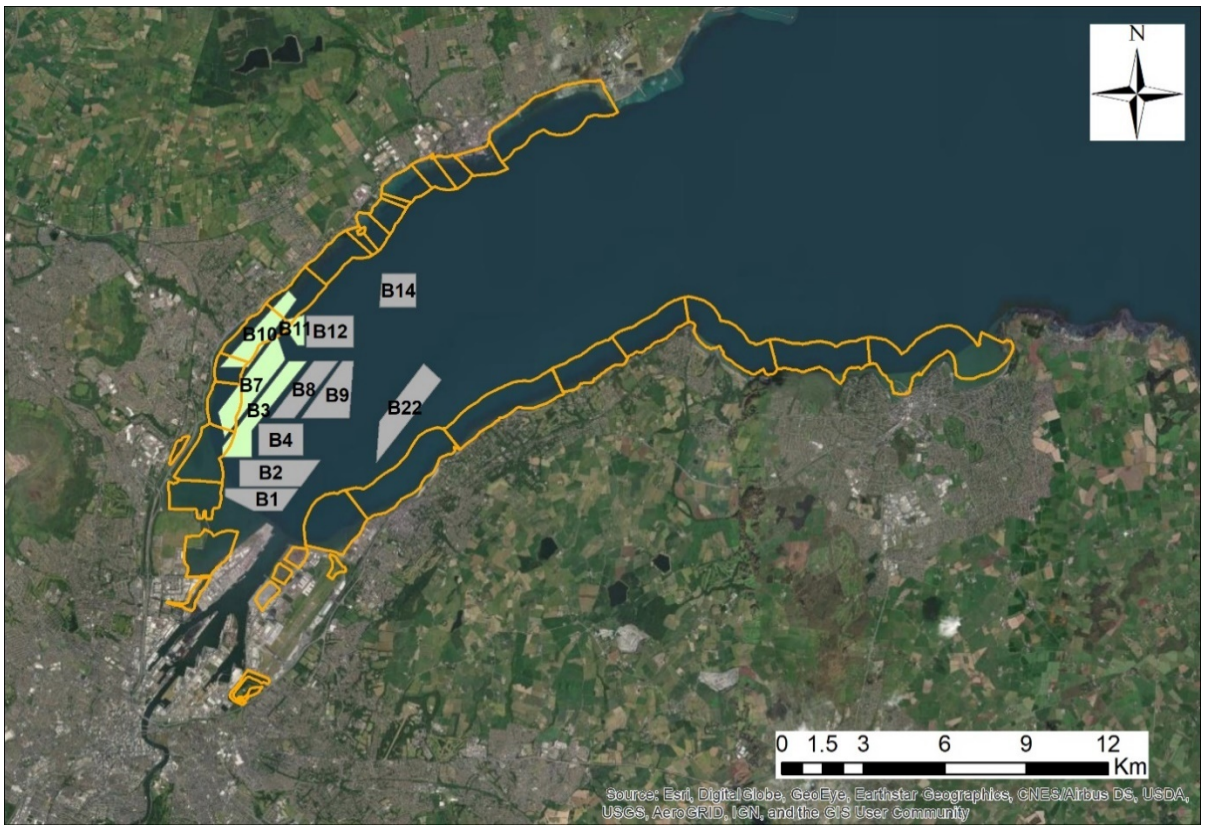


Figure 2.2.ii: Map of licenced, active bottom mussel beds in Belfast Lough. Licenced areas in green overlap Low Tide WeBS sectors, which are outlined in orange.

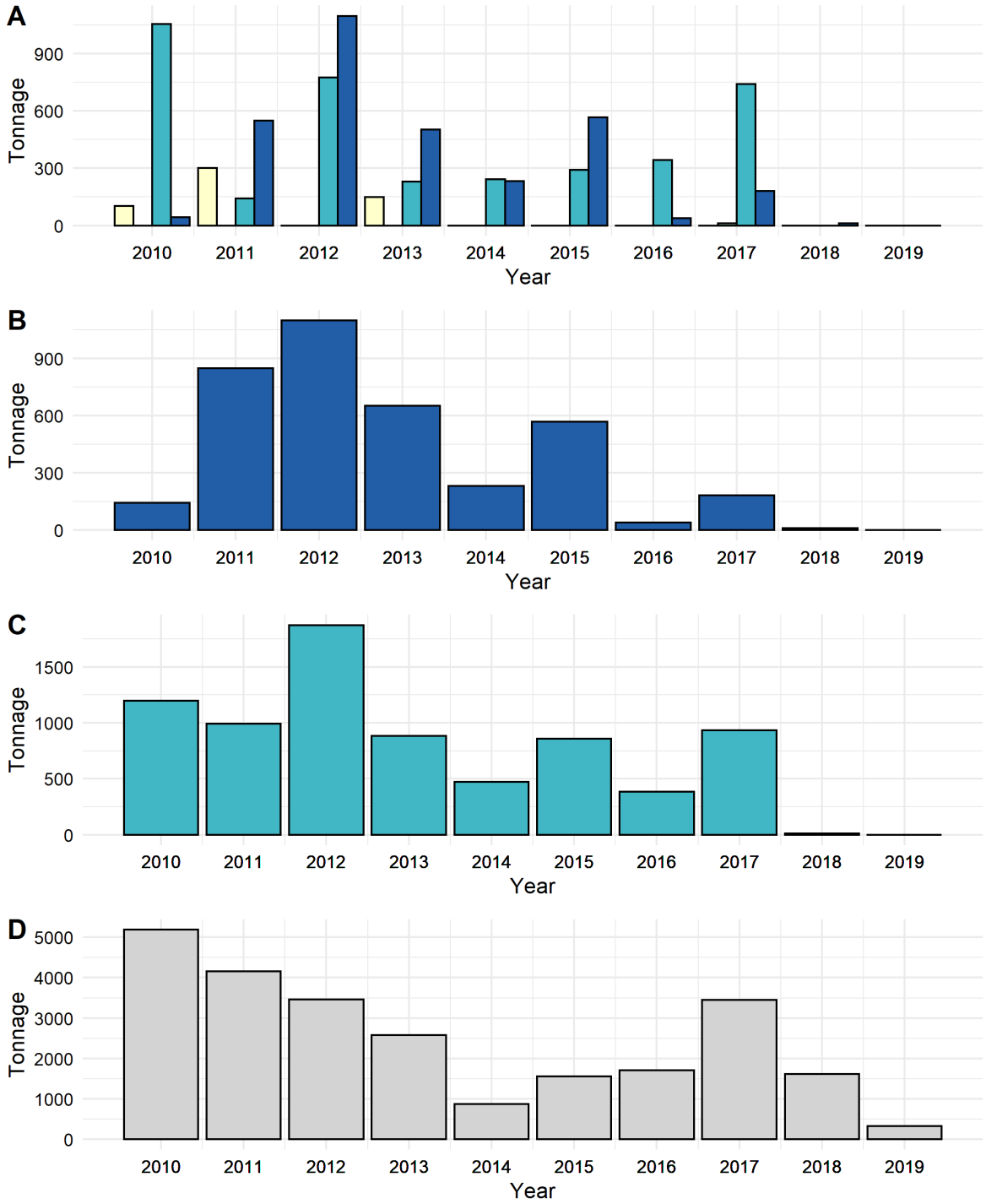


Figure 2.2.iii: Yield of mussels (tonnage) between 2010 and 2019 in Belfast Lough. A: Individual licensed areas that overlap with WeBS sectors in Belfast Lough (unlabelled to maintain anonymity). B: The combined tonnage of licensed areas that overlap with WeBS Core Count sectors in Belfast Lough. C: The combined tonnage of licensed areas that overlap with WeBS Low Tide Count sectors in Belfast Lough. D: The combined total tonnage of all active mussel beds in Belfast Lough.

3. Results

3.1. Sector trend plots

The trends of each species on each WeBS sector are supplied digitally, together with plots comparing the count sector trends with the site trends for Belfast Lough and Lough Foyle. This series of plots puts each sector into the context of trends of each of the loughs as a whole. Plots are grouped by sector and species presented in taxonomic order. This information is summarised below (Table 3, 6 and 7) and the underlying values representing percentage change to Belfast Lough and Lough Foyle are available in the accompanying Excel™ Workbooks ('Lough Foyle Result Matrices.xls', 'Belfast Lough Core Result Matrices.xls' & 'Belfast Lough Low Tide Result Matrices.xls). Colour coding is used to represent declines or increases; species are listed in taxonomic order and sectors have been listed to represent their geographical proximity to each other. Caution is advisable in interpreting individual cells in these tables at face value. For example, a 50% decline (shown in red) could represent a decline from 10,000 to 5,000 birds or could be a decline from 20 to 10. Consequently, it is important to be aware of the numbers of birds involved (obtainable from the plots supplied digitally or the mean of peak numbers in the Excel Worksheet. However, consistency between adjacent cells would suggest that either a group of species or a group of adjacent sectors have similar trends even when numbers of individuals involved are relatively low. Where this is the case, this may suggest that the trends represent real ecological changes. Note that trend graphs have not been presented for Greenshank due to the very low numbers or intermittent occurrence during the winter on the loughs.

This information is further summarised in map format, which better facilitates a geographic interpretation of the trends (Figure 3.1.i and 3.1.ii) (see also digital supplementary materials).

The importance of individual sectors for given species can be determined by considering the five-year mean of peak counts (Table 4 and 8) and underlying values are available in the supporting material ('Belfast Lough Core Result Matrices.xlsx', 'Belfast Lough Low Tide ResultMatrices.xlsx' and 'Lough Foyle Result Matrices.xlsx'); the importance of individual sectors to particular species clearly influences the level of concern regarding the characteristics of the trends. Peak counts from the most recent available winter (2018/19) are also provided in separate tables (Table 5 and 9, and supporting supplementary material). However, caution is advisable in interpreting these tables of peak counts to identify important sectors for given species rather than Table 4 and 8, as peaks from a single year are less robust against missing data or abnormal counts (e.g. caused by disturbance in an adjacent sector on the day of a count).

Table 3 Overview of population trends of waterbirds in Belfast Lough. Based on high-tide counts over the long- (2002/03 - 2017/18) the medium- (2009/10 - 2017/18) and the short- (2012/13 - 2017/18) terms. Cells are coloured to indicate trend status as follows: Red – a decline in numbers of at least 50%; Orange – a decline in numbers of at least 25% but less than 50%; White – a decline in numbers of less than 25% or an increase of less than 33%; Pale Blue – an increase in numbers of at least 33% but less than 100%; Dark Blue – an increase in numbers of at least 100%; Grey – insufficient data.

Table 3 i: Waterfowl

Sector Code	Sector Name	Mute Swan			LB Brent Goose			Shelduck			Wigeon			Teal			Mallard			Eider			Red-breasted Merganser			Scaup			Goldeneye			Great Crested Grebe			Coot		
		Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
01223	Belfast Lough - BP Pools and Victoria Park																																			
01422	Belfast Lough - Whiteabbey to River Lagan																																			
01424	Belfast Lough - Kinnegar to Greys Point																																			
01425	Belfast Lough - Greys Point to Ballymacormich Point																																			
02421	Belfast Lough - Kilroot to Whiteabbey																																			
02921	Seapark to Macedon																																			
02922	Kilroot to Seapark																																			
01900	Belfast Lough																																			

Table 3 ii: Waders and Cormorant

Sector Code	Sector Name	Oyster-catcher			Ringed Plover			Golden Plover			Purple Sandpiper			Lapwing			Dunlin			Knot			Black-tailed Godwit			Bar-tailed Godwit			Turnstone			Curlew			Redshank			Cormorant		
		Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
01223	Belfast Lough - BP Pools and Victoria Park																																			
01422	Belfast Lough - Whiteabbey to River Lagan																																			
01424	Belfast Lough - Kinnegar to Greys Point																																			
01425	Belfast Lough - Greys Point to Ballymacormich Point																																			
02421	Belfast Lough - Kilroot to Whiteabbey																																			
02921	Seapark to Macedon																																			
02922	Kilroot to Seapark																																			
01900	Belfast Lough																																			

Table 4 The most important sectors in the latest year (2018/19) for waterbirds in Belfast Lough shown by colour: Dark Blue- sectors with a mean peak count over the last five winters (2014/15 – 2018/19) that is at least 20% of the total mean peak counts for Belfast Lough over the same period; Light Grey – sites with a mean peak count over the last five winters that is between 10% and 20% of the total mean of peak count for Belfast Lough over the same period.

Sector Code	Sector Name	Mute Swan	LB Brent Goose	Shelduck	Wigeon	Teal	Mallard	Eider	Red-breasted Merganser	Scaup	Goldeneye	Great Crested Grebe	Coot	Oystercatcher	Ringed Plover	Golden Plover	Purple Sandpiper	Lapwing	Dunlin	Knot	Black-tailed Godwit	Bar-tailed Godwit	Turnstone	Curlew	Redshank	Cormorant
01223	Belfast Lough - BP Pools and Victoria Park	■		■	■	■	■						■	■		■		■	■	■	■	■		■	■	
01422	Belfast Lough - Whiteabbey to River Lagan		■	■	■	■	■		■	■	■	■		■		■		■	■	■	■	■		■	■	■
01424	Belfast Lough - Kinnegar to Greys Point		■						■		■	■					■						■			■
01425	Belfast Lough - Greys Point to Ballymacormich Point		■												■		■	■	■				■			
02421	Belfast Lough - Kilroot to Whiteabbey		■					■	■		■	■		■	■		■		■	■		■	■	■	■	■
02921	Seapark to Macedon		■					■	■		■	■		■	■		■		■	■		■	■	■	■	■
02922	Kilroot to Seapark		■					■	■					■	■				■				■		■	■

Table 5 The most important sectors in the latest year (2018/19) for waterbirds in Belfast Lough shown by colour: Dark Green – Sites with a peak count in the latest year that is at least 20% of the total peak count for Belfast Lough in the same year; Light Green – sectors with a peak count in the latest year that is between 10% and 20% of the total peak count for Belfast Lough in the same year.

Sector Code	Sector Name	Mute Swan	LB Brent Goose	Shelduck	Wigeon	Teal	Mallard	Eider	Red-breasted Merganser	Scaup	Goldeneye	Great Crested Grebe	Coot	Oystercatcher	Ringed Plover	Golden Plover	Purple Sandpiper	Lapwing	Dunlin	Knot	Black-tailed Godwit	Bar-tailed Godwit	Turnstone	Curlew	Redshank	Cormorant
01223	Belfast Lough - BP Pools and Victoria Park																									
01422	Belfast Lough - Whiteabbey to River Lagan																									
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02421	Belfast Lough - Kilroot to Whiteabbey																									
02921	Seapark to Macedon																									
02922	Kilroot to Seapark																									

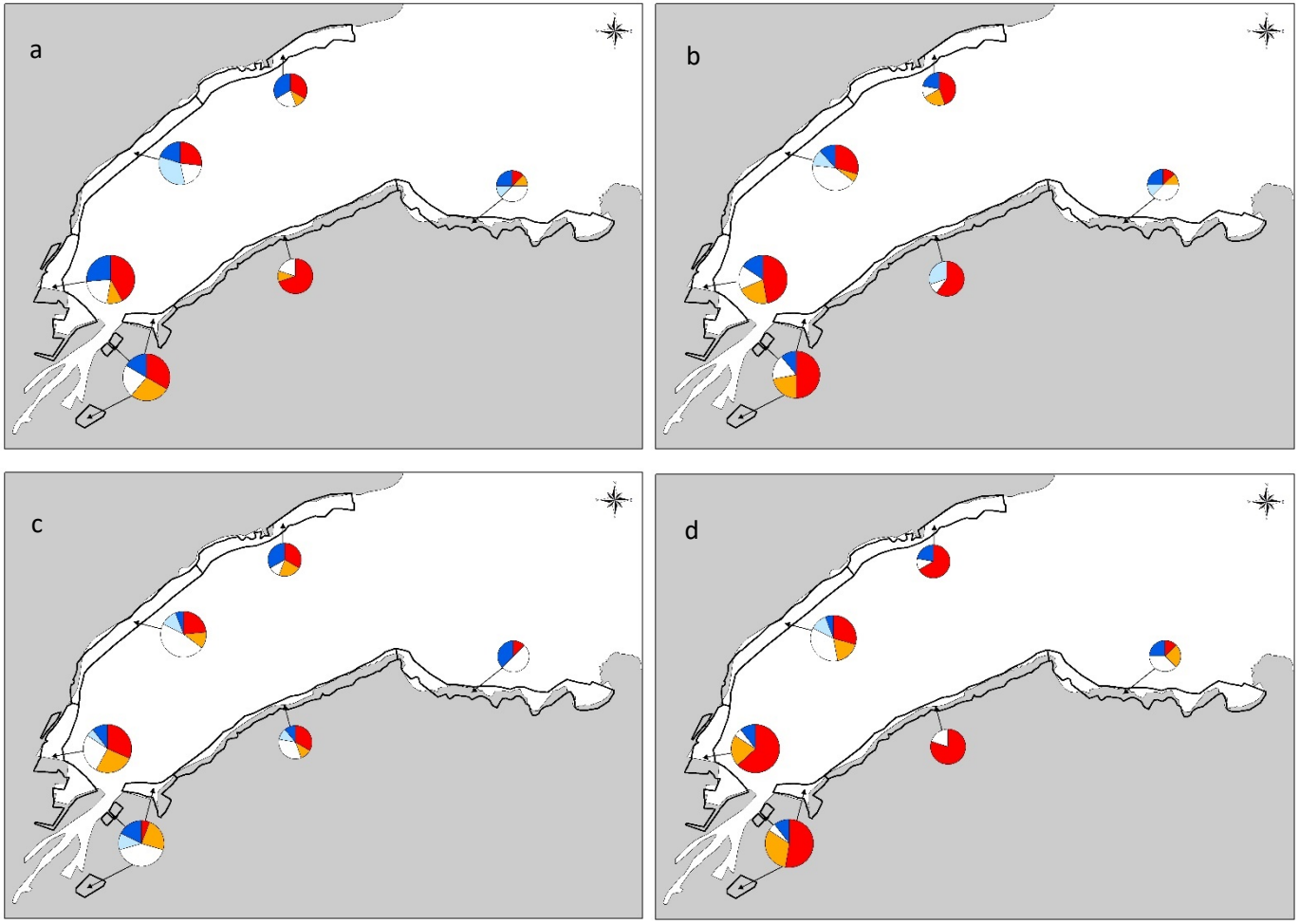

Figure 3.1.i: Population trends of waterbirds within Belfast Lough over (a) the long-term (2002/03 - 2017/18) (b) the medium-term (2009/10 - 2017/18); (c) the short-term (2012/13 - 2017/18) and (d) the "worst case" scenario of the three terms. The area of each pie chart relates to the number of species for which trends could be determined on the WeBS count sector in question and within each pie chart the proportions of those species that have undergone a substantial decline (red), a moderate decline (orange), "no" change (white), moderate increase (pale blue) and sharp increase (dark blue).

