dublin array

An Offshore Wind Farm
on the Kish and Bray Banks

Environmental Impact Statement

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Reviewed and Updated by

MRG CONSULTING ENGINEERS LIMITED

Prepared by

SAORGUS | ENERGY LTD

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Commercial Fisheries Impact Assessment

A marine ecological study of the Kish and Bray banks for a proposed off-shore wind farm development

Commercial fisheries

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LIST OF ACRONYMS

- BIM – Bord Iascaigh Mhara
- CFB – Central Fisheries Board
- CSO – Central Statistic Office
- DCENR – Department of Communications, Energy and Natural Resources
- ERFB – Eastern Regional Fisheries Board
- GOV – Grande Ouverture Verticale (trawl fishing method)
- HFO – Howth Fishermen's Organisation
- HFA – Howth Fishermen's Association
- ICES – International Council for the Exploration of the Sea
- IFI – Inland Fisheries Ireland
- IFO – Irish Fishermen's Organisation
- MI – Marine Institute
- SFPA – Sea Fisheries Protection Authority

1. INTRODUCTION

Saorgus Energy Ltd propose to establish a wind farm on the Kish and Bray banks in the Irish Sea off the coasts of Co. Dublin and Co. Wicklow. This will involve the siting of wind turbines on the seabed along the Kish Bank and Bray Bank. Ecological Consultancy Services Ltd (EcoServe) were commissioned by Saorgus Energy Ltd to update a review of available data and information on the commercial fisheries on and around the Kish and Bray banks, where original survey and extensive desk studies were carried out in 2002 and were updated in 2008. The aim of this report is to determine the potential impact of the proposed wind farm development on fisheries. Mitigation measures to avoid or minimise any impact are presented.

Data was gathered from the Marine Institute, the Department of Communications, Energy and Natural Resources (DCENR), Sea Fisheries Protection Authority (SFPA), Bord Iascaigh Mhara (BIM), the Irish Fishermen's Organisation (IFO), the Howth Fishermen's Association (HFA), the Central Statistics Office (CSO), the Inland Fisheries Ireland (IFI), Central and Eastern Regional Fisheries Boards (CFB, ERFB), local fishermen and sea anglers.

2. COMMERCIAL FISHERIES

2.1. Irish Sea fish stocks

This section is largely based on the Marine Institute's Stock Book 2010. The data is summarised graphically in Figures 1.1-1.7 in Appendix 1.

Fish stocks are rarely as localised as a specific bank so management occurs over a larger area, which in this case is the Irish Sea (ICES Area VIIa). Data from national programs can be beneficial in highlighting what commercial activity is likely to be prevalent in a local area, but drawing conclusions at a finer level is extremely difficult with this type of data (David Stokes, MI, pers. comm.).

Irish sea supports commercial fisheries for cod, and sole. The most abundant species recorded in trawl surveys are dab, plaice, solenette and common dragonet along with large numbers of poor-cod, whiting and sole. Lesser spotted dogfish is abundant throughout. There are also ray assemblage on sand hills in the Southern Irish Sea and Cardigan Bay. Herring and sprat are the main pelagic species in the Irish Sea.

Stocks of cod, whiting and sole are severely depleted. Trawling for Nephrops results in bycatch and discards of other commercial species, including cod, haddock, whiting, hake, monkfish, and megrim and this is a serious problem for the cod and whiting stocks. The discard rate by fleet in 2009 for cod was 100% for one-year-olds and almost all whiting caught were discarded.

A reduction in the abundance of large piscivorous fishes, such as cod and whiting, is paralleled by an increase in species which feed at a lower trophic level, such as Nephrops, which has resulted in a marked decline in mean trophic level of the fish community over time.

There has been an increase in water temperatures in this ecoregion, which is likely to affect the distribution area of some fish species, and some changes of distribution have already been noted. The combined effects of overexploitation and environmental variability might lead to a higher risk of recruitment failure and decrease in productivity.

Cod

The Irish Sea cod fishery has traditionally been carried out by otter trawlers targeting spawning cod in spring and juvenile cod in autumn and winter, and cod are also taken as a bycatch in fisheries for Nephrops, plaice, sole and rays. Total landings in 2009 are estimated at 470 t, which is the lowest on record (Figure 1.1 in Appendix 1). Reliable discard estimates are not available. A long-term cod management plan was agreed by the EU in 2008 (Council Regulation (EC) 1342/2008).

There is evidence that the reduction in cod recruitment observed in the Irish Sea since the 1990s may be due to a combination of small spawning-stock biomass and poor environmental conditions, coinciding with a shift towards above-average sea temperatures. Spawning-stock biomass has declined tenfold since the 1980s and total mortality remains very high. However, recruitment in 2009 was above the recent low average and is estimated to be the highest since 2001. The spawning-stock biomass is expected to increase in 2011 due to the higher recruitment estimated in 2009. Surveys of cod eggs in the Irish Sea in 2006 and 2008 indicated that more than half of the spawning took place in areas not included in the spring-spawning closure, indicating that the design of the closure may be inadequate.

Whiting

There is no targeted whiting fishery in the Irish Sea. Whiting are bycatch (and discarded) within in the main Irish Sea fisheries mainly by otter trawlers. The Nephrops fishery in particular shows high discard rates of whiting. The present stock size is extremely low. Landings have continuously declined since the early 1980s, reaching lowest levels in the 2000s (Figure 1.2 in Appendix 1). In 2009, a number of vessels in the Irish Sea introduced a Swedish grid (part of the Cod Long Term Management Plan), which is expected to significantly reduce whiting by-catch.

Haddock

Haddock are taken in Nephrops and mixed demersal trawl fisheries, using mid-water trawls and otter trawls. Landings are made throughout the year, but are generally more abundant during the third quarter. Total landings in 2009 are estimated at 800 t (Figure 1.3 in Appendix 1). Discarding is a problem for this stock. The discard rate by fleet was 100% for one-year-olds; 44–95% for two-year-olds and 19–75% for three-year-olds by number. Stock trends show an increase in spawning-stock biomass over time, but a reduction since 2008. Recruitment in 2009 appears high and this is likely to lead to an increase in SSB in 2011.

Nephrops

Nephrops is managed within distinct functional units and western Irish Sea is covered by unit FU-15. Density of Nephrops in FU-15 is considered very high (average density $1.1/m^2$). Landings within this area in 2009 were 9,100 t (Figure 1.4 in Appendix 1). Gears used are a mixture of single and twin-rig otter trawls. A number of Irish vessels are using separator trawls and Swedish grids to reduce bycatch. There are no explicit management objectives or a management plan. However, trawling for Nephrops results in significant bycatch and discards of other commercial species, including cod, haddock, whiting, hake, monkfish, and megrim and a potential displacement of Nephrops-directed effort from the western Irish Sea into other stocks has been suggested by ICES, particularly in associated with the cod long term management plan (EC 1342/2008).

Nephrops is limited to muddy habitat, and requires sediment with a silt and clay content of between 10–100% to excavate its burrows. Therefore the distribution of suitable sediment defines its distribution.

Plaice

Plaice are taken in a mixed demersal fishery by otter trawl, and as a bycatch in targeted sole beam trawl fisheries. Fishing effort has declined to the lowest level since 1979. There is a high rate of discarding. The otter trawl fleet seasonally targets plaice, but the fleet has declined markedly in the last decade. Total landings in 2009 were 460 t (50% by beam trawl and 50% by otter trawl) (Figure 1.5 in Appendix 1). There are no explicit management objectives or a management plan for this stock.