Table 6 Overview of population trends within low tide sectors of Belfast Lough over the long- (2002/03 - 2017/18 the medium- (2009/10 - 2017/8 and the short- (2012/13 - 2017/18) terms. Cells are coloured to indicate trend status as follows: Red – a decline in numbers of at least 50%; Orange – a decline in numbers of at least 25% but less than 50%; White – a decline in numbers of less than 25% or an increase of less than 33%; Pale Blue – an increase in numbers of at least 33% but less than 100%; Dark Blue – an increase in numbers of at least 100%; Grey – insufficient data. *Light-bellied Brent Goose.

Table 6 i: Waterfowl.

Sector Code	Sector Name	Mute Swan			LB Brent Goose			Shelduck			Wigeon			Teal			Mallard			Eider			Red-breasted Merganser			Scaup			Goldeneye			Great Crested Grebe			Coot		
		Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
BB001	Belfast Lough LTC 1.1																																			
BB002	Belfast Lough LTC 1.2																																			
BB003	Belfast Lough LTC 1.3																																			
BB004	Belfast Lough LTC 1.4																																			
BB005	Belfast Lough LTC 2.1																																			
BB006	Belfast Lough LTC 2.2																																			
BB007	Belfast Lough LTC 2.3																																			
BB008	Belfast Lough LTC 2.4																																			
BB009	Belfast Lough LTC 2.5																																			
BB010	Belfast Lough LTC 3.1																																			
BB011	Belfast Lough LTC 3.2																																			
BB012	Belfast Lough LTC 3.3																																			
BB013	Belfast Lough LTC 3.4																																			
BB014	Belfast Lough LTC 3.5																																			
BB015	Belfast Lough LTC 4.1																																			
BB016	Belfast Lough LTC 4.2																																			
BB017	Belfast Lough LTC 4.3																																			
BB018	Belfast Lough LTC 5.1																																			
BB019	Belfast Lough LTC 5.2																																			
BB020	Belfast Lough LTC 6.1																																			
BB021	Belfast Lough LTC 6.2																																			
BB022	Belfast Lough LTC 6.3																																			
BB023	Belfast Lough LTC 6.4																																			
BB024	Belfast Lough LTC 3.6																																			
BB025	Belfast Lough LTC 5.1a																																			
BB026	Belfast Lough LTC 5.1b																																			
BB027	Belfast Lough LTC 5.1c																																			
BB028	Belfast Lough LTC 1.2d																																			
BB029	Belfast Lough LTC 1.2c																																			
BB030	Belfast Lough LTC 1.2b																																			
BB031	Belfast Lough LTC 1.2a																																			
BB032	Belfast Lough LTC 1.3																																			
BB033	Belfast Lough LTC 1.4																																			
BB000	Belfast Lough (Low Tide)																																			

Table 6 ii: Waders and Cormorant.

Sector Code	Sector Name	Oyster-catcher			Ringed Plover			Golden Plover			Purple Sandpiper			Lapwing			Dunlin			Knot			Black-tailed Godwit			Bar-tailed Godwit			Turnstone			Curlew			Redshank			Cormorant		
		Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
BB001	Belfast Lough LTC 1.1																																					
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BB023	Belfast Lough LTC 6.4																																					
BB024	Belfast Lough LTC 3.6																																					
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BB032	Belfast Lough LTC 1.3																																					
BB033	Belfast Lough LTC 1.4																																					
BB000	Belfast Lough (Low Tide)																																					

Table 7 Overview of population trends of waterbirds in Lough Foyle based on high-tide counts over the long- (2002/03 - 2017/18) the medium- (2007/08 - 2017/18) and the short- (2012/13 - 2017/18) terms. Cells are coloured to indicate trend status as follows: Red – a decline in numbers of at least 50%; Orange – a decline in numbers of at least 25% but less than 50%; White – a decline in numbers of less than 25% or an increase of less than 33%; Pale Blue – an increase in numbers of at least 33% but less than 100%; Dark Blue – an increase in numbers of at least 100%; Grey – insufficient data.

Table 7 i: Waterfowl

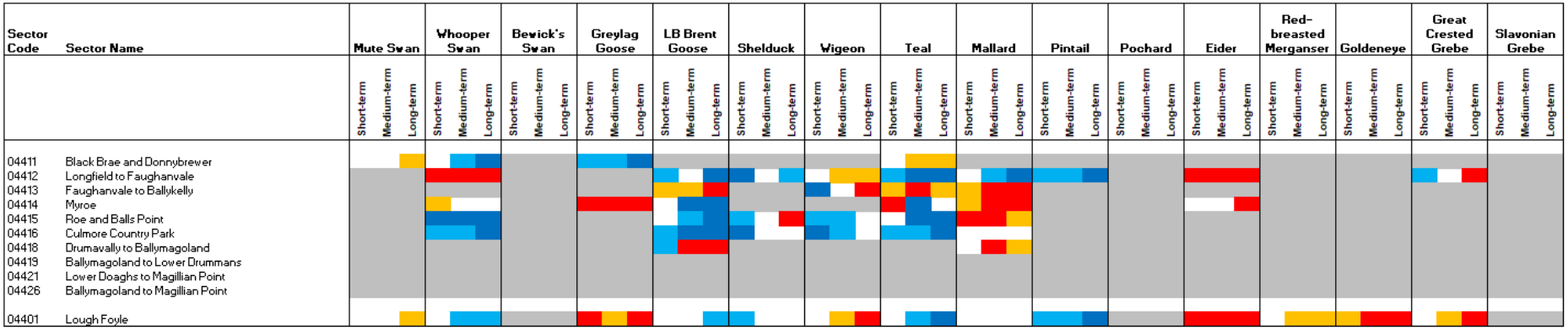

Table 7 ii: Waders and Cormorant

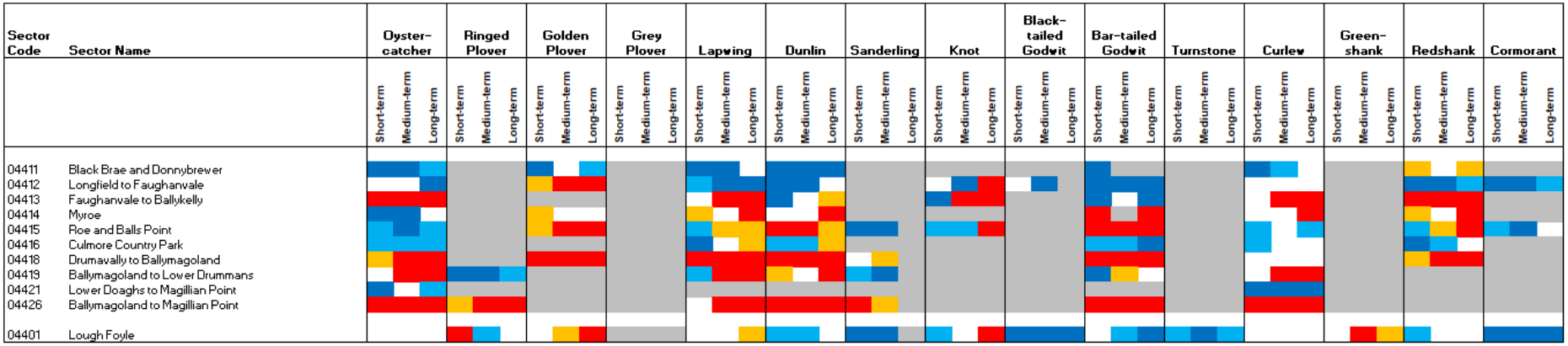

Table 8 The most important sectors for waterbirds in Lough Foyle shown by colour: Dark Blue- sectors with a mean peak count over the last five winters (2014/15 – 2018/19) that is at least 20% of the total mean peak counts for Lough Foyle over the same period; Light Grey – sectors with a mean peak count over the last five winters that is between 10% and 20% of the total mean of peak count for Lough Foyle over the same period.

Sector Code	Sector Name	Mute Swan	Whooper Swan	Bewick's Swan	LB Brent Goose	Greylag Goose	Shelduck	Wigeon	Teal	Mallard	Pintail	Pochard	Eider	Red-breasted Merganser	Goldeneye	Great Crested Grebe	Slavonian Grebe	Oystercatcher	Ringed Plover	Golden Plover	Grey Plover	Lapwing	Dunlin	Sanderling	Knot	Black-tailed Godwit	Bar-tailed Godwit	Turnstone	Curlew	Greenshank	Redshank	Cormorant
04411	Black Brae and Donnybrewer																															
04412	Longfield to Faughanvale																															
04413	Faughanvale to Ballykelly																															
04414	Myroe																															
04415	Roe and Balls Point																															
04416	Culmore Country Park																															
04418	Drumavally to Ballymagoland																															
04419	Ballymagoland to Lower Drummans																															
04421	Lower Doaghs to Magillian Point																															
04426	Ballymagoland to Magillian Point																															

Table 9 The most important sectors in the latest year (2018/19) for waterbirds in Lough Foyle shown by colour: Dark Green – Sectors with a peak count in the latest year that is at least 20% of the total peak count for Lough Foyle in the same year; Light Green – sectors with a peak count in the latest year that is between 10% and 20% of the total peak count for Lough Foyle in the same year.

Sector Code	Sector Name	Mute Swan	Whooper Swan	Bewick's Swan	LB Brent Goose	Greylag Goose	Shelduck	Wigeon	Teal	Mallard	Pintail	Pochard	Eider	Red-breasted Merganser	Goldeneye	Great Crested Grebe	Slavonian Grebe	Oystercatcher	Ringed Plover	Golden Plover	Grey Plover	Lapwing	Dunlin	Sanderling	Knot	Black-tailed Godwit	Bar-tailed Godwit	Turnstone	Curlew	Greenshank	Redshank	Cormorant
04411	Black Brae and Donnybrewer																															
04412	Longfield to Faughanvale																															
04413	Faughanvale to Ballykelly																															
04414	Myroe																															
04415	Roe and Balls Point																															
04416	Culmore Country Park																															
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04421	Lower Doaghs to Magillian Point																															
04426	Ballymagoland to Magillian Point																															

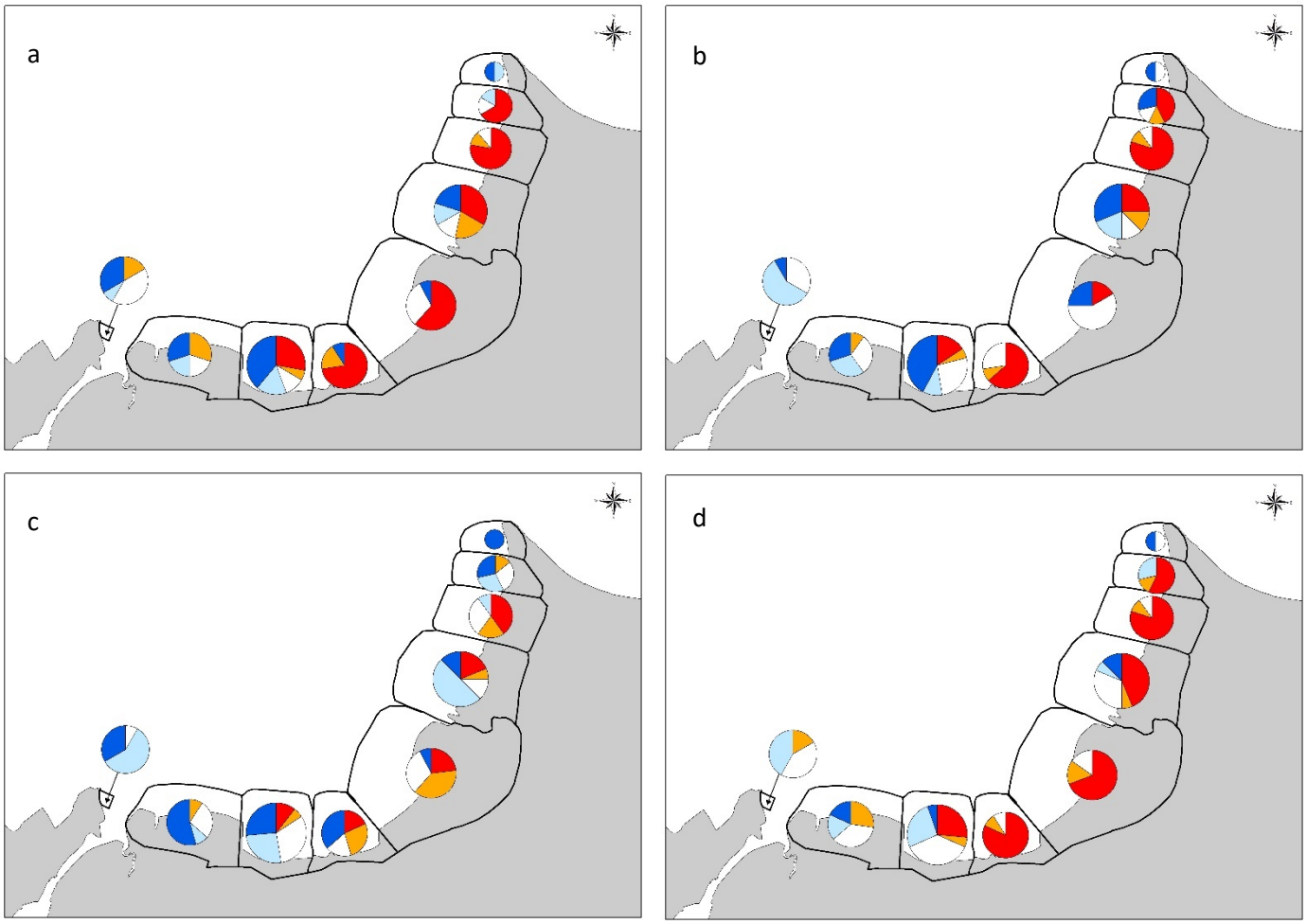

Figure 3.1.ii: Population trends of waterbirds within Lough Foyle over (a) the long-term (2002/03 – 2017/18) (b) the medium-term (2007/08– 2017/18); (c) the short-term (2012/13 – 2017/18) and (d) the "worst case" scenario of these. The area of each pie chart relates to the number of species for which trends could be determined on the WeBS count sector in question and within each pie chart the proportions of those species that have undergone a substantial decline (red), a moderate decline (orange), "no" change (white), moderate increase (pale blue) and sharp increase (dark blue).

4. Discussion and conclusions

4.1. Species trends - Belfast Lough Core Counts (high tide)

4.1.1. Mute Swan *Cygnus olor*

Numbers of Mute Swan in Northern Ireland appear to have been fairly stable over the study period. Few are found in Belfast Lough, and these are mostly located in the BP Pools and Victoria Park (01223) sector, which held over 20% of the site's Mute Swans in terms of both five-year mean peaks and mean winter peaks. Numbers declined steeply in this sector between 2003/04 and 2008/09 but since have become stable. A moderate increase (33% to 100%) was recorded in Belfast Lough as a whole in the short-term.

4.1.2. Light-bellied Brent Goose *Branta bernicla hrota*

Overwintering numbers of Light-bellied Brent Geese have increased over the medium- and long-term in Belfast Lough but have levelled in the short-term. Across Northern Ireland, numbers of Light-bellied Brent Geese have increased slightly, and it appears that increases in Belfast Lough, and in particular Seapark to Macedon have followed this trend, although with a slightly steeper increase between 2003/04 and 2008/09. Found in varying numbers in all sectors of the lough, Light-bellied Brent Geese five-year mean peaks were highest particularly on the northern coastline from Seapark to Macedon (02921) but were also concentrated in the Greys Point to Ballymacormich Point (01425) sector and were found in lower numbers closer to Belfast city.

4.1.3. Common Shelduck *Tadorna tadorna*

Belfast Lough contained around 10% of Northern Ireland's Common Shelduck during the study period and this varied little through time. Overall, the Northern Irish population declined, and while the population of Belfast Lough remained stable in the long- and medium-terms, short-term moderate declines (25% to 50%) were observed across the lough as a whole. At the sector level, BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422) sectors each held over 20% of the site's Shelduck in terms of both five-year mean peaks and mean winter peaks. The number of Shelduck in these sectors was stable in the long- and medium-terms but suffered a moderate short-term decline. Very few Shelduck were recorded outside these two sectors.