There are considered to be three principle spawning areas of plaice in the Irish Sea: one off the Irish coast, another northeast of the Isle of Man towards the Cumbrian coast, and the third off the north Wales coast. Cardigan Bay has also been identified as a spawning ground for plaice in the Irish Sea. The level of mixing between the eastern and western components of the Irish Sea stock appears small. Time series of recruitment estimates show negative relationships with sea surface temperature.

Sole

Sole are predominantly caught by beam trawl fisheries. Sole is caught in a mixed fishery with other flatfish as well as gadoids (cod family). Information from observer trips indicates that the discarding of sole is relatively low (0-8% by numbers). Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates. Total reported commercial landings in 2009 were 324 t (Figure 1.6 in Appendix 1).

The stock size is considered low. Spawning-stock biomass has continuously declined since 2001 to low levels and reached its lowest level in 2008. Even though ICES recommended zero catch to allow stock recovery, there are currently no specific management plans for this stock.

Herring

A pair of UK pair trawlers takes the majority of catches. A small local fishery continues to record landings on the traditional Mourne herring grounds. Herring fisheries tend to be clean with little bycatch of other fish. Total reported commercial landings in 2009 were 4,594 t (Figure 1.7 in Appendix 1).

There are two closed areas to protect the spawning stock during part of the spawning season and to prevent exploitation of juveniles: the area off the Louth and Down coast is closed from the 21st September until 31st December and the east of the Isle of Man is closed from 21st September until 15th November. Recent spawning-stock biomass assessments show an increasing trend and 2009 acoustic survey estimates suggest that it is close to its highest abundance in the 17 year time-series.

Herring are an important prey species in the ecosystem and also one of the dominant planktivorous fish. There are irregular cycles in the productivity of herring stocks and it is thought that the environment plays an important role through transport, prey, and predation.

2.1.1. Sprat

Landings from sprat fisheries display large inter-annual variation, both spatially and temporally. Industrial fisheries of the 1970s have ceased. All recent Irish sprat landings from Division VIIa have taken place in Division VIIaS, considered to be part of the Celtic Sea stock. Fisheries in Irish coastal waters are unregulated and unassessed. There is no ICES advice for sprat in this area and there are no management regulations for sprat fisheries around Ireland. Sprat is an important forage fish.

2.2. Kish and Bray banks

2.2.1. Commercial fishery

The main activity in the vicinity of the Kish Bank is whelk fishing (approx. 8-10 boats fishing whelk pots). Queen scallop fishing still takes place (including Northern Ireland boats). Mussels dredgers have also fished for seed in the area recently. There has been small trial attempts to fish for brown crab in the vicinity of the Kish Bank also (John Hickey, BIM, pers. comm.).

On the Bray bank, the main activity is whelk fishing with boats from Wicklow fishing this area. There has also been some fishing for scallop in the area, by one or two boats sporadically (John Hickey, BIM, pers. comm.).

Distribution of the fishing effort around the Irish coast is presented graphically in Appendix 2.

<u>Whelks</u>

According to MI data, in 2007 the southwest Irish Sea whelk fishery was at its lowest biomass level since MI commenced monitoring in 1994. A few boats fish over a wide area, which might include the northern limit of the Arklow-Wicklow nursery grounds and the Howth area (Edward Fahy, pers.comm.). There is no fishing with pots on the bank itself. The bank is surrounded by whelk pots as shallow as up to 10 m depth on the outside (east side) and up to 20 m depth on inside (west side) (Patricia Comiskey, BIM, pers. comm.).

Whelks are distributed in north-south orientated mud, sand and gravel banks in strong tidal currents, most of which are within five nautical miles from the shore. Rusk Bank and the nearby Codling Bank are thought to support the highest densities of whelk in the southern Irish Sea. Kish and Bray banks support low densities of whelks, potted mainly by vessels berthed in Dún Laoghaire and Howth.

<u>Scallops</u>

A profitable fishery for queen scallops used to take place in 1960s in the area approximately 6-8 miles south of the Kish Bank. Nowadays the fishery for this species is much more sporadic.

<u>Mussels</u>

Mussel seedbeds have been located inshore and south from the Kish and Bray banks over the years (Appendix 2). As mussel settlement is not consistent and varies from year to year (Terrence O'Carroll, pers. comm.).

During the benthic survey, which was conducted by EcoServe in 2008, large numbers of mussel shells of approximately the same age were collected with a Van Veen grab at one of the stations to the east of the bank (Station 5), but only one live mussel was found in the dredge sample. This may suggest that there is a mussel bed close by and currents have selectively deposited the dead mussel shells within the sampling area.

Finfish

The surrounding area used to be extensively trawled for haddock, plaice and spur dog, although very little trawling occurs inside the 20 m depth contour area from the north Kish Buoy to the northern half of the Bray Bank (i.e. on the banks) (John Lynch, Patricia Comiskey, pers. comm.). In addition, Welsh and Spanish boats were reported to trawl the surrounding area for ray (Charley Robinson, pers. comm.). However elasmobranches, such as spur dogs, basking shark and ray, which occur in the vicinity of the Kish Bank (with some prominent ray grounds to the south of the bank), have also been highlighted as species of some concern and may be the subject to a forthcoming EU plan of action on the conservation and management of sharks (Patricia Comiskey, pers.comm.). The Bray Bank is too dangerous to trawl and therefore acts as a sanctuary for fish. On the shallows of the banks flounder, plaice, dab, gurnard, whiting, coalfish, haddock and codling are caught (Charley Robinson, pers. comm.). Other species that have turned up in catches during last five years include: lesser spotted dogfish, mackerel, pollack, thornback ray, ballan wrasse and cuckoo wrasse (Norman Dunlop, pers. comm.). According to the consultations with anglers, stock levels of local species haven't changed much over the past few years with the exception of cod and plaice (Norman Dunlop, pers. comm.).

2.2.2. Commercial fish landings (Dún Laoghaire and Howth)

Commercial fisheries data from the Kish and Bray banks area was collected from a variety of sources and examined. This data is summarised in Appendix 3. Information on fisheries in this area is sparse as specific landings for the Kish and Bray banks are not given and are estimated from landings into the fishing ports of Dún Laoghaire and Howth. Data was available from the Marine Institute, BIM, CFB, DCENR, HFO and sea anglers. and this is presented in Tables 3.1-3.8 in Appendix 3. It was stressed that official figures were likely to be an underestimate as small boats, under 10 m, are not obliged to log their catch and there is a large unofficial market for fish in the Dublin area (Frank Doyle, pers. comm.).

Commercial fish caught in the vicinity of the Kish and Bray banks are mainly landed into the fishing ports of Dún Laoghaire and Howth. Figures for all fish (demersal, pelagic and shellfish) landings into Dún Laoghaire and Howth were supplied by the DCENR (2001) from 1997 to 2000 (Appendix 3, Tables 3.1 and 3.3). Figures for all fish landings into Howth from 2004 to 2007 (Appendix 3, Table 3.4.) and for shellfish landings into Dún Laoghaire port during the years: 2006 and 2007 (Appendix 3, Table 3.2.), were supplied by the Sea Fisheries Protection Authority (SFPA, 2008). Figures for live weight of landings and their values for Howth from 2001 to 2006 were also obtained from SFPA (Appendix 3, Table 3.6.). Figures for live weight of sea fish landings and their values for Dún Laoghaire and Howth from 2001 to 2004 were also collected from Central Statistics Office (CSO, 2008) (Appendix 3, Table 3.7.). Since these values are for the total landings into Dún Laoghaire and Howth, it is not possible to ascertain the percentage of these that were actually caught on or around the Kish and Bray banks. Similarly, it is not possible to determine the percentage of fish caught around the Kish and Bray banks and landed to other ports, such as Clogherhead or Wicklow. Caution must also be taken when examining these figures, as they may not reflect the actual landings into a port as vessels under 10 m are not required to report landings. As such these figures may be an underestimate of actual catch landed at these ports.

Demersal (bottom-dwelling) fish

Figures for demersal landings into Dún Laoghaire port are markedly lower (20.4 t in 1997 and 13.9 t in 1998) than those for Howth. Figures from Dún Laoghaire for most demersal fish are low for 1999 (5.1 t) with no demersal landings recorded starting from 2000 (Appendix 3, Table 3.1).

Total whiting landings were estimated to be 85 t in 2006. Vessels operating out of Dunmore East, Clogherhead and Howth traditionally take most of the Irish catches. Most of the recent Irish landings were from the Southern Irish Sea and may in fact be fish from the Celtic Sea stock (MI, 2007). However, according to SFPA (2008) data from Howth Port only, whiting landings were much higher and were estimated to be 176.7 t in 2004, 190.47 t in 2006 up to 205.37 t in 2007 (Appendix 3, Table 3.4).

The Irish landings of haddock were estimated at 183 t in 2006. However, according to SFPA (2008) landings in Howth Port only were: 158.6 t in 2004, 201.56 t in 2006 and 229.8 t in 2007 (Appendix 3, Table 3.4).

The main demersal species landed into Howth were ray and skate, cod, plaice, whiting and monkfish with peak landings of 3,397.1 t in 1998, dropping to 1,742.8 t in 2000 (Appendix 3, Table 3.3). Cod landings into Howth continue to decline from 574.8 t in 1997 to 141.8 t in 2007 (Appendix 3, Table 3.3 and 3.4). The main cod fishery is however further north and fished mainly by the Northern Irish fleets.

Total plaice landings were estimated to be 934 t in 2006 where the Irish landings were estimated to be 176 t. The UK (England) usually takes over 40% of the total landings. The Irish and Belgian fleets each traditionally take about a quarter of the landings. The Irish landings of this stock are taken mainly by otter trawl (targeting mixed species such as cod, whiting and Nephrops, but also by beam trawlers targeting sole in vessels operating out of Howth, Kilmore Quay and Clogherhead. Plaice landings into Howth Port also decreased from 123.93 t in 2004 to 54.04 t in 2007 (Appendix 3, Table 3.4). Estimated landings of sole were about 83 t in 2006.

Pelagic (mid-water) fish

Only a very small amount (0.5 t) of mackerel was landed into Dún Laoghaire in 1997; however since then no pelagic fish have been recorded as landed into this port (DCMNR, 2001, SFPA, 2008).

From 1997 to 1999 mackerel and herring were the only pelagic species landed into Howth with a maximum of 3.6 t landed in 1997, declining to 0.2 t in 1998 and 1.1 t in 1999. In 2000 however, 10.8 t of pelagic species were landed, which was mainly made up of ocean sunfish (8.1 t). According to SFPA data (2008) the situation has changed and in 2004 herring landings into Howth were recorded at 745 t with a maximum of 1,153 t in 2005 and strong decrease to 580 t in 2006. Other pelagic species landed into the port were: porbeagle in 2004 (vulnerable species), mackerel and John Dory (in very low amount every year from 2004 to 2007). Tuna-like fish and sardinella were also recently recorded as low landings (Appendix 3, Table 3.4).

Shellfish

The main shellfish species landed into Dún Laoghaire are whelks. In 2000, shellfish were the only catch landed into Dún Laoghaire with 611 t landed, constituting 93% of the total catch. Edible and velvet crabs and lobster made up the remaining 7%. Whelks were also the main catch during 2006 (87% of total catch) and 2007 (91% of total catch). European lobster, edible and velvet crabs completed the remaining 13 % in 2006 and 9% in 2007 (Appendix 3, Table 3.2). However, there has been a strong decline recorded in shellfish landings since 2000. The total shellfish landings are estimated for 22.5 t in 2006 and 115 t in 2007. (Appendix 3, Table 3.2).

The main shellfish species landed into Howth are the prawn *Nephrops norvegicus* (1,978 t in 2007), whelks (27 t in 2007 with marked decline from 190.5 t in 2006) and mussels (190 t in 2007). Edible crab, razor shell, squids and scallops make up the rest of the landings (Appendix 3, Table 3.4).

2.2.3. Spawning and nursery grounds

In general, pelagic species tend to have extensive spawning grounds whereas demersal species tend to have more restricted areas. Three species with extensive spawning areas are known to spawn within the development site, namely lemon sole, sprat and the prawn *Nephrops norvegicus* (Coull *et al*., 1998) (Table 4.1 and Figure 4.1 in Appendix 4). Sprat have a widespread spawning area that extends around the whole Irish coast, including the Irish Sea. Sprat spawn between May and August. The spawning area of lemon sole extends from Strangford Lough in Northern Ireland to Skibbereen in Co. Cork. Spawning occurs from April till the end of September. The Dublin Bay prawn, *Nephrops norvegicus*, has a wide spawning area around Ireland extending from Coleraine in Northern Ireland to Wicklow Head, south of the proposed development. Spawning occurs year round although peak occurs between April and June. The period from April until the end of September is therefore a sensitive time in the development area, for the three main spawning species.

Nursery areas which occur in the proposed development area include those for cod haddock, whiting, lemon sole (and Nephrops. The cod nursery area extends from Dundalk peninsula to Arklow bank; the haddock nursery area extends from Bangor to Wicklow Head; the whiting nursery area extends from Strangford Lough to Wicklow, the lemon sole from Newcastle to Skibbereen and those of *Nephrops norvegicus* from Coleraine to Wicklow Head (Figures 4.2-4.6 in Appendix 4).

Although the spawning and nursery areas of these species fall within the survey area it does not mean that these sites are exclusively important for the species. Spawning occurs over a wide area, which encompasses the proposed development site.

3. RECREATIONAL ANGLING

3.1.1. Shore angling

Shore angling is popular throughout the area. Most common species are codling, coalfish, plaice, pollock, dogfish, dab, bass, and whiting. Other fish caught include conger, mackerel, mullet, wrasse, nursehound, smoothound, spotted ray spurdog, thornback ray, cod, dogfish, gurnard, pouting, sole, turbot, ray and tope.

A wide range of fish turn up in the catches in Howth, Dún Laoghaire, Bray and Greystones. North Beach Greystones is renowned for its shore fishing for coalfish, codling, dogfish, dab, plaice and occasional turbot, sole and conger. Shore fishing from the beach at Killiney can be excellent at times for plaice, bass, codling, dogfish, coalfish and pollack. Newcastle offers some of the best winter fishing for cod and dab is to be found there just north of the access road. Killoughter beach produces the widest range of species from the shore in Co. Wicklow. Specimen homelyn ray, smoothound, spurdog, thornback ray and bullhuss have all been recorded recently, while the more "normal fishing" for dogfish, codling and flatfish has been above average. (David Byrne, IFI, pers. comm.) (See Table 5.1 in Appendix 5 for detailed species list).

3.1.2. Off-shore angling

General bottom fishing for plaice, codling, whiting, ray, tope, dogfish, dab, gurnard and mackerel takes place in the area. Large spurdog and tope turn up regularly in boat catches. Popular charter angling destinations include Ireland's Eye, Scotsmans Bay and Dalkey Island. Wreck and reef fishing off the Kish and Burford banks is also popular. Tournament boat fishing is extremely popular off Greystones with a number of events staged annually. (David Byrne, IFI, pers. comm.).