4.1.4. Eurasian Wigeon *Mareca penelope*

Northern Ireland's Wigeon population underwent a steep decline between 2003/04 and 2012/13 but has been variable but increasing since. Belfast Lough holds less than 10% of Northern Ireland's Wigeon, and the trend over time has been more stable than the national trend, although showing moderate declines (25% to 50%) over the long- and medium-terms. BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422) sectors each held over 20% of the site's Wigeon in terms of both five-year mean peaks and mean winter peaks, however the trends between these two sectors differed. Wigeon at BP Pools and Victoria Park declined steeply (by at least 50%) over the long- and medium-terms, and moderately over the short-term. Additionally, the proportion of the overall site total held in this sector declined over the study period. Meanwhile, Wigeon in Whiteabbey to River Lagan increased by at least 100% over all time periods, with the proportion of the site's Wigeon increasing since 2011/12. This suggests that although overall numbers of Wigeon

are declining in Belfast Lough, there may also be a redistribution of the population occurring between sectors perhaps indicative of local pressures in some areas of the lough.

4.1.5. Common Teal *Anas crecca*

The proportion of the Northern Irish population of Teal held by Belfast Lough over the study period has declined slightly, with moderate declines (25% to 50%) observed over the short- and medium-terms. In contrast, the Northern Irish population appears to have increased slightly. The most important sectors in the lough for Teal were BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422), both holding over 20% of the site's Teal in terms of both five-year mean peaks and mean winter peaks. Both of these sectors underwent moderate declines over the medium-term but were stable over the long-term. Numbers at Whiteabbey to River Lagan declined by at least 50% over the short-term however. There was a short-lived gain in Teal numbers in the Kinnegar to GreyPoint (01424) sector between 2005/06 and 2011/12, but Teal have not been much recorded in this sector since.

4.1.6. Mallard *Anas platyrhynchos*

While wintering Mallard abundance has remained stable in Belfast Lough over the long- and short-terms, in the medium-term there was a moderate population decline (25% to 50%). This is similar to the regional trend. Mallard are recorded in all sectors of the lough but are concentrated in BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422), both holding over 20% of the site's Mallard in terms of both five-year mean peaks and mean winter peaks. Similarly to the lough overall, both sectors experienced medium-term moderate declines in Mallard, but Whiteabbey to River Lagan also declined moderately over the long-term. Numbers of Mallard were low in Kilroot to Whiteabbey (02421, containing Seapark to Macedon (02921) and Kilroot to Seapark (02922)), however there was a medium-term slight increase (33% to 100%) in the number of Mallard observed here, although this again declined in the short-term.

4.1.7. Common Eider *Somateria mollissima*

Eider in Belfast Lough have undergone a moderate increase (33% to 100%) in numbers over the long-term, and the population of the lough has increased in its importance in the Northern Irish context from supporting around 60% of the population to around 80%. The most important sectors in the lough in terms of both five-year mean peaks and mean winter peaks were Kilroot to Whiteabbey (02421, containing Seapark to Macedon (02921) and Kilroot to Seapark (02922)). Seapark to Macedon and Kilroot to Seapark both supported at least 20% of the total Belfast Lough mean peak counts over the last five winters and in the most recent winter (2018/19), while Whiteabbey to River Lagan (01422) contained between 10% and 20% of the total peak count for the lough in the most recent winter analsyed. Trends were available for all sectors in the lough and were generally more positive on the north-west shore, and more negative on the south-east shore. In particular, Kilroot to Seapark increased by at least 100% across all time periods, although the last two years of data show a decline (Figure 4.1.7.(a)). In contrast numbers of Eider in Whiteabbey to River Lagan declined by at least 50% across all time periods (Figure 4.1.7.(b)).

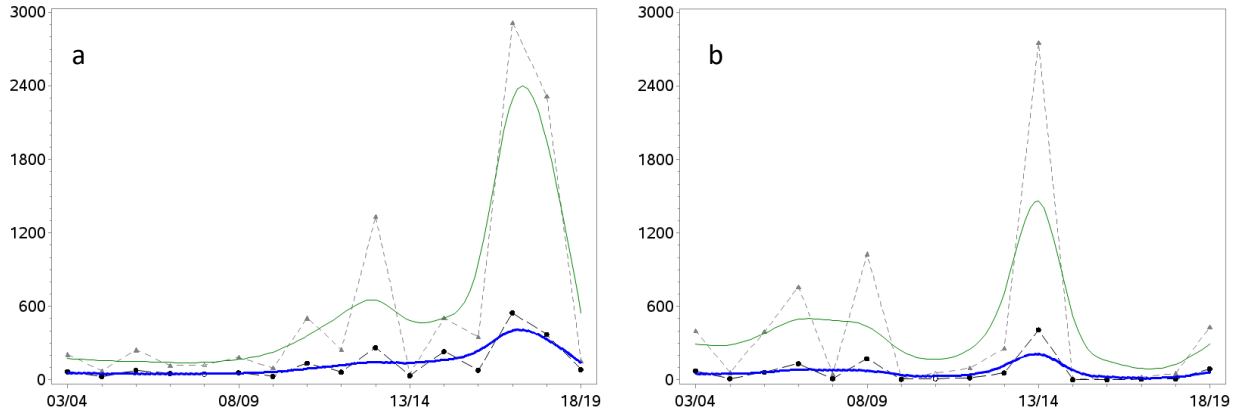

Figure 4.1.7: (a) The trend in the number of Eider on Kilroot to Seapark (02922), Belfast Lough. (b) The trend in the number of Eider on Whiteabbey to River Lagan (01422), Belfast Lough. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts.

4.1.8. Red-breasted Merganser *Mergus serrator*

Red-breasted Merganser can be found in all sectors of Belfast Lough, and the lough-wide population has remained stable across all time periods despite a steady decline across Northern Ireland as a whole. As a result, the proportion of the Northern Irish population of Red-breasted Merganser held by Belfast Lough has increased from around 20% to around 30%. Trends varied between sectors, although most increased over the long-term. The exception was Kinnegar to Grey Point (01424), which experienced steep declines of at least 50% over the long-term but was stable over the short-term and had a moderate increase (33% to 100%) over the medium-term. In contrast, Whiteabbey to River Lagan (01422) increased by at least 100% over the long-term but had steep declines over the medium- and short-terms. Trends were stable over the short-term on the north-west shore of the lough in Kilroot to Whiteabbey (02421, containing Seapark to Macedon (02921) and Kilroot to Seapark (02922)), with a slight increase over the long-term. Sectors with particularly large five-year mean peaks and mean winter peaks of Red-breasted Mergansers were Whiteabbey to River Lagan (01422) and Seapark to Macedon (in parent sector Kilroot to Whiteabbey). These sectors contrasted in the change in the percentage of the site total they supported during the study period, with the proportion found in Seapark to Macedon increasing from around 30% to around 50%, and the proportion found in Whiteabbey to River Lagan decreasing from a high of around 45% in 2008/09 to around 16%. This suggests that although overall numbers are stable, Red-breasted Mergansers are redistributing within the lough perhaps indicative of local pressures in some areas of the lough.

4.1.9. Greater Scaup *Aythya marila*

Scaup have suffered a significant decline in Northern Ireland since a peak in 2007/08. In Belfast Lough, a steep decline happened after a peak in 2009/10 and the importance of the site in the Northern Irish context has dropped from holding around 20% of the country's Scaup between 2003/04 and 2008/09 to only around 5% between 2012/13 and 2018/19. This may be indicative of Belfast Lough being less attractive relative to other sites in the face of a regional decline rather than local pressures. The most important sectors in the lough in terms of five-year mean peaks and mean winter peaks was Whiteabbey to River Lagan (01422). At the time of the greatest recorded number of Scaup in the Belfast Lough, this sector represented around 90% of the Scaup recorded. However, similarly to the trend for the site and other sectors within the site, Scaup in Whiteabbey to River Lagan suffered long- and medium-term declines and continued to decline at a slower rate over the short-term.

4.1.10. Common Goldeneye *Bucephala clangula*

While Goldeneye have undergone steep declines of at least 50% across all time periods in Belfast Lough as a whole, this matches a steady decline across the whole of Northern Ireland and the site itself has not declined disproportionally to Northern Ireland as a whole. It follows that declines on the lough itself are unlikely to be the result of local pressures. Goldeneye were recorded in all sectors of the lough, although the most important sectors in terms of five-year mean peaks and mean winter peaks were Whiteabbey to River Lagan (01422), Kinnegar to Grey Point (01424) and Kilroot to Whiteabbey (02421) predominantly represented by the sub-sector Seapark to Macedon (02921). All around the lough, steep declines were recorded across all time periods, and there did not appear to be any major redistribution of Goldeneye between the sectors of the site.

4.1.11. Great Crested Grebe *Podiceps cristatus*

Great Crested Grebes underwent steep declines of at least 50% across all time periods in Belfast Lough. Although the Northern Irish population as a whole also declined in the study period, the proportion of the reginal population supported by Belfast Lough has declined disproportionally from around 70% in 2005/06 and 2006/07 to just 10% since 2014/15 suggesting the site-specific factors may be influencing the wintering population of the lough (Figure 4.1.11: (a)).

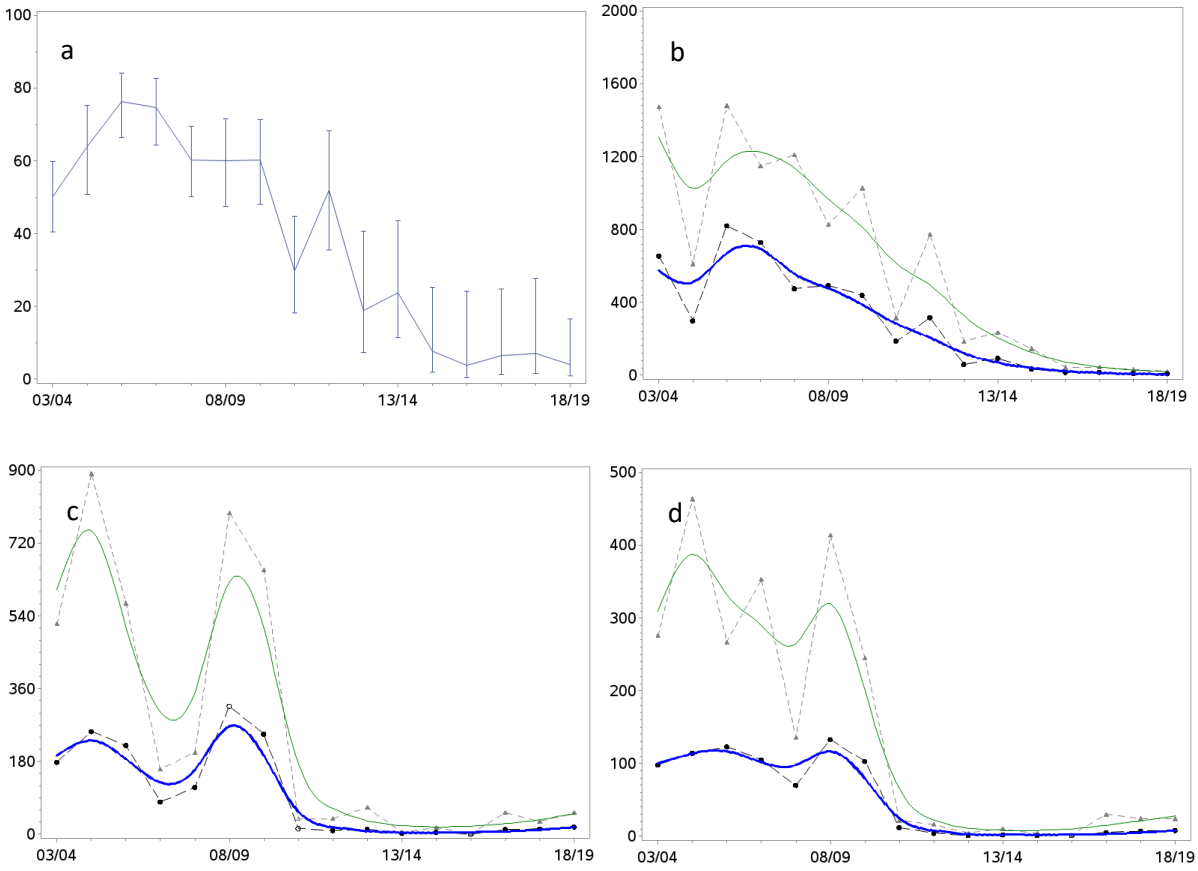

Figure 4.1.11: (a) The percent proportion of Great Crested Grebe in Northern Ireland that have been recorded in Belfast Lough between the winters of 2003/04 and 2018/19. (b - d) The trend in the number of Great Crested Grebe on (b) Seapark to Macedon (02921), (c) Whiteabbey to River Lagan (01422) and (d) Kinnegar to Greys Point (01424), Belfast Lough. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts.

The sector with the highest five-year mean peaks and mean winter peaks of Great Crested Grebes in Belfast Lough was Seapark to Macedon (02921, in Kilroot to Whiteabbey (02421), Figure 4.1.11: (b)). This sector supported between 50% to 90% of the site's population from 2003/04 and 2015/16, but the proportion appeared to drop steeply after the winter of 2015/16, although the confidence intervals for this measure were broad. Other important sectors in the lough by five-year mean peaks and mean winter peaks in the latest year were Whiteabbey to River Lagan (01422) and Kinnegar to Grey Point (01424). Both steeply declined (by at least -50%) over the medium- and long-terms, but showed slight recovery (33% to 100%) over the short-term (Figure 4.1.11: (c and d)). These disproportional declines between sectors may be indicative of local pressures in some parts of the site.

4.1.12. Eurasian Coot *Fulica atra*

The Coot population of Belfast Lough is very small compared to the overall Northern Irish population, which increased over the study period. However, Coot in Belfast Lough steeply declined over the long- and medium-terms, while over the short-term they stabilised. The most important sector of the lough for Coot was BP Pools and Victoria Park (01223), and very few Coot were recorded outside this sector. Declines were less steep over the long-term for Coot in BP Pools and Victoria Park, but medium- and short-term declines matched those of the overall site.

4.1.13. Eurasian Oystercatcher *Haematopus ostralegus*

Moderate declines in the wintering Oystercatcher population of Belfast Lough over the long- and medium-terms follow trends seen across Northern Ireland, and the lough contained approximately 20% of the total winter population of Northern Ireland throughout the study period. No sectors within the site saw increases at any time scale, and the only sector to remain stable was Seapark to Macedon (02921, in Kilroot to Whiteabbey (02421)). As a result, this sector became more important in terms of the proportion of the site's Oystercatcher it held over time. The sector with the highest five-year mean peak and mean winter peak in the latest year was Whiteabbey to River Lagan (01422) and this sector declined consistently but moderately (25% to 50%) over all time periods. Kinnegar to Grey Point (01424) and Kilroot to Seapark (02922, in Kilroot to Whiteabbey) both underwent steep declines (of at least 100%) over the long-term but stabilised at a lower population size in the short-term.

4.1.14. Common Ringed Plover *Charadrius hiaticula*

While Ringed Plover appeared to decline slightly over time in Northern Ireland, numbers in Belfast Lough remained stable throughout the study period. However, trends within the sectors were mixed. Ringed Plover declined steeply (by at least 50%) in BP Pools and Victoria Park (01223) over the long- and medium-terms, declining sufficiently that trends could not be calculated over the short-term. The most important sectors in the lough in terms of five-year mean peak and mean winter peak were those furthest from Belfast city, Greys Point to Ballymacormick Point (01425) and Kilroot to Seapark (02922, in Kilroot to Whiteabbey (02421)), but these had contrasting trends. Numbers of Ringed Plover in Grey Point to Ballymacormick Point increased by at least 100% across all time periods and increased in the proportion of the sites total it supported over time. Numbers in Kilroot to Seapark were stable over the long-term, but declined over the medium- and short-terms after reaching a peak in 2007/08. The redistribution within the lough may be indicative of local pressures in some areas within the lough.

4.1.15. European Golden Plover *Pluvialis apricaria*

The Northern Irish population of wintering Golden Plover suffered a steep decline between 2005/06 and 2010/11. Similarly, the population of Belfast Lough underwent a steep decline across all time-periods, with a notable decline between 2005/06 and 2008/09, followed by a recovery and another decline, which appears to have been driven by changes in the numbers found in BP Pools and Victoria Park (01223). This sector contained the majority of Golden Plover until more recent years, when Golden Plover have almost entirely disappeared from the lough.

4.1.16. Purple Sandpiper *Calidris maritima*

Few Purple Sandpiper are recorded in Northern Ireland, and at the Northern Ireland scale, this species has undergone a decline followed by a levelling out. Belfast Lough increased its importance for Purple Sandpiper in Northern Ireland from holding around 5% of the winter population 2005/06 to around 20% in the most recent five years. Despite this, numbers were low enough to make trend calculation unfeasible.

4.1.17. Northern Lapwing *Vanellus vanellus*

Declines in wintering Lapwing across all time periods in Belfast Lough follow declines seen at the Northern Ireland level. The most important sectors on the lough for Lapwing in terms of five-year mean peak and mean winter peak in the latest year were BP Pools and Victoria Park (01223), Whiteabbey to River Lagan (01422) and Greys Point to Ballymacormich Point (01425). Grey Point to Ballymacormick Point (01425) was the only sector to have an increase in Lapwing in any time-period. While it remained stable in the long-term, the sector had moderate (33% to 100%) increases over the medium-term and steep increases (of at least 100%) over the short-term. BP Pools and Victoria Park (01223) experienced declines across all time periods, and particularly steep declines over the long- and medium terms.

4.1.18. Dunlin *Calidris alpina*

Dunlin in Northern Ireland underwent a decline between 2003/04 and 2010/11 but have seen a very slight increase since. In contrast, numbers in Belfast Lough reached a peak in 2015/16 but have dropped steeply since then, and as a result while there was a moderate increasing trend in the medium term, the long- and short-term trends were stable. Within the lough, Dunlin tended to be increasing across most time periods. The exception to this was found in Whiteabbey to River Lagan (01422), which experienced a decline in Dunlin numbers across all time-periods. Until 2014/15, this sector contained 60% to 80% of the site's Dunlin (Figure 4.1.18: (a)). At around the same time, Dunlin appeared to be redistributing to Kilroot to Whiteabbey (02421, including Seapark to Macedon (02921) and Kilroot to Seapark (02922), Figure 4.1.18: (b)), which saw increases of at least 100% across all time periods. The only sector not to contain over 10% of the five-year mean peak numbers of Dunlin was Kinnegar to Grey Point (01424), and this sector and BP Pools and Victoria Park (01223) held less than 10% of the of the total peak count for Belfast Lough in the latest year. This redistribution may be indicative of local pressures acting in some areas of the lough

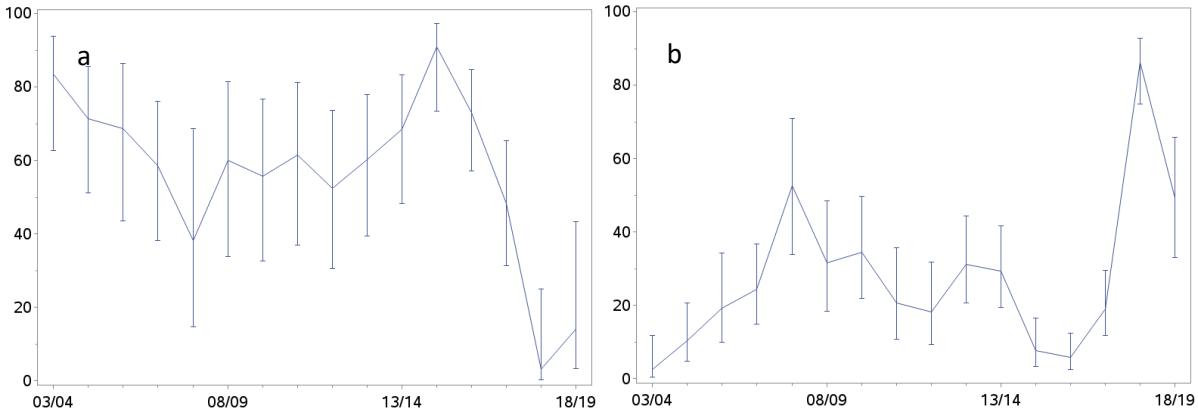

Figure 4.1.18: (a) The percent proportion of Dunlin in Belfast Lough that have been recorded in Whiteabbey to River Lagan between the winters of 2003/04 and 2018/19. (b) The percent proportion of Dunlin in Belfast Lough that have been recorded in Kilroot to Whiteabbey between the winters of 2003/04 and 2018/19.

4.1.19. Red Knot *Calidris canutus*

Numbers of Knot in Northern Ireland were variable throughout the study period but were generally in decline. However, the population of Knot found in Belfast Lough, increased across all time periods, particularly increasing by at least 100% over the medium- and long-terms. The most important sectors in the lough in terms of both five-year mean peaks and mean winter peaks were BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422). While there was insufficient data to calculate long- and medium-term trends for BP Pools and Victoria Park, in the short-term this sector experienced a steep increase in Knot numbers, and Knot in Whiteabbey to River Lagan steeply increased over the long- and medium-terms but were stable in the short-term.

4.1.20. Black-tailed Godwit *Limosa limosa*

Black-tailed Godwit were on the increase in Northern Ireland, but increases were more moderate in Belfast Lough, which reached a peak in 2013/14 but declined after that. Over the long-term this resulted in a moderate increase (33% to 100%) and a decline in the importance of the lough for Black-tailed Godwit in a Northern Ireland context. Sector-level trends generally followed that of the site overall, although BP Pools and Victoria Park (01223) remained stable across all time periods. The most important sectors in the lough in terms of both five-year mean peaks and mean winter peaks were BP Pools and Victoria Park and Whiteabbey to River Lagan (01422).

4.1.21. Bar-tailed Godwit *Limosa lapponica*

Bar-tailed Godwit increased moderately (33% to 100%) across all time periods, matching increases seen across Northern Ireland. The greatest increases within the site were seen in BP Pools and Victoria Park (01223). Only Whiteabbey to River Lagan (01422) had a negative trend during the study period, with numbers of Bar-tailed Godwit declining steeply (by at least 50%) over the medium-term. Insufficient numbers of Bar-tailed Godwit were recorded in Kinnegar to Greys Point (01424), Greys Point to Ballymacormich Point (01425) and Kilroot to Seapark (02922, in Kilroot to Whiteabbey (02421)). The most important sectors in the lough by five-year mean peaks and mean winter peaks in the latest year were BP Pools and Victoria Park, Whiteabbey to River Lagan and Seapark to Macedon (02921, in Kilroot to Whiteabbey). This redistribution may be indicative of local pressures acting in some areas of the lough.

4.1.22. Ruddy Turnstone *Arenaria interpres*

The importance of Belfast Lough for Turnstone in a Northern Ireland context has increased during the study period from holding around 20% of the population, to around 35%. This is due to steady declines in the total Northern Ireland population in combination with stability over the long- and medium-terms in Belfast Lough. However, in the short-term Turnstone declined moderately (25% to 50%) in the lough. Turnstones were commonly recorded in all sectors of the lough and trends between sectors were variable (Figure 4.1.22). Turnstone were stable on the south-east shore of the lough and increased over the long term in BP Pools and Victoria Park (01223) and Seapark to Macedon (02921, in Kilroot to Whiteabbey (02421)). However, steep declines (by at least 50%) were observed in Whiteabbey to River Lagan (01422) across all time periods.

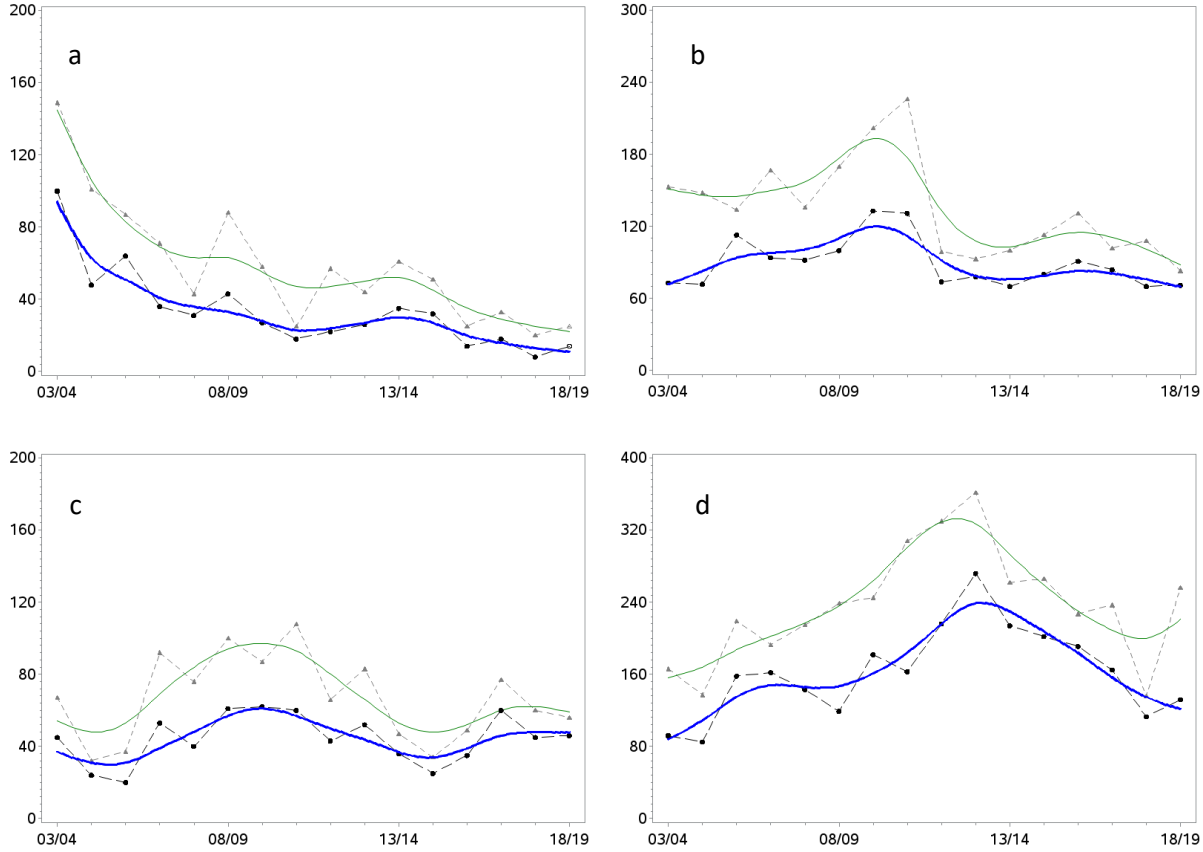

Figure 4.1.22: The trend in the number of Turnstone on (a) Whiteabbey to River Lagan (01422), (b) Kinnegar to Greys Point (01424), (c) Greys Point to Ballymacormich Point (01425) and (d) Kilroot to Whiteabbey (02421), Belfast Lough. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts.

4.1.23. Eurasian Curlew *Numenius arquata*

The winter population of Curlew in Northern Ireland declined steadily throughout the study period. In Belfast Lough, declines were observed over the long- and medium-term but stabilised over the short-term, although the proportion of the Northern Ireland total changed little over time. Curlew were recorded in all sectors of the site, but the most important sectors in terms of both five-year mean peaks and mean winter peaks were BP Pools and Victoria Park (01223) and Seapark to Macedon (02921, in Kilroot to Whiteabbey (02421)), containing over 20% of the site total. Trends could be generated for all sectors but Grey Point to Ballymacormick Point (01425), and the majority of these were strongly negative. However, overall Kilroot to Whiteabbey (02421) remained stable

across all time periods, possibly due to the contrast in trends within the sub-sectors; declines across all time periods in Kilroot to Seapark (02922) and long-term moderate increases (33% to 100%) in Seapark to Macedon.

4.1.24. Common Redshank *Tringa totanus*

There was a strong long-term decline and moderate declines over the medium- and short-terms in wintering Redshank numbers in Belfast Lough, consistent with declines seen across Northern Ireland. At the sector level, the strongest long-term declines were recorded in Whiteabbey to River Lagan (01422) and Kinnegar to Grey Point (01424). In the last five winters, most sectors contained at least 10% of the site's total mean peak, but the most important sectors in the most recent year were Whiteabbey to River Lagan and Kilroot to Whiteabbey (02421, including Seapark to Macedon (02921) and Kilroot to Seapark (02922)). This sector remained stable over the long- and medium-terms and increased in its importance in the site context from supporting around 15% to around 25% of the site's total Redshank over the study period. Grey Point to Ballymacormick Point (01425) was the only sector to have a positive trend in any time period and was recorded as having moderate increases (33% to 100%) over the long-term.

4.1.25. Great Cormorant *Phalacrocorax carbo*

While numbers of wintering Cormorant appeared to decline over the long-term across Northern Ireland, numbers remained stable in Belfast Lough across all time periods. Cormorants were recorded in all sectors of the site, and the distribution was fairly even in terms of five-year mean peaks and the most recent mean winter peaks. Most trends in the sectors were positive. Only one sector maintained stable numbers over the long-term, Kinnegar to Grey Point (01424), and one sector with strong declines over the long-term as well as the medium- and short-terms, Grey Point to Ballymacormick Point (01425).

4.2. Species trends - Belfast Lough Low Tide Counts (low tide)

4.2.1. Mute Swan *Cygnus olor*

Very few Mute Swans were recorded in the low tide sectors of Belfast Lough during the study period. The only sector to have sufficient data to generate trends was Belfast Lough LTC 3.5 (BB014), namely Victoria Park. While there were moderate increases of at least 33% but less than 100%) over the short-term, numbers of Mute Swans in the park declined by at least 50% over the long term.

4.2.2. Light-bellied Brent Goose *Branta bernicla hrota*

Light-bellied Brent Geese increased in numbers by at least 100% over the long-term during low tide in Belfast Lough, although over the medium- and short-term numbers were stable. Only two sectors of the lough had sufficient records of Light-bellied Brent Geese to generate trends: Belfast Lough LTC 1.2 (BB002, now split into BB028-BB031) and Belfast Lough LTC 5.1 (BB018). Both sectors increased their numbers of Light-bellied Brent Geese in the long-term and were stable over the short-term. However, Belfast Lough LTC 1.2 underwent a steep decline (by at least 50%) in the medium-term while Belfast Lough LTC 5.1 underwent a steep increase (by at least 100%) during the same time period, suggesting that between 2007/08 and 2017/18 there may have been some redistribution of Brent geese in the low tide sectors of the lough.

4.2.3. Common Shelduck *Tadorna tadorna*

The majority of Shelduck were recorded in the low tide sectors in the south west of the lough, close to Belfast Harbour. Trends across the whole lough were stable for all time periods but varied between sectors. Belfast Lough LTC 2.2 (BB006) was the only sector to see declines in numbers of Shelduck across all time periods, while numbers in neighbouring sector Belfast Lough LTC 2.3 (BB007) increased by at least 100% across all time periods, suggesting that there has been a redistribution of Shelduck between particularly this sector and surrounding sectors. This redistribution may be indicative of local pressures acting in some parts of the lough.

4.2.4. Eurasian Wigeon *Mareca penelope*

Unlike the declines recorded over the long-term in the Core Counts, at low tide Wigeon remained stable over the medium- and long-terms in Belfast Lough as a whole, and numbers increased moderately over the short-term. However, similarly to the pattern observed at high-tide, trends were more negative in sectors east of the Lagan, particularly in Belfast Lough LTC 3.3 (BB012), whereas Belfast Lough LTC 2.2 (BB006) experienced increases in numbers of at least 100% over all time periods.

4.2.5. Eurasian Teal *Anas crecca*

Teal were mostly recorded in sectors close to Belfast Harbour, and trends could only be generated for three sectors. Belfast Lough LTC 1.2 (BB002, now split into BB028-BB031) and Belfast Lough LTC 2.2 (BB006) both declined steeply across all time periods, while in Belfast Lough LTC 2.3 (BB007), just north of Giant's Park and BB006, Teal increased by at least 100% over the long- and short-terms. However, despite these increases, low tide trends for Teal in Belfast Lough were more negative than the Core Count trends, and overall they declined steeply (by at least 50%) across all time periods.

4.2.6. Mallard *Anas platyrhynchos*

Similarly to the Core Count trends, Mallard at low tide were stable over the long-term in Belfast Lough. At low tide, Mallard were concentrated in sectors close to Belfast Harbour. Trends could be generated for eight sectors, and within these, Mallard increased over the long-term in five. In particular, Mallard in Belfast Lough LTC 2.1 (BB005) and Belfast Lough LTC 2.3 (BB007) increased by at least 100% over al time periods. The only sector to show long- and medium-term steep declines (of at least 50%) was Belfast Lough LTC 3.3 (BB012); the RSPB Belfast Lough Reserve.

4.2.7. Common Eider *Somateria mollissima*

Eider abundance remained stable at low tide in Belfast Lough over all time periods, contrasting to the Core Counts, where a moderate long-term increase was observed. Numbers of Eider observed in low tide sectors around Belfast Lough varied hugely. The sector which recorded the highest low tide mean peak counts over the last five winters was Belfast Lough LTC 1.2c (BB029), with neighbouring sectors on the north-west shore of the lough also containing the majority of the lough's wintering Eider. Trends could be generated for seven sectors, and these were mixed and did not appear to follow a spatial pattern. Belfast Lough LTC 2.3 (BB007), adjacent to Giant's Park, saw steep increases (of at least 100%) across all time periods. Eider increased at Belfast Lough LTC 3.3 (BB012) and Belfast Lough LTC 3.6 (BB024) in the short-term, although in these sectors the short-term increases were preceded by declines. Steep declines (of at least 50%) were recorded in Belfast Lough LTC 2.1 (BB005) and Belfast Lough LTC 2.5 (BB009) over the long-term.

4.2.8. Red-breasted Merganser *Mergus serrator*

Red-breasted Merganser abundance was stable at low tide in Belfast Lough over the medium- and short-terms, but showed signs of a moderate long-term increase, contrasting with the stability seen over the long-term in Core Counts. Trends were generated for 17 sectors around the lough, and the majority of these showed increases in Red-breasted Merganser numbers over time. In particular, Belfast Lough LTC 3.1 (BB010) off the coast of Holywood, and Belfast Lough LTC 1.2d (BB028) and Belfast Lough LTC 1.2c (BB029) near Jordanstown showed consistent large increases (of at least 100%) over all time periods. However, Belfast Lough LTC 5.1c (BB027) and Belfast Lough LTC 1.2b (BB030), neighbouring Belfast Lough LTC 1.2c and d had contrasting trends, with long-term stability but declined moderately (25% to 50%) in the medium-term and steeply (by at least 50%) in the short-term. Sectors on the outer edges of the lough appeared to have mostly increased over the long-term.

4.2.9. Greater Scaup *Aythya marila*

Few Scaup were observed at low tide in Belfast Lough, but numbers were stable across all time periods. This contrasts strongly with the site-level Core Count trend, which showed the Scaup had declined strongly over all time periods. Trends could only be generated for three low tide sectors, and while these contained consistent numbers of Scaup over the medium- and short-terms, trends varied over the long-term. Belfast Lough LTC 1.2 (BB002, now split into BB028-BB031) underwent long-term increases, although the sub-sector contained within it, Belfast Lough LTC 1.2d (BB028), had a steep decline in Scaup over the long-term. This suggests that Scaup may have redistributed between sectors in this area of the lough. The other sector with trends generated was Belfast Lough LTC 4.1 (BB015), and this sector also had long-term, steep declines (by at least 50%) in Scaup.