Kish Bank

The Kish Bank is a popular fishing location for small and charter boat anglers. It is home to a very large number of ship wrecks, which provide an ideal habitat for many species including conger, pollock, cod, mackerel, wrasse, coalfish, flatfish species, dogfish, bass, ray, spurdog and tope (David Byrne, IFI, pers. comm.) with he latter two turning up in good numbers (Charley Robinson, pers. comm.).

Pollock and occasionally conger eels were recorded around the Kish Lighthouse in slack water. In the deeper water, to the east of the bank significant numbers of spur dog and ray were found in spring and summer. On the southern side of the bank where it drops off, one- and two-year codling and whiting were found in autumn and large fish have been lost on rod and line near the surface and bass have been recorded on the bank from time to time (Norman Dunlop, CFB, pers. comm.).

4. FISHERIES RESEARCH

Detailed annual surveys of the fisheries in the Irish Sea are conducted by the Marine Institute, Fisheries Services Division. Two surveys, the Irish Sea and Celtic Sea Ground Fish Survey and the Juvenile Plaice Survey, annually sample in the Kish and Bray banks area as part of the greater survey. However, in general the development area has not been studied in detail due to difficulties in sampling the banks.

4.1. Irish Sea and Celtic Sea ground fish survey

The Irish Sea and Celtic Sea Ground Fish Survey has been in operation since 1997 and are conducted in November of each year. The location of the sites within the local area of the Kish and Bray banks area are shown in Appendix 6, Figure 6.1 and Table 6.1. A number of these sites are within the development area and some are as far as 3 km from the development site. A Grande Ouverture Verticale (GOV) trawl was deployed at each site and a straight tow conducted for 30 minutes before being hauled and the contents identified.

A diverse range of fish species were recorded from these surveys; 34 species in total (Appendix 6, Table 6.2). Of these whiting, plaice, sprat, lesser spotted dogfish, dab and haddock were the most abundant in the survey area.

4.1.1. Demersal species

Whiting, haddock and cod were the most abundant demersal fish recorded from the trawls with the plaice and dab being the most abundant flatfish. The thornback ray and lesser spotted dogfish were the most abundant elasmobranchs recorded.

Species that are non-target, but are taken as commercial by-catch, include common dragonet, common goby, bib, pogge, grey and tub gurnard and butterfly blenny. These species are not of direct commercial value, but may be important prey items for a number of commercial species and are thus indirectly important.

4.1.2. Pelagic species

Sprat were the most abundant fish in terms of numbers caught in the area, followed by herring and poor cod. Sprat were recorded from surveys since 1997, but herring and poor cod were only recorded since 2000 and 2001.

4.2. Juvenile plaice survey

The Juvenile Plaice Survey (1992-2002) was designed to examine juvenile plaice recruitment. A 3 m beam trawl was deployed for 15 minutes before it was hauled and the contents of the trawl identified. Surveys were conducted between May and September each year. Up until 1996 only plaice were recorded, however after this date all species caught were recorded. The survey has a number of sites in the Kish and Bray bank area (Appendix 6, Table 6.3). Two of the sites occur within the development area, with the rest being up to 15 km away.

Thirty one species were recorded in total. Plaice and dab were the most dominant species within and around the survey area (Appendix 6, Table 6.4 and Table 6.5).

4.2.1. Demersal species

The most abundant flat fish recorded were plaice and dab. The lesser spotted dogfish was the most abundant elasmobranch recorded from the trawls. Species such as sand eel, grey gurnard, cod and pipefish were recorded in low numbers.

4.2.2. Pelagic species

Pelagic fish were not well represented in the Juvenile Plaice Survey, with herring only recorded at one site. This is to be expected owing to the type of gear used in this survey.

4.3. Biological sampling survey

This survey was planned to address the requirements of the Data Collection Regulation 1639/2001. Information on growth, maturity and sex ratio (biological data) were collected for a range of commercially important species. Ovary samples were collected to validate visual maturity staging. Additionally, ovary samples were taken for the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in Lowestoft (UK) and tissue samples were taken for genetics projects within the Marine Institute as well as other labs. Samples of whole flatfish were taken for meristics analysis by the Galway-Mayo Institute of Technology (Marine Institute, 2004). The survey sampled a number of sites in the Kish and Bray bank. Six species were recorded in total. Haddock and whiting were the most dominant species within and around the survey area (Appendix 6, Figure 6.2).

4.3.1. Demersal species

Haddock and whiting were the most abundant demersal fish with plaice, cod and monkfish being less abundant. Ray was the only elasmobranches recorded.

4.3.2. Pelagic species

No pelagic fish were recorded within the Kish and Bray banks area during the survey.

5. POTENTIAL IMPACTS

The construction of an offshore wind farm has the potential to adversely impact the immediate and adjacent habitats. Such impacts include loss of habitats and species, sedimentation, alteration of the hydrology, vibrations, noise and electromagnetic fields and pollution of the water and seabed. Impacts may be divided up into those that may occur during the construction phase, and those that may occur during the operational phase. The cumulative impacts of offshore wind farms are also investigated.

5.1. Construction phase

5.1.1. Loss or alteration of fish habitat

Seabed habitats are likely to be lost in the short-term during the construction of the turbines, cable trenches of the turbine network and connection to the grid. As a result, fish species may be disturbed. In addition, these habitats are likely to be unavailable for feeding or spawning during this period.

These impacts are, however, likely to be minimal as they will be restricted to the ‘footprint’ area of the turbine foundations and the width of the cable trenches. When these trenches have been backfilled, habitats and feeding grounds are likely to return to their original state.

5.1.2. Loss of species

Adult and juvenile shellfish, fish, larvae and eggs may be directly lost and disturbed during the construction phase through the removal of sediment when constructing the turbine foundations and when laying the cable trenches. Fish species are mobile and readily move from one area to another if disturbed or if environmental conditions are not suitable. The most likely impact would occur if their habitat, food source or spawning grounds are disturbed and if no alternative is available to them.

The extent of the fish habitat available in the Kish and Bray banks area is so great that the area that will be lost or altered by constructing the turbine foundations and laying the cables will not be significant.

5.1.3. Increased turbidity

There will be an increase in the turbidity of the water during construction of the wind farm. This increase in turbidity could result in increased siltation, smothering or negative effects on adult and juvenile shellfish, fish, larvae and eggs. High levels of suspended sediment may clog the gills of fish. Other fauna that fish feed on, the substrata or seaweeds that fish lay their eggs on may be lost or impacted on. High levels of suspended solids settling on the seabed can alter habitat resulting in a potential loss of feeding and spawning grounds. The turbidity of the water may reduce light levels, which would effect seaweed growth. Mobile species may move away from unfavourable conditions, however sessile, benthic fauna and flora may be smothered and lost.

Impacts are likely to be minimal as there is a high degree of naturally suspended solids on the Kish and Bray banks due to the high tidal current regime and sedimentary nature of the area. Additional suspended solids are likely to be rapidly dispersed by the strong currents, while the coarse nature of the sediment across much of the study area will result in the sediment resettling close to the point of disturbance.

5.1.4. Noise and vibration

Fish perceive sound through their lateral line and swim bladder, if they possess one. The lateral line system is sensitive to the vibration component of sound waves. The swim bladder is a gas filled sack located within the body of some fish species and is sensitive to the pressure component of sound waves. Flatfish and elasmobranches do not have a swim bladder. The vibration and pressure components of sound change with distance from the noise source.

Noise and vibrations from equipment such as drilling or piling equipment occurring during the construction phase of the development may disturb marine mammals, fish and benthic organisms around the site, particularly during spawning, nursery or migratory periods (Soker *et al.*, 2000). The loudest noises are likely to be associated with the installation of the piled foundations, should that option be used.