4.2.10. Common Goldeneye *Bucephala clangula*

Consistent with Core Count trends, Goldeneye in Belfast Lough at low tide underwent steep declines in abundance (by at least 50%) over the long- and medium-terms, although declines were less steep than observed for Core Counts in the short-term. Goldeneye were recorded in low numbers around the lough at low tide, and trends could only generated for four sectors. Of these, the majority were negative, and all sectors with trends declined in their numbers of Goldeneye over the long-term. Only one sector had a positive trend, and this was Belfast Lough LTC 3.1 (BB010), off the coast of Holywood, where Goldeneye increased by at least 100% over the short-term.

4.2.11. Great Crested Grebe *Podiceps cristatus*

Great-crested Grebe declined by at least 50% over the long- and medium-terms in Belfast Lough at low tide, although this decline was less steep in the short-term than that seen in the Core Counts. Trends were generated for ten Sectors, and the majority of these were steeply negative, with numbers of Great Crested Grebes declining steeply in the medium- and long-terms in all but one sector (Belfast Lough LTC 2.3 (BB007), north of Giant's Park), which had a stable medium-term trend. However, there were signs of recovery in the south-west corner of the lough, with increases in numbers of at least 100% for sectors Belfast Lough LTC 2.2 (BB006) to Belfast Lough LTC 2.4 (BB008) over the short-term.

4.2.12. Eurasian Coot *Fulica atra*

Similarly to findings for Core Counts, Coot were rarely recorded in the wider lough at low tide and trends were only available for Belfast Lough LTC 3.5 (BB014), Victoria Park. Mirroring Core Count

findings, Coot were strongly in decline during the study period at low tide, reducing in numbers by at least 50% across all time period in BB014, but less strongly in the short-term for the lough overall.

4.2.13. Eurasian Oystercatcher *Haematopus ostralegus*

Oystercatchers were commonplace in most counted sectors around Belfast Lough at low tide, and overall trends matched those of the Core Count, with medium- and long-term moderate declines (25% to 50%) and stability over the short-term. Trends were generated or 29 of the 33 low tide sectors, and on the whole these were negative. No sectors experienced increases in Oystercatchers over the long-term, while 12 sectors underwent declines of at least 100% and a further 14 declined in numbers by at least 25% but less than 50%. Some increases were recorded over the medium-term between Belfast Lough LTC 2.3 (BB007) and Belfast Lough LTC 2.5 (BB009), while declines tapered to stability in the short-term on the outer edges of the lough in sectors between Belfast Lough LTC 4.2 (BB016) and Belfast Lough LTC 6.3 (BB022).

4.2.14. Common Ringed Plover *Charadrius hiaticula*

Although numbers were stable over the medium- and short-terms, Ringed Plover declined over the long-term in low tide sectors in Belfast Lough, contrasting with the long-term stability observed in the Core Counts. Sectors within the site varied in their trends, and there did not appear to be a spatial pattern to changes. Numbers on Belfast Lough LTC 3.5 (BB014) declined sufficiently over the long- and medium-terms (by at least 50%) that no short-term trend could be generated, and Belfast Lough LTC 5.2 (BB019) declined steeply across all time periods. Two sectors that held the greatest number of Ringed Plover in the last five years, Belfast Lough LTC 6.4 (BB023) and Belfast Lough LTC 5.1a (BB025) increased over the long- and medium-terms, and remained stable, respectively. Short-term increases were also observed in Belfast Lough LTC 3.1 (BB010). The variation in trends suggests that while declines were occurring in some areas, these could be redistributions to other sectors. This may be indicative of local pressures underpinning declines in some areas of the lough

4.2.15. European Golden Plover *Pluvialis apricaria*

There were insufficient Golden Plover recorded at low tide in Belfast Lough to generate trends at the sector- or site-level. This is reflective of the fact that Golden Plover are unlikely to be found foraging on inter-tidal areas.

4.2.16. Purple Sandpiper *Calidris maritima*

There were insufficient Purple Sandpiper recorded at low tide in Belfast Lough to generate trends at the sector- or site-level.

4.2.17. Northern Lapwing *Vanellus vanellus*

Lapwing numbers underwent steep declines at least 50% over the long- and medium-terms, and continued to decline moderately over the short-term, matching trends seen in Core Counts over the same time periods. Trends were generated on nine sectors for Lapwing, and of these, the majority showed steep declines, influencing the overall negative trend of the site. Only one sector, Belfast Lough LTC 6.3 (BB022) near Carnalea, increased in the number of Lapwing it held across all time periods. An increase in numbers of at least 100% was observed in Belfast Lough LTC 2.3 (BB007) in the medium-term, however this sector also had steep declines in the long- and short-terms. Moderate increases were also observed over the short-term in Belfast Lough LTC 1.3 (BB032). However, these small gains were not sufficient to slow the decline in Lapwing recorded during the low tide at the site level.

4.2.18. Dunlin *Calidris alpina*

Low tide trends in Dunlin abundance on Belfast Lough matched those of the Core Counts; numbers remained stable over the long- and short-terms but increased moderately in the medium-term. Dunlin were relatively widespread in the low tide sectors of the lough but were concentrated most around the mouth of the harbour between Belfast Lough LTC 2.2 (BB006), around Giant's Park, and Belfast Lough LTC 3.1 (BB010), near Holywood. Within-site trends were varied; trends were available for 10 sectors, and in five of these steep declines in Dunlin of at least 50% were recorded over the long-term, while only two increased by at least 100% over the long-term. Similarly, over the short-term, Dunlin declined in five sectors but only increased in one. These differences, paired with the overall stability of the Dunlin numbers in the lough, suggests that the location of Dunlin in Belfast Lough at low tide is very variable and that gains and losses at the sector-level are on the whole due to within-site movements. This may be indicative of local pressures underpinning declines in some areas of the lough.

4.2.19. Red Knot *Calidris canutus*

Similarly to Dunlin, Knot appeared to be most common in sectors between Belfast Lough LTC 2.2 (BB006), around Giant's Park, and Belfast Lough LTC 3.1 (BB010), near Holywood, although numbers were fewer. Despite their low numbers, Knot increased their presence in Belfast Lough at low tide across all time periods by at least 100%, echoing gains also seen in the Core Counts. However, numbers per sector were low, and it was only possible to generate sector-level trends for one sector, Belfast Lough LTC 2.3 (BB007) at the medium- and short-term time periods. At the scale of both time periods, Knot increased in number by at least 100%.

4.2.20. Black-tailed Godwit *Limosa limosa*

During low tides around Belfast Lough, Black-tailed Godwit followed Core Count trends of a long-term moderate increase (33% to 100%) and short-term moderate decline (25% to 50%), but fared better than Core Counts over the medium-term, showing a moderate increase. Long-term trends in the sectors of the lough were generally strongly positive, with increases of at least 100% in the Black-tailed Godwit recorded on five of the eight low tide sectors with trends available. These increases were all on the western shore of the lough, while in Belfast Lough LTC 3.3 (BB012), the RSPB Belfast Lough Reserve, steep declines were observed over the long- and medium-terms. In the short-term, three sectors experienced steep declines in Black-tailed Godwit, Belfast Lough LTC 1.2 (BB002, now split into BB028-BB031), Belfast Lough LTC 2.2 (BB006) and Belfast Lough LTC 3.5 (BB014), likely leading to the overall moderate decline seen at the site-level. Declines on some sectors in this species, one increasing in abundance nationally and UK-wide, suggest that local pressures may be having an impact on numbers.

4.2.21. Bar-tailed Godwit *Limosa lapponica*

Bar-tailed Godwits were much fewer in number in Belfast Lough than their relatives, the Black-tailed Godwit. Their numbers at low tide were steadier during the study period than seen in the Core Counts, with long- and short-term stability, and a moderate medium-term increase. Generally, Bar-tailed Godwit were recorded in similar sectors as Black-tailed Godwit, but due to their low numbers trends could only be generated for two sectors. Both of these sectors showed medium-term strong increases (by over 100%) but they different in their long- and short-term trends, suggesting some redistribution between these neighbouring sectors. Belfast Lough LTC 2.3 (BB007), just north of Giant's Park, experienced strong declines in Bar-tailed Godwit over the long-term, but numbers stabilised over the short-term, while numbers in Belfast Lough LTC 2.4 (BB008), just north of BB007,

increased strongly over the long-term but declined slightly over the short-term. These contrasting trends are therefore reflective of some redistribution over time between these neighbouring sectors, possibly indicative of local pressures affecting some areas within the lough.

4.2.22. Ruddy Turnstone *Arenaria interpres*

Turnstone could be found in most sectors of Belfast Lough at low tide in small numbers, although declines occurred over a longer time-period at low tide than during the Core Counts (medium- and short-term moderate declines of 25% to 50%). Trends could be generated for 12 sectors, and these became more negative in the short-term, while long-term trends were more likely to be positive or stable than negative. Positive or negative trends at the sector-level did not follow a clear spatial pattern, although sectors Belfast Lough LTC 5.2 (BB019), Belfast Lough LTC 6.2 (BB021) and Belfast Lough LTC 5.1b (BB026) were the only sectors in increase in their numbers of Turnstone over the long-term, and these sectors were at the outer edges of the lough.

4.2.23. Eurasian Curlew *Numenius arquata*

Wintering Curlew were commonly recorded in most sectors of Belfast Lough, although greatest numbers were observed in sectors close to harbour. Their low tide trends matched those of the Core Counts, with moderate declines observed over the long- and medium-term, while numbers were stable over the short-term. This pattern was reflected within-the site; most sectors with trends declined in their number of Curlew over the long- and medium-terms. Only Belfast Lough LTC 1.3 (BB003) off the coast of Greenisland, underwent a moderate increase (of at least 33% but less than 100%) over the long-term.

4.2.24. Common Redshank *Tringa totanus*

Like Turnstone and Curlew, Redshank were commonly recorded all around Belfast Lough. Declines at low tide at the site level were less steep than recorded in Core Counts; moderate declines (of less than 25% or an increase of less than 33%) were recorded over the long- and medium-terms, while over the short-term numbers were stable. Sectors between Belfast Lough LTC 2.2 (BB006) and Belfast Lough LTC 3.1 (BB010) in Belfast Harbour were the most important areas of the lough for Redshank, and trends within these sectors were mixed. The majority declined to varying degrees over the long-term, whereas numbers of Redshank in Belfast Lough LTC 2.4 (BB008) increase moderately (33% to 100%) over the long-term and steeply (by at least 100%) over the medium-term, suggesting some redistribution of Redshank in this area. In contrast, further north up the shore, numbers of Redshank declined steeply (by at least 50%) in Belfast Lough LTC 1.2d (BB028) and Belfast Lough LTC 1.2c (BB029) in all time periods, although the numbers of Redshank counted in this area were lower overall. Redistribution over time between sectors, is possibly indicative of local pressures affecting some areas within the lough.

4.2.25. Great Cormorant *Phalacrocorax carbo*

No site-level low tide trend was available for Cormorant in Belfast Lough. Most sectors in Belfast Lough contained fewer than 10 Cormorant at low tide, however, trends were available in five sectors (although Belfast Lough LTC 1.3 (BB003) was replaced by Belfast Lough LTC 1.3 (BB032) and therefore these sectors essentially cover the same area). None of these sectors had positive long-term changes in Cormorant, although the furthest two sectors from Belfast Harbour remained stable. In the medium- and short-terms, most sectors experienced increases in the number of Cormorants, especially Belfast Lough LTC 6.2 (BB021) at Helen's Bay, which increased by at least 100% over the medium- and short-terms.

4.3. Species trends – Lough Foyle Core Counts (high tide)

4.3.1. Mute Swan *Cygnus olor*

Although largely stable over the study period across Northern Ireland as a whole, the relatively small number (approximately 5% of the Northern Irish population) found on the Northern Irish shore of Lough Foyle declined moderately over the long-term (25% to 50%), but was stable over the medium- and short-term. The most important sectors in the lough in terms of five-year mean peaks were Black Brae and Donnybrewer (04411), Faughanvale to Ballykelly (04413) and Myroe (04414), each holding 20% or more of the five-year mean peak for the site. Black Brae and Donnybrewer and Faughanvale to Ballykelly also held more than 20% of Lough Foyle's most recent year mean peak of Mute Swan. Trends could only be calculated for Black Brae and Donnybrewer, and this followed the pattern of the site overall, with a long-term moderate decline and stability over the medium- and short-terms.

4.3.2. Whooper Swan *Cygnus cygnus*

The Northern Irish shore of Lough Foyle supported approximately 40% of Northern Ireland's Whooper Swan between 2003/04 and 2009/10, but this became more variable after 2009/10 and on the whole supported a lower percentage (approximately 30%) between 2013/14 and 2018/19. Across Northern Ireland, Whooper Swan increased in number over the study period, so the decline in Lough Foyle's importance for the species may be due to the moderate long- and medium-term increases being less pronounced than those elsewhere in the region. It is also possible that a greater proportion of the Whooper Swans associated with Lough Foyle may now be foraging outside the area covered by WeBS counts, depending on how far inland counts coverage extends. Trends within the site were variable; one of the most important sectors in terms of the five-year mean peak for the site was Black Brae and Donnybrewer (04411, Figure 4.3.1(a)), and this sector had steep declines in Whooper Swan (of at least 50%) across all time periods, whereas Roe and Balls Point (04415, Figure 4.3.1(b)), which also held over 20% of the site's five-year mean peak, increased steeply over the same time periods. Of the five sectors with calculatable trends however, three had strongly positive long-term increases in Whooper Swan, therefore while there may have been some redistribution within the site, overall numbers increased during the study period.

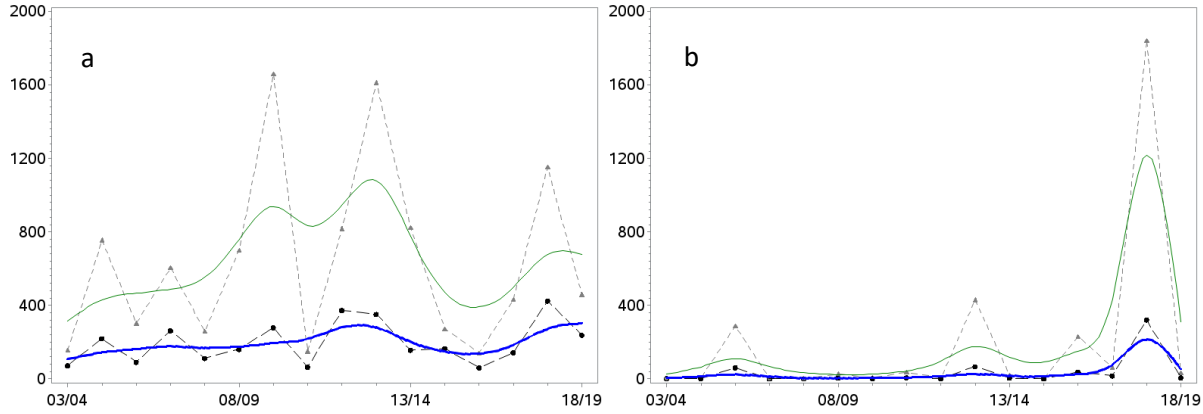

Figure 4.3.1: (a) The trend in the number of Whooper Swan on Black Brae and Donnybrewer (04411), Lough Foyle. (b) The trend in the number of Whooper Swan on Roe and Balls Point (04415), Lough Foyle. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts.

4.3.3. Bewick's Swan *Cygnus columbianus bewickii*

Very few Bewick's Swan were counted across the whole of Northern Ireland during the study period (a maximum mean count of nine in 2003/04). Since 2008/09 no Bewick's Swan were recorded on the Northern Irish shore of Lough Foyle and the species is essentially extirpated from the site. Consequently, no site- or sector-level trends could be generated.

4.3.4. Greylag Goose *Anser anser*

While fairly stable between 2003/04 and 2012/13, there was a decline in number of Greylag Geese in Northern Ireland between 2012/13 and 2016/17. The Northern Irish shore of Lough Foyle experienced a more variable population trend over time, but overall there were steep declines (of at least 50%) over the long- and short-terms, and moderate declines (25% to 50%) over the medium-term. Only two sectors generated trends in the lough: Black Brae and Donnybrewer (04411) and Myroe (04414). The sector with the highest five-year mean peak and mean winter peak of Greylag Goose in Lough Foyle was Black Brae and Donnybrewer, and numbers increased here over all time periods, causing it to contain nearly the whole site's population in the latest four survey years. In contrast, Myroe was formerly the most important sector for Greylag Goose in Lough Foyle and its importance has declined along with the numbers found there during the study period (a decline in numbers of at least 50% over all time periods).

4.3.5. Light-bellied Brent Goose *Branta bernicla hrota*

Lough Foyle supported around 10% of the Northern Irish population of Light-bellied Brent Goose, and numbers on the lough increased slightly (33% to 100%) over the long-term, following the overall increase seen in the region. Trends were generated for six sectors and most of these showed long-term increases in numbers of Light-bellied Brent Goose. However, Faughanvale to Ballykelly (04413, Figure 4.3.5) and Drumavally to Ballymagoland (04418) experienced long-term declines of at least 50%. There was some recovery over the short-term in Drumavally to Ballymagoland, while moderate declines continued over the short-term in Faughanvale to Ballykelly. This sector dropped in its site-level importance for Light-bellied Brent Goose from holding around 70% of the total in 2003/04 to only 15% in 2016/17 (Figure 4.3.5(b)). The most important sectors on the lough for Light-bellied Brent Goose in terms of five-year mean peak were Longfield to Faughanvale (04412), Faughanvale to Ballykelly and Myroe (04414) and the sectors with the greatest mean winter peak in the latest year were Longfield to Faughanvale and Faughanvale to Ballykelly. This apparent redistribution over time between sectors is possibly indicative of local pressures affecting some areas within the lough.