Noise and vibration associated with construction will be temporary and it is envisaged that fish may be temporarily scared away from the construction sites.

5.1.5. Pollutants and waste

Pollutants and chemicals used during the construction phase of the wind farm could contaminate the area. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials from the foundations may occur. This material could be toxic to marine organisms whilst the grout is wet, while potentially contaminating the seabed sediments and inhibiting recolonisation of the area after construction. Chemical contamination could also occur from accidental spillages, such as oil and other chemicals through poor operational management, non-removal of spillages, storage, handling and transfer of oil and chemicals. However, if suitable precautions are taken and best practice for the storage, handling and disposal of such material are followed, this should be minimal.

5.2. Operation phase

5.2.1. Loss or alteration of habitat

There will be a permanent, direct loss of seabed habitat under the ‘footprint’ of the turbine foundations as a result of the direct removal and disturbance of sediments. As a result non-mobile species occurring in the ‘footprint’ will be lost by smothering and clogging and mobile species utilising these habitats for feeding and spawning will lose this resource. However, the total area of the turbine ‘footprints’ will be low compared to the total available habitat in the area.

Habitat may also be altered due to a change in water movement both locally around the base of the turbines and perhaps at a larger scale (see alteration of hydrology).

The addition of the turbine foundations and scour protection (if used) will provide areas of hard substrata, providing a new habitat within the area, similar to an artificial reef. Areas of hard substrata are limited on the Kish and Bray banks and it is predicted that the additional habitat may result in colonisation of the bank by new species. The turbine bases and scour protection could quickly become colonised by a new suite of hard substrata species, which may in turn attract more fish species. Artificial reefs are used world wide as a tool in fisheries, nature conservation and coastal zone management. Specially designed and constructed steel and concrete reefs have been used to modify about 10% of the Japanese coastline to enhance fisheries (Byrne O'Cleirigh & EcoServe, 2000).

There may be local changes in the morphology of the immediate area and reduction of local water depths. If spoil from the cable trenches and turbine foundations is deposited on the seabed changes in species composition may occur. Due to the high current velocity in the area it is predicted that the sediments on the banks are highly mobile and that the impact would be minimal.

5.2.2. Loss of species

There will be a permanent, direct loss of sessile species under the 'footprint' of the turbine foundations. Mobile species will not be directly affected as they will move from the disrupted area but may be indirectly affected as feeding and spawning grounds will be reduced.

Species composition may change as a result of the alteration of water movements, the addition of new habitats in the form of hard substrata and potential changes in seabed morphology and water depth. However, it is predicted that these impacts will be minimal as the existing environment is already a dynamic one.

5.2.3. Alteration of hydrology

The physical presence of the turbines may alter the diffraction and focus of waves and currents over the bank, both locally and on a wider scale. This may result in a change in sediment deposition and erosion patterns creating changes in the substratum and habitat at these locations resulting in an alteration in species composition.

It is recommended that any potential alterations of hydrology resulting from the development be assessed fully.

5.2.4. Noise and vibrations

Noise and vibrations generated by the operation of the wind turbines may disturb marine fauna in the area, particularly fish and marine mammals; however it is not well documented. It is known that both fish and marine mammals are sensitive to noise in the marine environment, with sensitivity depending upon the noise frequency, power level and duration. If adversely affected by noise or vibration, fish and marine mammals could move from an area permanently. The noise and vibrations will differ depending on the foundation design. Some information on the affects of vibrations and noise on benthic communities is known from the Vindeby offshore wind farm in Denmark, however the data is somewhat sparse, and more research is needed in this area.

5.2.5. Electromagnetic fields

The installation of offshore wind turbines will transport electricity via submarine cables between turbines and to the shore. The current flow within submarine cables causes electromagnetic fields around the cables which could potentially have an effect on electro-sensitive marine fauna. Fish and marine mammals, which use the electric outputs of organisms in saltwater to detect their prey and use the Earth's magnetic field for navigation may be particularly sensitive. However, information on electromagnetic fields emanating from underwater power cables used for offshore wind farms is limited. There was a study carried out to determine if elasmobranches (sharks and rays) are attracted or repelled by strong electric fields close to the cable (Gill & Taylor, 2001). Preliminary research demonstrated that the dogfish *Scyliorhinus canicula* avoids electric fields at 1000 µV/m, which are the maximum predicted to be emitted from 3-core undersea 150 kV, 600 A cables. The same species were attracted to a current of 8 µA (representing an electric field of 0.1 µV/cm at 10 cm from the source), which is consistent with the predicted bioelectric field emitted by prey species. However, a longer term study is required to ascertain the relevance of avoidance or attraction behaviour by elasmobranches from an ecological perspective.

There is also a potential for heat emissions from the cables while conducting currents. However it is thought that this will generally dissipate into the immediate sediment covering the cable and not increase the temperature at the surface of the seabed.

5.2.6. Pollutants and waste

Contamination of the area due to accidental spillage of pollutants or waste from vessels maintaining the turbines may occur during the operational phase of the wind farm. However, if suitable precautions are taken the risk of this occurring should be minimal.

5.3. Cumulative impacts of offshore wind farms

When assessing the impacts of this development it is necessary to consider the cumulative effect on the marine environment resulting from other developments. This impact could be at a regional level (within the immediate geographic area of the development), but also in terms of the resource that is being impacted, in the case of the current development, the sandbanks along the east coast of Ireland.

The sand bank habitat resource along the east coast of Ireland is finite and the cumulative impact on it should be assessed. Within the immediate geographic area, the Arklow Bank wind farm is currently operating and has a foreshore lease that allows further development, while the Codling Bank wind farm has also been granted a foreshore lease. Further consideration should also be given to the cumulative effects of proposed wind farm developments on the Blackwater Bank, Dundalk Bay and other areas if licences to develop are granted and also to any sand and gravel extraction that may take place on the offshore banks.

The main cumulative impacts of offshore wind farms on marine benthos are the loss of habitat and species under the ‘footprint’ of the turbine foundations and cable laying, the alteration of the hydrology and the effects of vibration, noise and electromagnetic fields emanating from the cables.

5.3.1. Loss of habitats and species

It is predicted that the total area of habitats lost by cumulative developments is likely to be low compared to the total available habitat along the east coast of Ireland. In addition cumulative species loss is likely to be low as the sand banks are low in species diversity due to the mobile nature of the substratum. The increase in areas of hard substratum in areas of mobile sand may increase the species diversity along the banks over time as new species colonise the turbine foundations and attract fish and mobile invertebrates, potentially increasing local biodiversity. It is often not clear whether coastal structures simply concentrate existing populations of fish or whether they contribute to enhanced fish production (Byrne O’Cleirigh & EcoServe, 2000).

5.3.2. Alteration of hydrology

The siting of wind turbines on the sand banks may alter the water movements locally and on a wider scale. It is unlikely that the cumulative effect of the developments along the east coast of Ireland will have a significant effect on the hydrology thus affecting the benthos however detailed hydrological assessments should be conducted.

5.3.3. Noise and vibrations

The effects of noise and vibrations emanating from the cables and turbine foundations on marine benthos are largely unknown. As such it is difficult to quantify the impact of cumulative developments along the east coast of Ireland. Further research is required in this area.

5.3.4. Electromagnetic fields

The effects of electromagnetic fields created by the submarine cables on fish are largely unknown and poorly researched. As such it is difficult to quantify the impact of cumulative developments along the east coast of Ireland, however it is predicted that electromagnetic fields will be localised. Further research is required in this area.