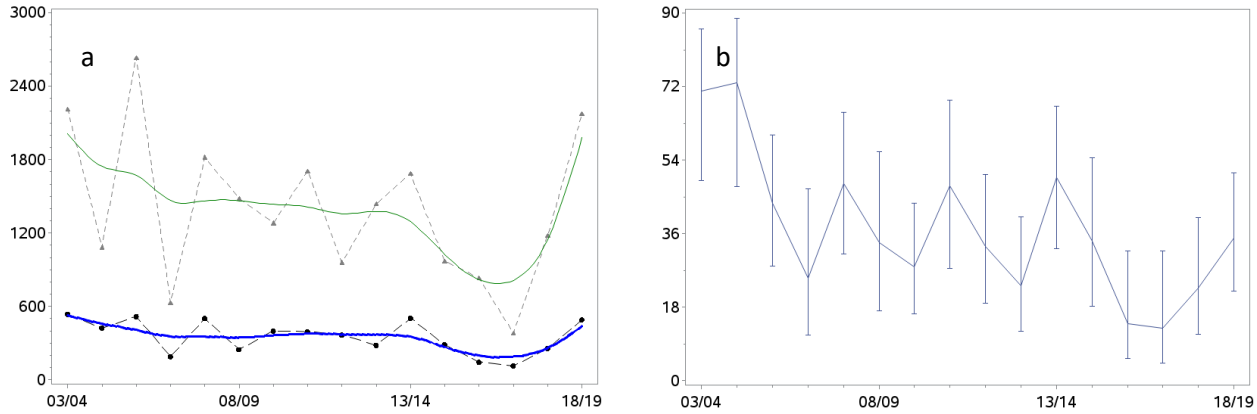

Figure 4.3.5: (a) The trend in the number of Light-bellied Brent Goose on Faughanvale to Ballykelly (04413), Lough Foyle. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts. (b) The percent proportion of Light-bellied Brent Goose in Lough Foyle that have been recorded in Faughanvale to Ballykelly (04413) between the winters of 2003/04 and 2018/19.

4.3.6. Common Shelduck *Tadorna tadorna*

Against a backdrop of regional declines, Shelduck have been stable over the long- and medium-terms on the Northern Irish shore of Lough Foyle, and over the short-term numbers have increased moderately (by 33% to 100%). As a result, the lough has become more important for Shelduck in recent years, although still represents only around 10% of the Northern Irish population at the last year of survey data. Trends were available for three sectors, Longfield to Faughanvale (04412), Roe and Balls Point (04415) and Culmore Country Park (04416), all of which had stable numbers of Shelduck over the medium-term but increased over the short-term. Over the long-term, declines in the number of Shelduck on Roe and Balls Point appeared to be balanced out by increases in Longfield to Faughanvale. The most important sectors in the lough in terms of five-year mean peaks were Longfield to Faughanvale and Roe and Balls Point, while mean winter peaks in the most recent year were highest in Longfield to Faughanvale. This apparent redistribution over time between sectors, is possibly indicative of local pressures affecting some areas within the lough.

4.3.7. Eurasian Wigeon *Mareca penelope*

Wigeon abundance declined steeply in Northern Ireland until 2012/13, and the Northern Irish shore of Lough Foyle also experience long-term steep declines (of at least 50%) and medium-term moderate declines (25% to 50%). However, the small decrease in the proportion of the regional total Wigeon found in the site from around 25% to around 15% suggests that Wigeon numbers are declining faster in the lough than across the region overall. Longfield to Faughanvale (04412) was the most important sector in terms of the five-year mean peak and most recent year mean peak, and generally represented around 70 to 80% of the lough's Wigeon over the study period. This sector experienced moderate declines in the long- and medium-term and it is likely that due to its importance in the site that this sector drives trends for Wigeon in Lough Foyle. Steep declines were also observed in Faughanvale to Ballykelly (04413) over the long-term. However, three out of four sectors for which trends could be calculated showed increases in Wigeon over the short-term, while Longfield to Faughanvale stabilised. On balance, it appears that the lough is relatively less attractive to this species than other sites in Northern Ireland and the observed declines could be due to birds favouring other sites rather than pressures on the lough.

4.3.8. Eurasian Teal *Anas crecca*

Although the Northern Irish population of Teal has increased, the proportion of the total population found in Lough Foyle also increased over the study period from around 15% to 30%, and Teal increased by at least 100% over the long-term in the lough, and by at least 33% but less than 100% over the medium-term. Sector-level trends were generally positive; across the six sectors for which trends were available, half were positive over the long-term, and four over the medium-term. The most important sectors in terms of the five-year mean peak were neighbouring Longfield to Faughanvale (04412) and Faughanvale to Ballykelly (04413). These sectors had contrasting trends. Longfield to Faughanvale increased strongly over the medium- and long-term, and moderately over the short-term, while Faughanvale to Ballykelly declined across all time periods, moderately over the long- and short-terms, and strongly over the medium-term. This suggests that conditions in this part of the lough shore have changed for Teal during the study period, either by becoming more favourable in Longfield to Faughanvale or less favourable in Faughanvale to Ballykelly, or a combination of these changes.

4.3.9. Mallard *Anas platyrhynchos*

Following the regional trend, Mallard on the Northern Irish shore of Lough Foyle remained stable over all time periods despite sector trends, being generally negative, particularly over the medium-term. Only Culmore Country Park (04416) remained stable across all time periods. However, those sectors level declines have been offset by long- and medium-term increases in the Mallard recorded in Longfield to Faughanvale (04412), which was the sector with the highest five-year mean peak. In the most recent year, both Longfield to Faughanvale and Faughanvale to Ballykelly (04413) held over 20% of the site's mean peak Mallard numbers. It may be that increase in the Longfield to Faughanvale sector is indicative of local pressures affecting other areas within the lough.

4.3.10. Northern Pintail *Anas acuta*

Numbers of Pintail have fluctuated across the study period in Northern Ireland, but generally followed an increasing trend. During this time, the Northern Irish shore of Lough Foyle increased its importance in the proportion of the national Pintail population held there from less than 10% between 2003/04 and 2006/07 to around 30% between 2016/17 and 2018/19. The Pintail population of the lough rose steeply (by at least 100%) over the long-term and moderately (by 33% to 100%) over the medium- and short-terms. Nearly all Pintail counts in Lough Foyle came from Longfield to Faughanvale (04412), and therefore the trend of this sector matched that of the site and was the only sector-level trend available.

4.3.11. Common Eider *Somateria mollissima*

Numbers of Eider in Lough Foyle are very low compared to the overall Northern Irish population and declined steeply in all time-periods. Trends were available for only two sectors, Longfield to Faughanvale (04412) and Myroe (04414), and these sectors had the highest proportion of the five-year mean peak numbers of Eider in the site. Over the long-term Myroe underwent a steep decline when a relatively high mean count of around 200 in 2003/04 dropped off to fewer than 30 by 2004/05, and has remained stable since. Longfield to Faughanvale historically held the majority of the site's Eider, but this sector had strong declines (of at least 50%) across all time periods. The decline in numbers of Eider on the lough may well be due to local pressures.

4.3.12. Red-breasted Merganser *Mergus serrator*

Few Red-breasted Merganser were counted on the Northern Irish shore of Lough Foyle, and long- and medium-term moderate declines followed the general decline observed at the regional level. Although the greatest five-year mean peak was found in Longfield to Faughanvale (04412), numbers were insufficient to generate sector level trends.

4.3.13. Common Goldeneye *Bucephala clangula*

The Goldeneye population of Lough Foyle represented a very small proportion of the Northern Irish population but followed the regional trend with declines across all time periods, these being particularly steep (by at least 50%) over the medium- and long-terms. There were insufficient Goldeneye counted in each sector to generate any sector-level trends.

4.3.14. Great Crested Grebe *Podiceps cristatus*

Numbers of Great Crested Grebes were low on the Northern Irish shore of Lough Foyle. The magnitude of decline on the site is small compared to that seen across the region, but steep declines (of at least 50%) were observed over the long-term, moderate declines (25% to 50%) over the medium-term, and numbers stabilised at a low-level over the short-term. Great Crested Grebes were counted in low numbers across all sectors in Lough Foyle, but the most important in terms of the five-year mean peaks were Black Brae and Donnybrewer (04411), Longfield to Faughanvale (04412) and Faughanvale to Ballykelly (04413). Only Longfield to Faughanvale had sufficient data to generate trends, and these were slightly more positive than the site-level trend, with moderate increases (33% to 100%) observed over the short-term and stable numbers over the medium-term.

4.3.15. Eurasian Oystercatcher *Haematopus ostralegus*

Numbers of Oystercatcher have steadily decreased across Northern Ireland, but numbers in Lough Foyle have remained stable across all time periods. As a result, this site became more important in terms of the proportion of national total Oystercatcher it supported over the study period. Trends were generated for all sectors in the site and were mixed in direction although there was no clear spatial pattern. Out of the ten long-term sector-level trends calculated, five were positive, four negative and one was stable, suggesting that while individual sectors may have gained or lost Oystercatchers, overall this is due to movement within the site. Black Brae and Donnybrewer (04411), Longfield to Faughanvale (04412) and Roe and Balls Point (04415) were the most important sectors for Oystercatcher in Lough Foyle in terms of the five-year mean peaks, and these sectors and Myroe (04414) also had the highest mean-peak in the most recent year. Of these, Black Brae and Donnybrewer and Roe and Balls Point increased across all time periods. Of the sectors with negative trends, Faughanvale to Ballykelly (04413) and Ballymagoland to Magillian Point (04426) declined in the number of Oystercatchers across all time periods. Faughanvale to Ballykelly historically used to support up to around 50% of the site's Oystercatcher but declines in this sector have resulted in its importance dropping to less than 10% (Figure 4.3.16). This apparent redistribution over time between sectors, is possibly indicative of local pressures affecting some areas within the lough.

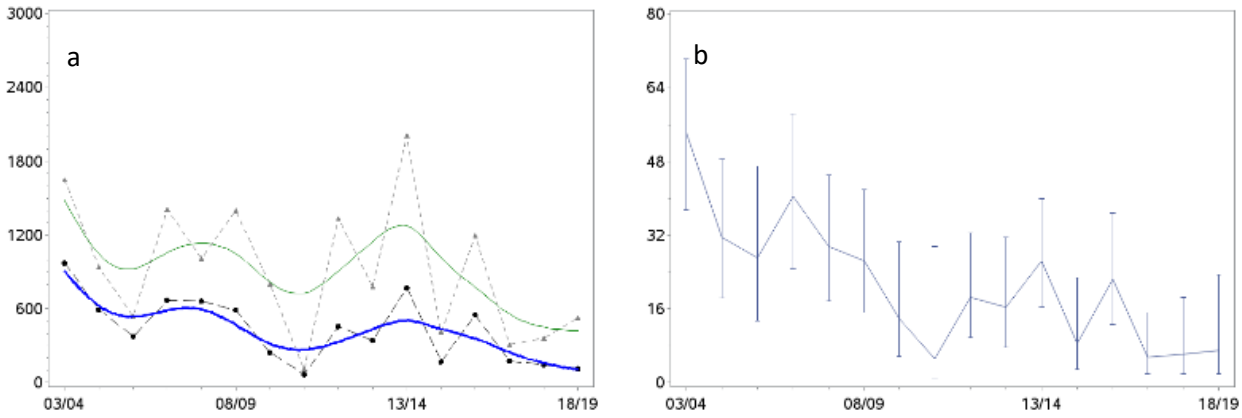

Figure 4.3.16: (a) The trend in the number of Oystercatcher on Faughanvale to Ballykelly (04413). The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts. (b) The percent proportion of Oystercatcher in Lough Foyle that have been recorded in Faughanvale to Ballykelly (04413) between the winters of 2003/04 and 2018/19.

4.3.16. Common Ringed Plover *Charadrius hiaticula*

Few Ringed Plover were counted in Lough Foyle during the study period, and the site generally represented only a very small proportion of the declining Northern Irish population. Numbers reached a peak around 2013/14 and before declining to previous levels, resulting in long-term stability. Small numbers of Ringed Plover were counted in most sectors of the lough, but trends were only generated for two nested sectors. While numbers increased in Ballymagoland to Lower Drummans (04419) across all time periods, the parent sector, Ballymagoland to Magillian Point (04426) showed long- and medium-term steep declines (of at least 50%) and moderate declines (25% to 50%) over the short-term, indicating contrasting trends at sub-sector level in this area.

4.3.17. European Golden Plover *Pluvialis apricaria*

Against a background of decline in Northern Ireland's Golden Plover population, numbers at Lough Foyle fluctuated over the study period, reaching a low number in 2010/11. Site trends revealed that over the long-term Golden Plover declined steeply (by at least 50%) and declined moderately over the medium-term, although in the short-term there was some stability. Sector-level trends could be generated for five sectors and these were generally negative. The only sector to show positive population change was Black Brae and Donnybrewer (04411), where numbers of Golden Plover increased moderately (33% to 100%) over the long-term and steeply (by at least 100%) over the short-term. Alongside Black Brae and Donnybrewer, Myroe (04414) and Roe and Balls Point (04415) also held a significant proportion of the site's five-year mean peak, and whilst Myroe remained stable over the long-term, numbers of Golden Plover at Roe and Balls Point underwent strong long-term declines.

4.3.18. Grey Plover *Pluvialis squatarola*

The Grey Plover population of Northern Ireland was low during the study period, and few were recorded in Lough Foyle. As a result, no site or sector-level trends were available for Grey Plover.

4.3.19. Northern Lapwing *Vanellus vanellus*

Lapwing have declined steadily in Northern Ireland and in Lough Foyle numbers declined until 2012/13, but generally increased since, resulting in a moderate long-term decline (25% to 50%) and stability over the medium- and short-terms. Lapwing were recorded in varying numbers in all sectors

of the lough, and trends could be generated for nine sectors, of which seven were declining over the long-term. The most important sectors in terms of the five-year mean peaks were Black Brae and Donnybrewer (04411), Myroe (04414), Roe and Balls Point (04415) and Culmore Country Park (04416). The highest mean-peaks in the most recent year were counted in Myroe, Black Brae and Donnybrewer and Longfield to Faughanvale (04412). Black Brae and Donnybrewer and Longfield to Faughanvale, neighbouring sectors immediately east of the mouth of the River Foyle, generally had more positive trends than other sectors, and in the short-term most sectors fared better than across longer time periods. The only sector to not generate trends was Lower Doaghs to Magillian Point (04421).

4.3.20. Dunlin *Calidris alpina*

Medium- and short-term moderate increases (33% to 100%) in the Dunlin population of Lough Foyle resulted in the proportion of the Northern Irish population held by the site increasing from around 20% between 2003/04 and 2012/13 to around 30% in more recent winters, with an overall stability observed over the long-term. Trends were generated for nine sectors across the study period, and the majority of these were negative. Similarly to the pattern seen in Lapwing numbers, only Black Brae and Donnybrewer (04411) and Longfield to Faughanvale (04412) were stable or increasing over the long-term. These two sectors increased over the medium- and short-terms also. However, unlike the Lapwing trends, trends in Dunlin numbers were less positive over the short-term, with four sectors showing declines, four showing increases and one stable. The most important sectors in terms of the five-year mean peaks were Black Brae and Donnybrewer, Longfield to Faughanvale and Faughanvale to Ballykelly (04413), and Black Brae and Donnybrewer and Longfield to Faughanvale had the highest mean peak counts in the most recent year. This apparent redistribution over time between sectors, is possibly indicative of local pressures affecting some areas within the lough.

4.3.21. Sanderling *Calidris alba*

Numbers of Sanderling recorded in Northern Ireland during the study period have dramatically increased, and while they were absent in the sectors monitored in Lough Foyle until 2006/07, the extension of the site to include sectors north of Roe and Balls Point (04418) from the winter of 2007/08 has resulted in the majority of the Northern Irish population being found within the site. Due to their more recent inclusion in the lough due to the expansion of coverage, long-term trends were not available for the site (or sectors), but over the medium- and short-term, Sanderling increased in number by over 100%. Sanderling were concentrated in different sectors of the lough to other *Calidris* waders, with the most important sectors being further northeast along the shoreline, at Roe and Balls Point (04415) and Ballymagoland to Magillian Point (04426). Despite moderate declines (25% to 50%) in Drumavally to Ballymagoland and Ballymagoland to Magillian Point (04426), increases in Roe and Balls Point and Ballymagoland to Lower Drummans are sufficient that the overall trend for the site to remain positive, suggesting that increases are not only due to movement between sectors, but increases in visiting Sanderling to Lough Foyle. The contrasting trends between parent sector Ballymagoland to Magillian Point and subsector Ballymagoland to Lower Drummans may be due to the pattern of count coverage across these sectors during the peak for Sanderling in this area of the lough. The number of visits per sector in 2015/16 to 2017/18, when peak Sanderling were observed in Ballymagoland to Lower Drummans, the majority of the counts were made at the Ballymagoland to Magillian Point level rather than at the two lower subsector levels.

4.3.22. Red Knot *Calidris canutus*

Numbers of Knot in declined from 2003/04 to 2009/10, but have partially recovered in recent years, resulting the site level trends showing steep long-term declines (of at least 50%), stability over the

medium-term, but moderate increases (25% to 50%) over the short-term. Trends were only available for three sectors in the lough, and all of these underwent steep long-term declines. Roe and Balls Point (04415) was an important sector for Knot until 2006/07 when the population declined to nearly zero, and although it underwent moderate increases in the medium- and short-terms, the number of Knot in this sector remained low. After a low count in 2004/05, Knot have steadily increased in Longfield to Faughanvale (04412) and numbers of Knot in Faughanvale to Ballykelly (04413) varied a lot over time, resulting in steep medium-term declines. Longfield to Faughanvale and Faughanvale to Ballykelly were the most important sectors for Knot in terms of five-year mean peaks, while these sectors and Drumavally to Ballymagoland (04418) had the highest mean peak counts in the latest year.