Overall, it is expected that the cumulative effect of the Arklow Bank, Codling Bank and Oriel wind farm developments and the Kish and Bray banks development on the fish of the sand banks along the east coast of Ireland will be minimal. However, further consideration should be given to the accumulative effects of additional developments if they are granted lease.

6. MITIGATION MEASURES

6.1.1. Loss or alteration of habitats and loss of species

To minimise habitat and species loss and disturbance, efforts should be made to keep the area of seabed disturbed by the cable trench and turbine foundations to a minimum and sensitive periods such as spawning and migration should be avoided as well as seedbed areas. Following construction of the cable trenches, efforts should be made to restore habitats to their current condition, if impacted upon. Cable trenches should be filled to their pre-construction level, minimising changes in the water flow regime, and with material of a similar particle size to allow recolonisation of benthic species. The siting of the turbine foundations and cable trenches in low species diversity habitats will minimise the loss of species.

Should a gravity caisson design be used for the turbine foundations, the design should consider the criteria used in the development of artificial reefs. This would maximise the potential of the foundation to be colonised by marine life including species of nature conservation and economic importance.

6.1.2. Increased turbidity

To minimise the amount of suspended solids released into the water column during construction, efforts should be made to minimise the area of seabed disturbed. Where possible, construction works should not be carried out on a large number of turbines or trenches in close proximity to each other at once. Should more than one foundation be installed at a time, they should be carried out in as restricted an area as possible.

6.1.3. Noise and vibration

Should dredging, blasting and piling be required the area of seabed impacted upon should be kept to a minimum and should avoid sensitive periods such as spawning and migration seasons. Noise pollution should be kept to a minimum and follow the guidelines developed by the UK Joint Nature Conservation Committee to minimise the impacts. A soft-start procedure during piling activities should be instigated. This would reduce the impact of the initial noise generated by piling on fish close to the works. If the hammering is slowly increased fish would be able to move away from the activity until noise levels are acceptable.

Information on the underwater noise and vibrations (frequency and sound power level) generated by the offshore wind farm should be estimated in order to enable better understanding of the likely effects on the fish.

6.1.4. Electromagnetic fields

Information on the impacts of the electromagnetic currents generated by the submarine cables should be estimated in order to enable better understanding of the likely effects on the fish. Detailed studies are required to ascertain the impacts of these fields on the fish. Cables should avoid sensitive areas such as those used for spawning or nursing. Electromagnetic fields would be reduced through insulation of cables and burial to a minimum depth of 1 m. The use of scour protection along the cables would reduce the chance of cables surfacing.

6.1.5. Pollutants and waste

Contractors installing turbines should use chemicals that have been approved for use in the marine environment and employ methods that minimise the release of polluting materials into the water column.

To minimise the impact of pollution and waste from maintenance and boat traffic it is necessary to minimise the likelihood of any spillage or contamination. Potential contaminants should be stored in suitable storage facilities, such as bonded containers while at sea.

Waste and litter generated during construction should be returned to the shore for authorised disposal at suitable facilities. Utmost care and vigilance should be followed to prevent accidental contamination of the site and surrounding environment during the construction of the wind farm. Construction and on site operating procedures should be followed to the highest standard to minimise unnecessary disturbance and prevent accidental spillage of contaminants.

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APPENDIX 1 – Irish Sea landings

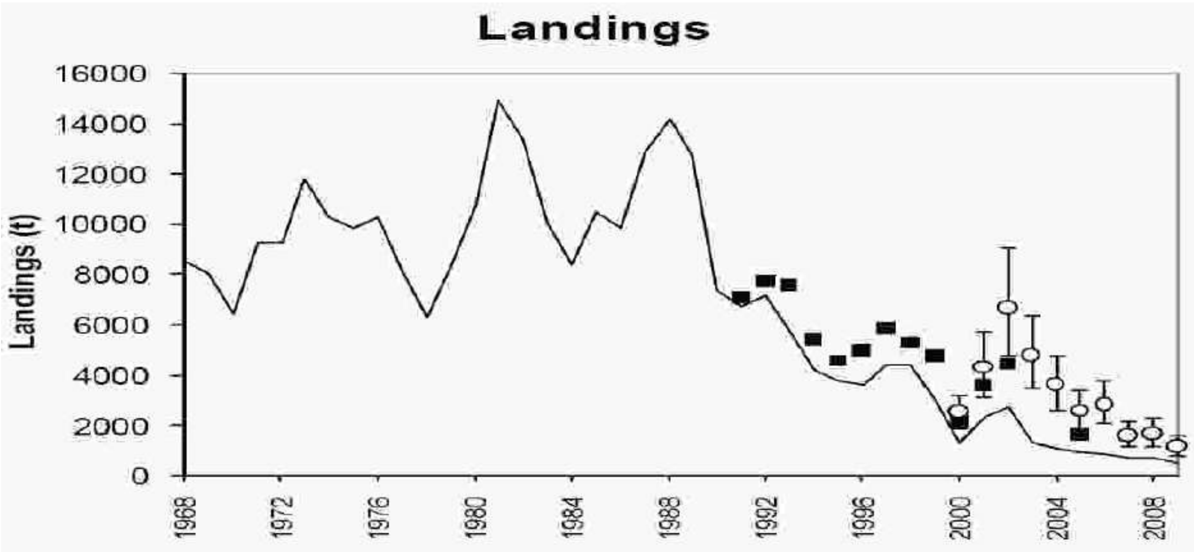


Figure 1.1 Cod landings from the Irish Sea (ICES area VIIa) (Source: MI 2010). Filled squares are landings incorporating sample-based estimates at three ports. Open circles with 90% confidence intervals are total catches estimates.

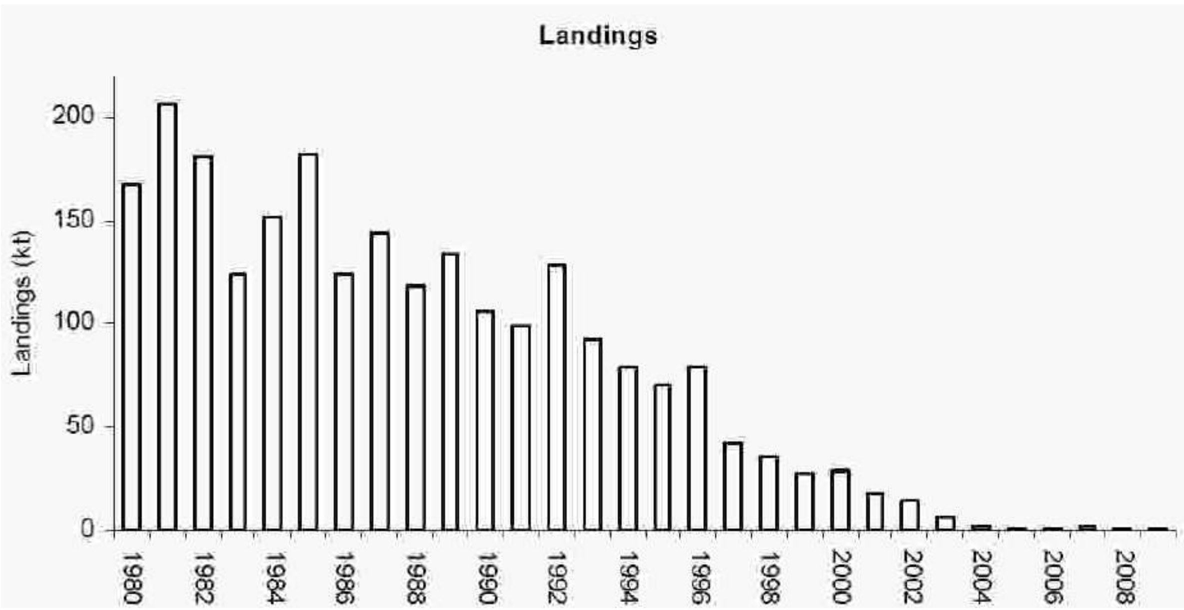


Figure 1.2 Whiting landings from the Irish Sea (ICES area VIIa) (Source: MI 2010).

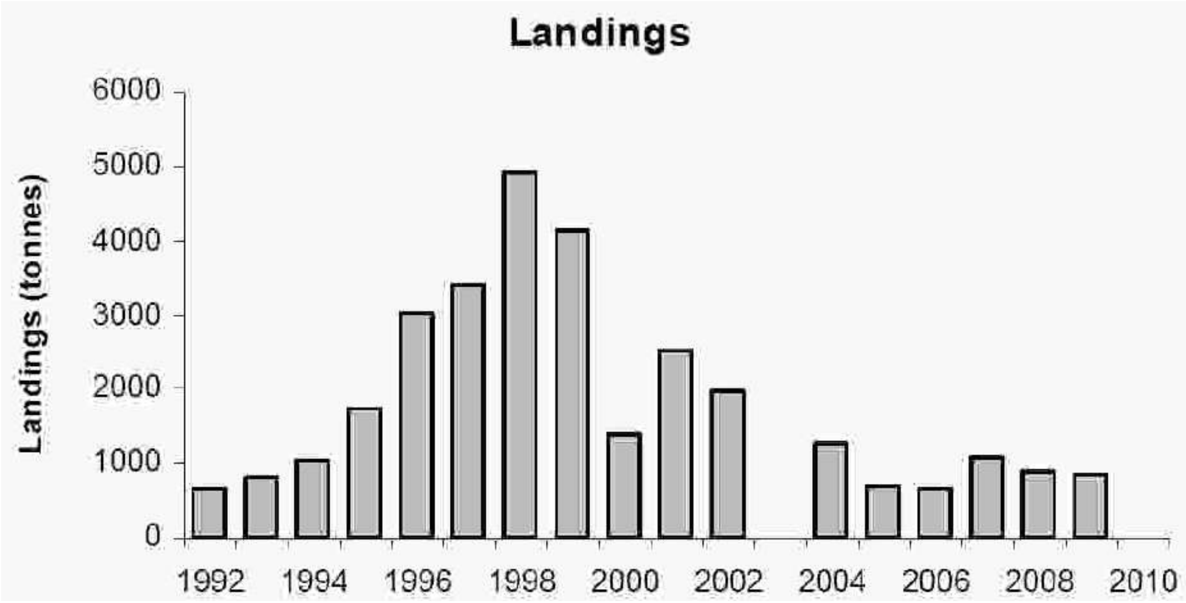


Figure 1.3 Haddock landings from the Irish Sea (ICES area VIIa) (Source: MI 2010).

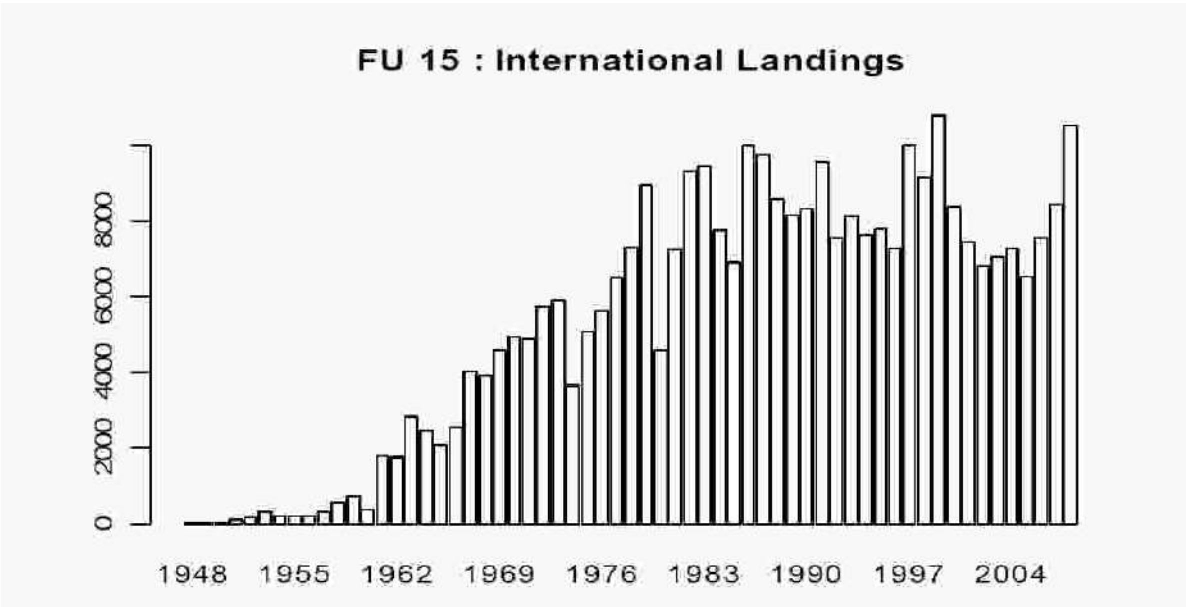


Figure 1.4 *Nephrops* landings from western Irish Sea (ICES FU15 zone) (Source: MI 2010).

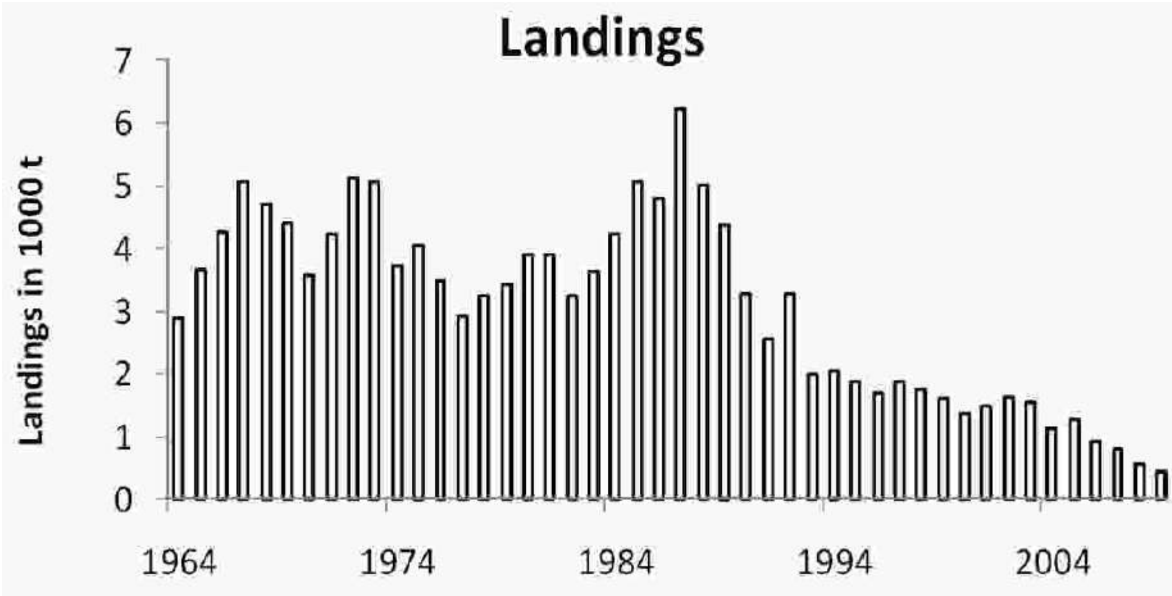


Figure 1.5 Plaice landings from the Irish Sea (ICES area VIIa) (Source: MI 2010).