4.3.23. Black-tailed Godwit *Limosa limosa*

Lough Foyle supported a low proportion of Northern Ireland's growing Black-tailed Godwit population over the study period, and numbers remained relatively low until an increase in 2016/17. However, calculated trends for the site show that Black-tailed Godwit increased steeply (by at least 100%) across all time periods. There were few Black-tailed Godwit counted outside Longfield to Faughanvale (04412), and this sector was the only one for which a trend could be produced, although the lack of Black-tailed Godwit between 2003/04 and 2009/10 meant than no long-term trends were available. This sector saw a steep medium-term increase in Black-tailed Godwit followed by a stabilisation in numbers, suggesting the continued growth of the population at the site-level is due to increasing numbers in other sectors. The most important sectors in terms of five-year mean peaks and mean peaks in the most recent year were Black Brae and Donnybrewer (04411), Longfield to Faughanvale and Faughanvale to Ballykelly (04413).

4.3.24. Bar-tailed Godwit *Limosa lapponica*

The Northern Irish population of Bar-tailed Godwit increased over the study period, and so too did the apparent population in Lough Foyle, which showed strong increases (of at least 100%) over the long-term and moderate increases over the medium-term. However, interpretation of longer-term trends for this species in Lough Foyle is complicated by the late addition of the most northerly sectors of Drumvalley to Ballymagoland (04418), and Ballymagoland to Magillian Point (04426, including Ballymagoland to Lower Drummans (04419) and Lower Doaghs to Magillian Point (04421)) to the site in 2007/08. For example, the population growth in the lough was greater than that seen regionally, as the proportion of Northern Ireland's Bar-tailed Godwit supported by Lough Foyle increased from around 30% in 2003/04 to around 80% in the last five years of counts, making the site a very important location for the species in Northern Ireland. However, some of this increase will be explainable by the expansion of the site boundaries to the mouth of the lough. Within the lough, sector-level trends were mixed. Of the eight sectors with long-term trends, four were negative, three positive and one stable, whereas there were nine trends available over the short-term, and five of these were positive while four were negative. The most important sectors of the lough in terms of five-year mean peaks were Longfield to Faughanvale (04412) and Faughanvale to Ballykelly (04413). Longfield to Faughanvale only recently (since 2013/14) began to see large numbers of Bar-tailed Godwit and as a result experienced steep increases over all time periods. Roe and Balls Point (04415), Drumavally to Ballymagoland and Ballymagoland to Magillian Point all experienced steep declines (of at least 50%) over all time periods, although long-term trends for the latter two sectors should be treated with caution. The overall pattern at the lough level appeared to be for increases in sectors in the southwest of the site and decreases in sectors further north and east. This is possibly indicative of local pressures affecting the northeast of the lough.

4.3.25. Ruddy Turnstone *Arenaria interpres*

Lough Foyle supports very few Turnstone in the Northern Irish context, however although in decline at the regional level, Turnstone increased in the lough moderately (by at least 33% but less than 100%) over the long- and short-terms, and strongly (by at least 100%) over the medium-term. Sector-level trends could not be produced for Turnstone, but five-year mean peaks and the highest mean peaks in the most recent year were fairly evenly spread across sectors between Black Brae and Donnybrewer (04411) and Myroe (04414), making this southern area of the site the most important area for Turnstone in the Northern Irish shore of the lough.

4.3.26. Eurasian Curlew *Numenius arquata*

Although the Northern Irish wintering population of Curlew declined steadily during the study period, numbers in Lough Foyle remained relatively stable across all time periods. Curlew were recorded in all sectors of the lough and the proportion of five-year mean peaks was high across a large area between Black Brae and Donnybrewer (04411) and Drumavally to Ballymagoland (04418). Trends in the sectors were varied although there did not appear to be any strong spatial pattern in the trends. In two sectors of the site, Longfield to Faughanvale (04412) and Drumavally to Ballymagoland (04418), there was no change in numbers of Curlew across all time periods, whereas Ballymagoland to Magillian Point (04426) experienced strong declines (of at least 50%) at the same temporal scales. Strong declines were also recorded in Faughanvale to Ballykelly (04413, (Figure 4.3.27(a)) and Ballymagoland to Lower Drummans (04419) over the medium- and long-terms. More positive trends were observed over the short-term than across other time-periods, and in particular Black Brae and Donnybrewer (Figure 4.3.27(b)) and Lower Doaghs to Magillian Point (04421) had strongly positive short-term trends. The varied fortunes of the sectors over time, is possibly indicative of local pressures affecting some areas within the lough.

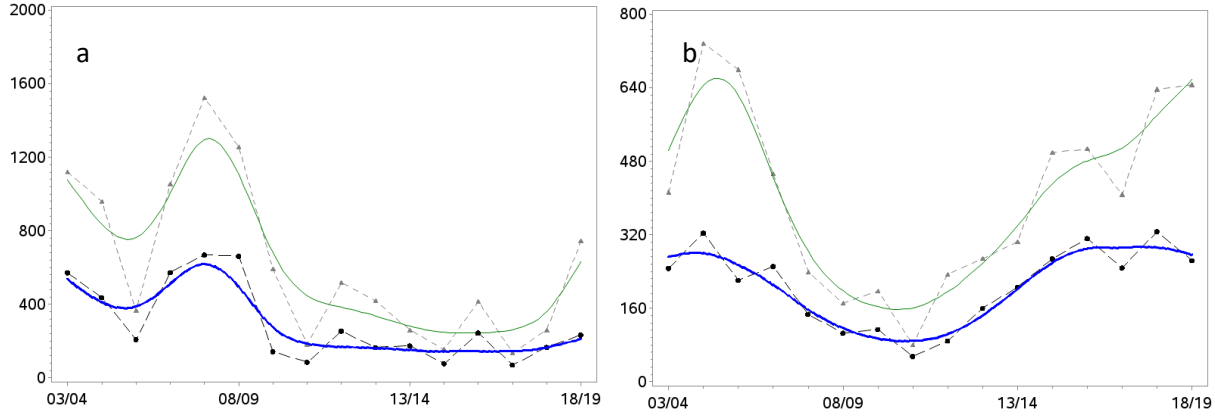

Figure 4.3.27: (a) The trend in the number of Curlew on Faughanvale to Ballykelly (04413). (b) The trend in the number of Curlew on Black Brae and Donnybrewer (04411). The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts.

4.3.27. Common Greenshank *Tringa nebularia*

Greenshank are not recorded in great numbers in Northern Ireland but maintained a steady population size of around 80 to 100 individuals during the study period. However, in Lough Foyle Greenshank underwent moderate declines over the long-term and strong declines over the medium-term, and in 2017/18 the importance of the site in the Northern Ireland context declined from around 20% to around 10%. No sector-level trends were available for Greenshank, but the most important sectors in terms of five-year mean peaks were the sectors between Longfield to

Faughanvale (04412) and Roe and Balls Point (04415), while the greatest mean peaks in the most recent year were found in Myroe (04414) and Roe and Balls Point.

4.3.28. Common Redshank *Tringa totanus*

Counter to the declines observed in Redshank across Northern Ireland, in Lough Foyle numbers remained steady over the long- and medium-terms, while over the short-term there was a slight increase (33% to 100%). This resulted in Lough Foyle increasing the proportion of the Northern Irish wintering population of Redshank it supported from a low of around 10% in 2010/11 to around 20% in 2018/19. Trends could be produced for seven sectors, and of these five were declining over the long-term and only one was positive, at Longfield to Faughanvale (04412). Because the overall site trend was stable over the same time period, this increase is likely to represent a movement of Redshank from other sectors into Longfield to Faughanvale. This sector was also the only one to show increases across all time periods and was the most important sector in terms of five-year mean peaks and mean peaks in the most recent year. Too few Redshank were counted in Ballymagoland to Lower Drummans (04419, including Lower Doaghs to Magillian Point (04421) and Ballymagoland to Magillian Point (04426)) to generate trends. The apparent redistribution towards the Longfield to Faughanvale sector is possibly indicative of local pressures influencing numbers elsewhere within the site.

4.3.29. Slavonian Grebe *Podiceps auratus*

Very few Slavonian Grebe are recorded in Northern Ireland and in most years during the study period Lough Foyle contained the majority of these. Nonetheless, numbers were too few and variable to be able to generate trends at the site- or sector- level. Northern Ireland's Slavonian Grebe population would be best surveyed using a bespoke, boat-based methodology under ideal weather conditions (Neil McCulloch, NIEA, *pers. comm*.).

4.3.30. Great Cormorant *Phalacrocorax carbo*

The proportion of the Northern Irish population of Cormorant represented by Lough Foyle gradually increased over the study period as the site underwent strong increases over the long-, medium- and short-terms. While Cormorant were recorded in all sectors of the lough, they only did so in sufficient numbers on two sectors to generate trends. Cormorant numbers in Longfield to Faughanvale (04412) increased across all time periods, but increases were stronger in the medium- and short-terms, while in Roe and Balls Point (04415) over the long-term numbers were stable but increases were observed over the medium- and short-terms. Longfield to Faughanvale was the most important sector in terms of five-year mean peaks and mean peaks in the most recent year.

4.5 Broad patterns

4.5.1 Belfast Lough

4.5.1.1 Shelduck and waders

As in Austin *et al*. (2008) and Ross-Smith *et al*. (2013), Shelduck and waders are discussed together because all these species feed on mudflat invertebrates, and are therefore likely to respond in similar ways to changes in the environment. Of the 13 species considered, eight declined over at least one time period in Belfast Lough in the 15 winters covered by this report. Some wading species - Oystercatcher, Lapwing, Turnstone, Curlew and Redshank - appeared to be declining across multiple sectors and a range of time scales, and Whiteabbey to River Lagan (01422), Kinnegar to

Grey Point (01424) and Kilroot to Seapark (02922) appeared to fare particularly poorly. Similarly at low tide, trends for these species across the sectors were generally negative, in particular for Redshank around BB028 and BB029, around Whiteabbey and Jordanstown.

Steep declines were also seen in Golden Plover at the lough scale, and these were driven by a single sector for which trends could be calculated (BP Pools and Victoria Park (01223)). However, other wading species showed a contrasting trend, with multiple sectors showing an increase in Dunlin, Knot and Black- and Bar-tailed Godwit across a range of time scales, although short-term trends for Black-tailed Godwit showed a moderate decline across all three sectors where trends could be generated. While Shelduck remained stable over the long and medium-terms, short-term trends showed a moderate decline in BP Pools and Victoria Park and Whiteabbey to River Lagan.

4.5.1.1 Dabbling ducks

Wigeon, Teal, Mallard all declined across at least one time scale in Belfast Lough during Core Counts, although trends varied between sectors and species. BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422), contained the vast majority of dabbling ducks in the lough. Whiteabbey to River Lagan underwent steep increases in Wigeon over all time scales, but these were counteracted by declines in BP Pools and Victoria Park, and overall the site-level trend was negative over the medium- and long-terms. Teal contrasted their trend with Wigeon in Whiteabbey to River Lagan, declining over the short- and medium-terms but remaining stable over the long-term at the site-level, while Mallard were more widespread but also remained stable across most sectors. Low tide trends were more positive for Mallard than for Teal with the former increasing long-term in five out of seven sectors, while the latter declined in two out of three sectors.

4.5.1.2 Seaducks, diving ducks and grebes

Of the five species in this category (Eider, Red-breasted Merganser, Scaup, Goldeneye and Great Crested Grebe) only Eider showed any increase at the site-level and Goldeneye and Great Crested Grebe declined steeply across all time periods. For these three declining species, it did not appear to be a particular sector driving declines as these were apparent across all sectors, although there had been a moderate recent increase for Great Crested Grebe in Whiteabbey to River Lagan (01422) and Kinnegar to Greys Point (01424). While Eider did increase moderately in the long-term in Belfast Lough, sector trends contrasted between Kilroot to Whiteabbey (02421, containing Seapark to Macedon (02921) and Kilroot to Seapark (02922)) where they increased across all time periods, to sectors between Whiteabbey and Greys Point, where trends were more variable but generally negative. While Eider, Red-breasted Mergansers and Scaup all remained relatively stable at the site-level at low tide counts, Goldeneye and Great Crested Grebes both declined steeply long term, and in particular at BB015 of the coast of Cultra.

4.5.1.4 Other wildfowl

Other species for which trends could be calculated for Belfast Lough were Mute Swan, Light-bellied Brent Goose, Coot and Cormorant. Mute Swan and Coot were uncommon around the lough and sector trends were only generated for BP Pools and Victoria Park (01223), where both declined in the medium- and long-terms. Light-bellied Brent Goose and Cormorant increased however, although Cormorant was more widespread and increased in all sectors but Greys Point to Ballymacormich Point (01425) where steep declines resulted in a stable population overall in the lough. Few trends were available for Low Tide sectors for these species.

4.5.2 Lough Foyle

4.5.2.1 Shelduck and waders

Of the 15 species considered, sector level trends were not available for Grey Plover, Turnstone and Greenshank. Site level trends for Shelduck and waders were mostly positive or stable. While many sectors at different time scales saw steep declines in numbers, particularly at Drumavally to Ballymagoland (04418) and Ballymagoland to Magillian Point (04426), trends were generally more positive at the southern shore of the lough around Black Brae and Donnybrewer (04411) and Longfield to Faughanvale (04412). Therefore, despite strong declines in some sectors, site trends for Dunlin and Bar-tailed Godwit were largely positive across the time periods considered, and stable for Curlew and Redshank.

4.5.2.2 Dabbling ducks

Teal and Pintail increased at the site-level in Lough Foyle, while Mallard remained stable and Wigeon declined steeply in the long-term and moderately over the medium-term. Dabbling ducks were not found in sufficient numbers to generate trends in the Drumvally to Ballymagoland (04418), Ballymagoland to Lower Drummans (04419) and Lower Doaghs to Magillian Point (04421) at the northern end of the shore. Roe and Balls Point (04415) and Culmore Country Park (04416) were particularly good for Wigeon and Teal, in contrast to Mallard which declined and remained stable in these sectors, respectively.

4.5.2.3 Seaducks, diving ducks and grebes

Of the five species in this category (Pochard, Eider, Red-breasted Merganser, Goldeneye, Great Crested Grebe and Slavonian Grebe), Pochard and Slavonian Grebe were recorded too infrequently to generate a site-level trend, and Red-breasted Merganser and Goldeneye too infrequently to generate sector-level trends. However, all species with trends declined over the medium- and long-terms, while Red-breasted Merganser and Great Crested Grebe stabilised in the short-term. The most important sectors in terms of five-year mean peaks for the group generally were between Black Brae and Donnybrewer (04411) and Myroe (04414).

4.5.2.4. Swans, geese and other wildfowl

No trends were available for Bewick's Swan at the site-level, as few have been observed in the lough over the study period. Black Brae and Donnybrewer (04411) was the most important sector in terms of five-year mean peaks for Mute and Whooper Swans. This was the only sector for which a trend could be produced for Mute Swan, which declined over the long-term in contrast to long- and medium-term site-level increases in Whooper Swan. Site-level trends for the two goose species also contrasted: while Light-bellied Brent Goose increased moderately over the long-term, Greylag Goose declined across all time periods, driven by losses at Myroe (04414). Although generally on the increase, two of the six sectors for which trends could be generated for Light-bellied Brent Goose showed declines: Faughanvale to Ballykelly (04413) and Drumavally to Ballymagoland (04418). Cormorants increased at the site level across all time periods, and also increased in both sectors for which there were trends over the medium- and short-terms.

4.6 Broad patterns in relation to aquaculture in sectors

Studies of the impacts of mussel aquaculture mostly focus on inter-tidal mussel beds, where the response of waterbirds may depend on a variety of factors, such as the size of the mussels used to seed aquaculture plots, the age of the plots, the availability of alternate feeding grounds, and the reliance on bivalves in the diet (Caldow *et al*. 2003). Bottom-culture mussel and cockle (*Cerastoderma edule*) aquaculture has largely been shown to have a negative impact on bird populations due to the removal of prey biomass from the environment (Atkinson *et al.* 2003, 2010; Bowgen *et al.* 2022; Cervencl *et al*. 2015; Goss-Custard *et al*. 2004; Laursen *et al*. 2009; Smit *et al*. 1998). This is particularly important for species that feed on bivalves such as Oystercatcher, Knot and Shelduck which forage on the shore and sub-surface foraging Eider. Positive associations between shorebirds and inter-tidal mussel beds have been reported for Curlew and Redshank (Caldow *et al*. 2003), but these may be due to an increase in other invertebrate prey species caused by the laying of mussel beds.

In Belfast Lough all mussel beds are sub-tidal and therefore the potential impacts on shorebirds are likely to be limited. While the impacts of inter-tidal aquaculture have been the subject of many studies, the potential effects of sub-tidal culture of mussels are less well understood and may have mixed positive and negative influences on waterbirds. Due to their dietary reliance on bivalves, Eider have been shown to be particularly associated with sub-tidal mussel aquaculture. Cervencl *et al*. (2015) found that during the winter Eider in the Wadden Sea were more likely to be distributed in areas with high densities of medium or large-sized mussels, particularly from culture plots. However, due to the harvesting of mussel biomass in the winter, Eider were forced to switch to less profitable prey, which can impact their body condition and therefore survival (Laursen *et al.* 2009). Thus, mussel aquaculture may be providing a food source to Eiders, but also may be providing something of an ecological trap.

Human-related disturbances to foraging or resting waterbirds during the winter can come from a range of sources, from people on foot or using machines or vehicles, and from industrial or recreational sources (Robinson and Pollitt 2002). Anthropogenic disturbances may cause birds to fly away to alternate areas (Gittings and O'Donoghue 2016; Goss-Custard *et al*. 2006; Jarrett *et al*. 2018, 2020) although this may not be the case in all situations (Collop *et al*. 2016; Gill *et al.* 2001; Maslo *et al*. 2020), and little research has been done on seaducks, grebes or divers. It is reasonable to assume an increase in human activity in the areas of mussel-beds, for example increased traffic by boats or deliberate disturbance due to conflict between shellfisheries and foraging birds, could be ways in which mussel aquaculture could affect waterbirds in the sectors, and some evidence to support this was found in a recent assessment of potential sources of disturbance to Eider in Belfast Lough for the MarPAMM programme (Booth Jones *et al*. 2022).

4.6.2 Belfast Lough

4.6.2.2 Core Count (high tide) trends

Only two active mussel beds overlapped to any extent with the shore-side delineation of WeBS Core Count sectors (Figure 2.2.i): Whiteabbey to River Lagan (01422) overlapped licenced area B7 and Seapark to Macedon (02921) overlapped licensed areas B7 and B10 (Table 3); although, as described in the methods, all active aquaculture sites in the lough were in fact encompassed by the Core Counts, as these are made from the shore to the mid-point of the lough. Between 2010 and 2019, the year of operation with the highest yield of mussels for these licensed areas (combined,

preserving anonymity of exact tonnage for each area) was 2012, and after 2015 yield was relatively low (Figure 2.2.iii). To assess the potential impact of aquaculture on waterbird trends in Whiteabbey to River Lagan and Seapark to Macedon, medium-term trends (2009/10 - 2018/19), coinciding with the entire period for which tonnage data were available, were compared with short-term trends (2014/15 - 2018/19), coinciding with a time-period of relatively low activity on the mussel beds. If sector-level trends diverged more from the site trend over the medium-term than over the short-term, then this would lend support to the hypothesis that mussel aquaculture in overlapping licenced areas impacted waterbird numbers in these sectors, if tonnage is a useful proxy for aquaculture activity and therefore disturbance potential. Annual means, annual peak numbers and percent proportion of the site total were used as additional evidence throughout this period.

The trends for Dunlin, Bar-tailed Godwit, Turnstone and Redshank were more negative over the medium-term (and also short-term in the case of Dunlin, Bar-tailed Godwit and Turnstone) than the site-level trend in Whiteabbey to River Lagan, and also more negative for Curlew and Light-bellied Brent Goose over the medium-term in Seapark to Macedon (Table 10). However, since these are shorebirds and the mussel beds in the vicinity of these sectors are sub-tidal, it is unlikely that aquaculture activities impacted these trends.

Waterbirds likely to be found in the area of the mussel beds are ducks, grebes, divers and Cormorant. Whiteabbey to River Lagan was a particularly important sector of Belfast Lough in terms of five-year mean peaks for duck species (although notably not Eider), Red-breasted Merganser, Great Crested Grebe and Cormorant, while Seapark to Macedon was important for Eider, Red-breasted Merganser, Goldeneye and Cormorant (Table 4). Of the two sectors, only Whiteabbey to River Lagan had any species with steeper declines in the medium-term than the site-level trend: Eider and Red-breasted Merganser (Table 10). While these species remained stable across Belfast Lough, in Whiteabbey to River Lagan they both declined by at least 50% over the medium-term, and also over the short-term.

Table 10 Short- and medium-term Core Count population changes of wintering waterbirds in the sectors Whiteabbey to River Lagan and Seapark to Macedon, compared to the site trend of Belfast Lough. Trends are taken from Table 2. Red – a decline in numbers of at least 50%; orange – a decline in numbers of at least 25% but less than 50%; white – a decline in numbers of less than 25% or an increase of less than 33%; pale blue – an increase in numbers of at least 33% but less than 100%; dark blue – an increase in numbers of at least 100%; grey – insufficient data.

	Short-term			Medium-term		
	Whiteabbey to River Lagan	Seapark to Macedon	Belfast Lough	Whiteabbey to River Lagan	Seapark to Macedon	Belfast Lough
Mute Swan						
Shelduck						
Wigeon						
Teal						
Mallard						
Eider						
Red-breasted Merganser						
Scaup						
Goldeneye						
Great Crested Grebe						
Coot						
Oystercatcher						
Ringed Plover						
Golden Plover						
Purple Sandpiper						
Lapwing						
Dunlin						
Knot						
Black-tailed Godwit						
Bar-tailed Godwit						
Turnstone						
Curlew						
Redshank						
Light-bellied Brent Goose						
Cormorant						

4.6.2.3 Low tide trends

Although Core Counts provide important information on the number of birds within the loughs and sectors of the loughs, there are additional advantages to analysing low tide trends for the assessment of impacts of human activities on waterbirds, because the ebb and flow of the tide has a large influence on the foraging habitat available within sectors. For example, the birds counted at high tide in one sector may be roosting in that sector but foraging elsewhere in a different sector. In particular with relation to sub-tidal aquaculture, the low tide may increase the accessibility of mussel beds in licensed areas to diving species (by reducing the dive depth needed to reach them), and thus there may be a greater risk of disturbance and conflict between waterbirds and shellfisheries at low tide. Recent research on Eider in Belfast Lough found that Eider were more likely to be found in the vicinity of mussel beds on the north-west shore of Belfast Lough at low tide (Booth Jones *et al*., 2022). There were four active areas that overlapped with the shoreline delineation of WeBS Low Tide sectors; B3, B7, B10 and B11 (Figure 2.2.ii and Table 2), and BB029 was the sector with the greatest level of overlap with a licensed mussel bed. However, as mentioned in the methods, due to the practice of counting all birds from the shore to the midpoint of the lough, all aquaculture sites were essentially encompassed by LowTide count sectors. Within the overlapping sites included in this analysis and across the period for which data were available (2010 – 2019), the year with the highest yield of mussels was 2012, and this fell dramatically in 2018 and 2019 to 10 tonnes and zero, respectively (Figure 2.2.iii).

There were insufficient data to calculate any sector-level trends for 15 species over the medium- and short-term in the low tide sectors that overlapped the licensed mussel beds in Belfast Lough (Table 10), however in general medium-term sector-level trends tended to be more negative than short-term trends. Shorebirds (Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Turnstone, Curlew and Redshank) had more positive trends in BB008 than the site-level in the medium and short-terms (with the exception of Curlew, which showed a moderate short-term decline in comparison to stability at the site-level). Trends for Oystercatcher were available for all five sectors overlapping licensed mussel beds, and these tended to match the site-level trend in most cases, although steep declines were observed over the medium- and short-terms in BB001 (Table 10). However, as stated previously, it is unlikely that the activity generated by sub-tidal aquaculture would impact shorebirds, so deviations from the site-level trend in these cases likely have other potential causes.

There were few trends available for ducks and grebes, the species most likely to be affected by aquaculture disturbance in this area. However, across the five sectors trends were generally more positive for Red-breasted Merganser, with the exception of BB030 in the medium-term which underwent moderate declines, and BB008 and BB030 in the short-term which underwent steep declines (Table 11). In the three sectors for which trends were calculated for Great Crested Grebe, BB001, BB008 and BB029, all three experienced steep declines in numbers over the medium-term, following the site-level trend, but trends for these sectors were mixed in the short-term (Table 11).

Table 11 Short- and medium-term Low Tide population changes of wintering waterbirds in the sectors BB001, BB008, BB028, BB029 and BB030, compared to the site trend of Belfast Lough (BB000). Trends are taken from Table 5. Red – a decline in numbers of at least 50%; orange – a decline in numbers of at least 25% but less than 50%; white – a decline in numbers of less than 25% or an increase of less than 33%; pale blue – an increase in numbers of at least 33% but less than 100%; dark blue – an increase in numbers of at least 100%; grey – insufficient data.

	Short-term						Medium-term					
Sector Code	**BB001**	**BB008**	**BB028**	**BB029**	**BB030**	**BB000**	**BB001**	**BB008**	**BB028**	**BB029**	**BB030**	**BB000**
Sector Name	**LTC 1.1**	**LTC 2.4**	**LTC 1.2d**	**LTC 1.2c**	**LTC 1.2b**	**Belfast Lough (Low Tide)**	**LTC 1.1**	**LTC 2.4**	**LTC 1.2d**	**LTC 1.2c**	**LTC 1.2b**	**Belfast Lough (Low Tide)**
Mute Swan												
Shelduck												
Wigeon												
Teal												
Mallard												
Eider												
Red-breasted Merganser												
Scaup												
Goldeneye												
Great Crested Grebe												
Coot												
Oystercatcher												
Ringed Plover												
Golden Plover												
Purple Sandpiper												
Lapwing												
Dunlin												
Knot												
Black-tailed Godwit												
Bar-tailed Godwit												
Turnstone												
Curlew												
Redshank												
Light-bellied Brent Goose												
Cormorant												

Conclusions

While it might be expected that activity on the licensed mussel beds in Belfast Lough could cause disturbance to, and displacement of, waterbirds in the concurrent WeBS sectors (Hirons and Thomas 1993), there was no strong signal for the impact of sub-tidal aquaculture on sector-level population trends for either Core Counts or Low Tide counts. However, it is unclear how impacts might be acting at the site-level, encompassing all active aquaculture sites; therefore, contrasts made between the potentially impacted sector-level trends and the site-level trends, which here are treated as unaffected by aquaculture, must be treated with caution.

The strong sector-level decline in Eider and Red-breasted Merganser numbers in Whiteabbey to River Lagan in contrast to the overall site-level trend is of concern, however there was not a clear signal for the impact of aquaculture on these species in this area of the lough, despite evidence for the sensitivity of these species to disturbance being found elsewhere (Gittings and O'Donoghue, 2016; Jarrett *et al*. 2018; Merkel *et al*. 2009). This is not to say that there was no impact, but detecting this through the comparison of WeBS trends with tonnage data from licensed areas is difficult due to the very low area of overlap between licensed areas and count sectors and the difficulty in assessing potential disturbance without an accurate measure of activity in licensed areas. However, a genuine lack of disturbance from the sectors might be expected if there was a low availability of similarly suitable foraging habitat nearby, which would result in waterbirds remaining in the area despite the fitness costs of remaining (e.g. reduced foraging efficiency, increased time in flight), and therefore may have population-level effects (Gill *et al.* 2001). Over the medium-term, Red-breasted Mergansers actually increased in in Low Tide sectors in the vicinity of mussel beds, indicating that conditions in this area at low tide for this species may be better than elsewhere in the lough, where the population remained stable. Shorebird species declined more in the focal sectors compared to their lough-level trends at both high tide and low tide, therefore it may be that other human or environmental impacts are influencing waterbird numbers in these sectors.

5. Recommendations

Sector-level analysis of WeBS data from Belfast Lough and Lough Foyle highlighted areas and species in the loughs with declining trends. Because both Belfast Lough and Lough Foyle are important sites both nationally and internationally for waterbirds, it will be important to conduct further research into the causes of these declines.

Sectors between Black Brae and Donnybrewer (04411) and Roe and Balls Point (04415) tended to be the most important for waterbirds in Lough Foyle, and trends were generally positive in this area for both waterfowl and waders, with the exception of Faughanvale to Ballykelly (04413). This sector experienced declines in 10 of the 11 species for which trends could be generated, including Light-bellied Brent Goose which is a feature of the SPA and of international importance in Lough Foyle. This species generally increased in Northern Ireland during the same period, therefore declines at Lough Foyle may indicate a site-specific issue. Declines also occurred here for Wigeon, Teal, Mallard, Oystercatcher, Lapwing, Dunlin, Knot, Curlew and Redshank; all components of the SPA's nationally important waterbird assemblage. However, Bar-tailed Godwit bucked the trend, increasing in this sector. These changes highlight that there may be conditions in the Faughanvale to Ballykelly sector that differ from its neighbours and would be worth further investigation.

While a total of 20 species (Table 1) are cited in the SPA conservation objectives document for their international and national importance at Lough Foyle (DAERA, 2015), more recent assessment of WeBS data by Frost *et al*. (2021) identified Pintail, Black-tailed Godwit, Sanderling and Greenshank as exceeding the national threshold for the site, while Bewick's Swan is no longer recorded. Therefore, it is important when considering changes in species abundance and distribution in a site to not limit the scope to a historical snapshot of key species, as new species may also increasingly rely on particular sites in future international and national contexts.

Sector-level trends for waterbirds in Belfast Lough Core Counts showed interesting patterns of increase and decrease between different species, which were largely consistent with Low Tide trends. BP Pools and Victoria Park (01223) and Whiteabbey to River Lagan (01422), contained the vast majority of dabbling ducks, shelduck, swans and geese.

Across wading species, declines were observed at nearly all sectors for which trends could be calculated for Oystercatcher, Golden Plover, Lapwing, Turnstone, Curlew and Redshank, of which five are listed as important species for the Inner and Outer Belfast Lough ASSI in their citation documents. Redshank are also a feature of Belfast Lough SPA, therefore their long-term steep decline in the lough is of concern. In contrast, other wader species, Dunlin, Knot, Bar-tailed and Black-tailed Godwit largely increased across all the sectors for which trends could be calculated. The contrast in trends that can be seen across multiple sectors in the lough suggests that there is not a particular area of the lough driving population changes in this group, but that there are widespread changes, likely external to the lough, that are benefiting some but detrimental to others.

Diving species were another group with marked differences between species and sectors. Steep declines in the populations of Scaup, Goldeneye and Great Crested Grebe were observed across multiple time periods and in all sectors where trends were available. In the case of Goldeneye, these declines follow the Northern Ireland-wide trend, but for Scaup and, more dramatically, Great Crested Grebe, these declines are disproportionate to the region-level, indicating problems specific

to the Belfast Lough population. Great Crested Grebe are a feature of the Belfast Open Water SPA, and therefore their rapid decline in the lough merits further investigation. In particular, the max monthly peak of Great Crested Grebe declined steeply following a very cold winter in 2009/10, but continued to fall without recovery after this (Neil McCulloch, NIEA, *pers. comm.*). However, since declines were consistent across sectors, there were not particular areas of the lough that stood out as trouble spots. In addition, there is a mismatch between the monitored areas covered by the WeBS sectors and the area of SPA for which Great Crested Grebes are the feature, and therefore trends may differ in areas not currently monitored. Meanwhile, the proportion of Northern Irish wintering Eider found in Belfast Lough increased, and trends were generally positive, although Whiteabbey to River Lagan (01422) and Kinnegar to Greys Point (01424) showed evidence of decline. These sectors also showed declines in Red-breasted Merganser, although this species maintained a steady population in Belfast Lough over the study period, against Northern Ireland-wide declines.

There are many reasons why particular sectors may be experiencing declines in the loughs. Recreational human use of the loughs, for example for wildfowling, walking and boating may cause disturbance to birds while they are feeding or roosting, which has the potential to be very energetically costly to wintering species. Other human impacts may modify the habitat or ecosystem, making it less suitable for foraging or roosting for waterbird populations, for example development, pollution and aquaculture. Specifically to this report, we investigated the potential for sub-tidal mussel aquaculture to impact WeBS trends in sectors that intersect active licensed areas of Belfast Lough. However, very little evidence of impact was observed on the diving species that might be expected to experience disturbance and displacement from this industry.

There are a number of reasons why this might be the case. Primarily, the total licensed area may not necessarily reflect the actual mussel bed area, and therefore areas of overlap between WeBS sectors and areas of activity may have been misrepresented. Even considering the full licensed area, in some cases the area of overlap between this and WeBS sectors was very low. In addition to this, the annual yield of mussels from licensed areas may not be representative of the level of activity, and thus disturbance, per year. Thirdly, as stated by Gill *et al*. (2001), impacts may not cause direct displacement of birds if no equivalently valuable foraging habitat is available nearby, and may instead cause population impacts by decreasing foraging efficiency and therefore lowering individual survival probability. It has recently been observed elsewhere that mussel dredgers in Belfast Lough appeared to deliberately displace flocks of Eider by means of boats (Booth Jones *et al.* 2022), and because this may be a rare event it would be unlikely that the impacts of this would show up strongly in smoothed WeBS trends.

It is important to ensure that the biodiversity of Northern Ireland's sea-loughs is protected while their sustainable use is promoted. Therefore, to build on the findings of this report we recommend developing more targeted field-based studies to assess the potential impact of disturbance associated with aquaculture activity on waterbirds, which could also be expanded to include other potential form of disturbance. Data collection describing how the numbers and behaviour (e.g. feeding, diving, resting) of waterbirds vary through the tidal cycle would be of particular importance, as the tide has a strong influence on both the behaviour of waterbirds in estuaries, and also influences the husbandry activity in intertidal oyster trestle areas. A detailed, field-based study could provide an assessment of differences in the behaviour and numbers of waterbirds between sites with and without intertidal aquaculture, thereby informing on the potential impacts of disturbance

associated with aquaculture on species' activity budgets and providing an assessment of the activities causing disturbance and birds' responses.

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Analysis of waterbird population trends for Northern Ireland's sea loughs: assessing the potential impacts of aquaculture and disturbance.

Part 2 – Belfast Lough and Lough Foyle

This study aims to produce the first sector-level analysis of Wetland Bird Survey (WeBS) data in Northern Ireland, on two of the sea-lough sites that host aquaculture activities. This will improve understanding of the fluctuations in numbers of waterbirds within the sites and inform the consenting of operations and assessment of development plans on these SPAs.

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