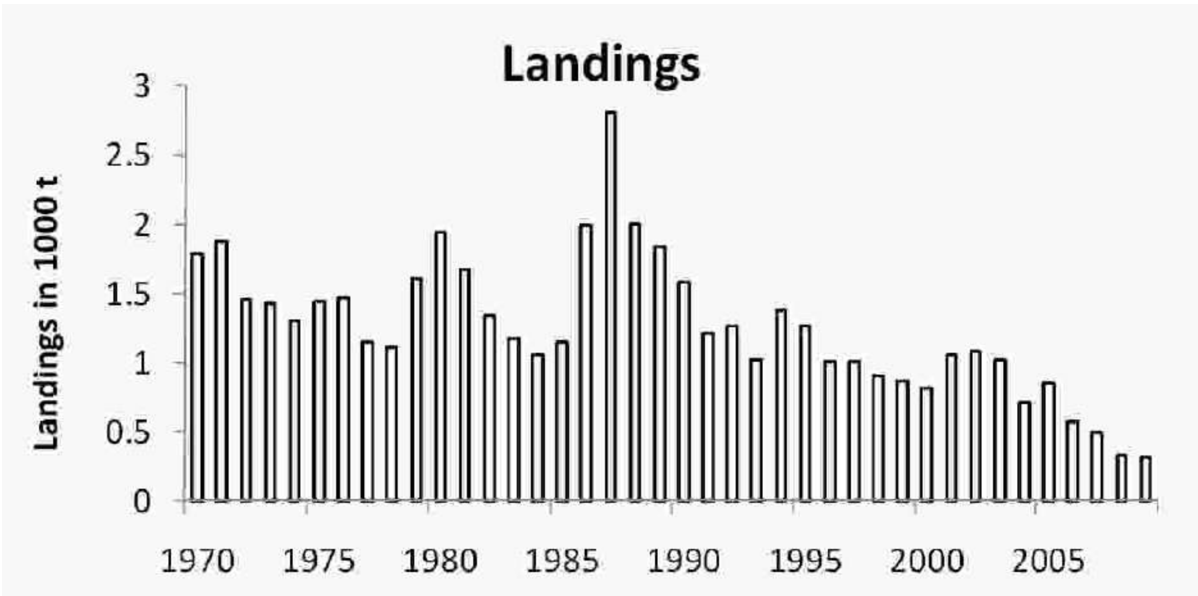


Figure 1.6 Sole landings from the Irish Sea (ICES area VIIa) (Source: MI 2010).

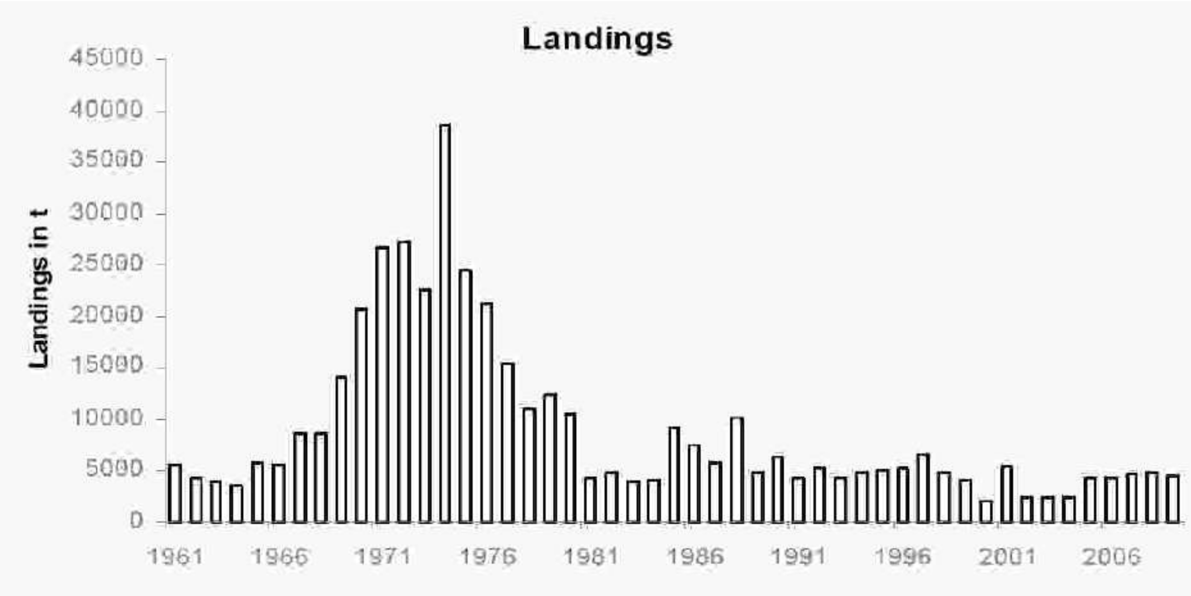
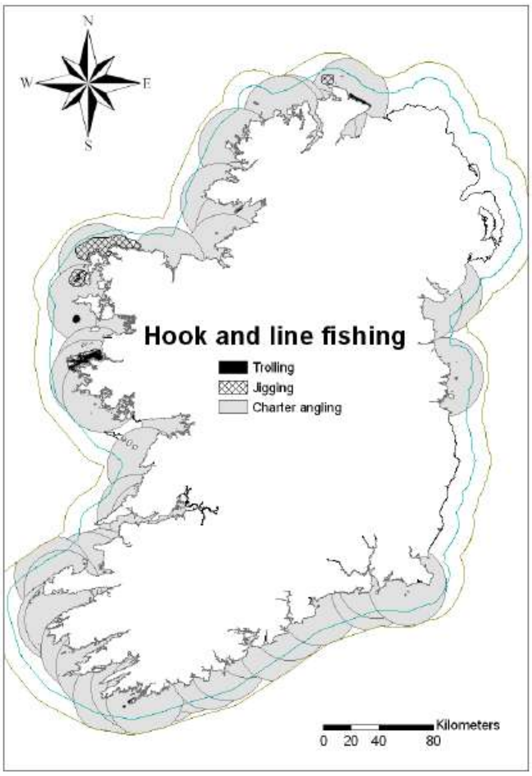
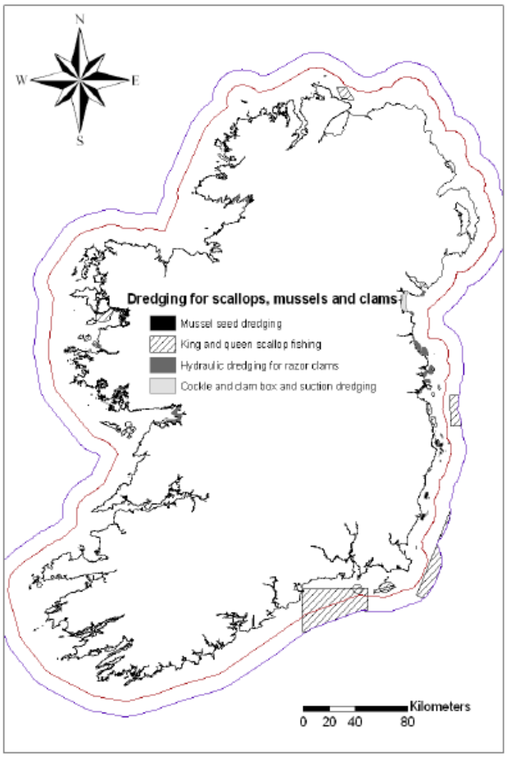
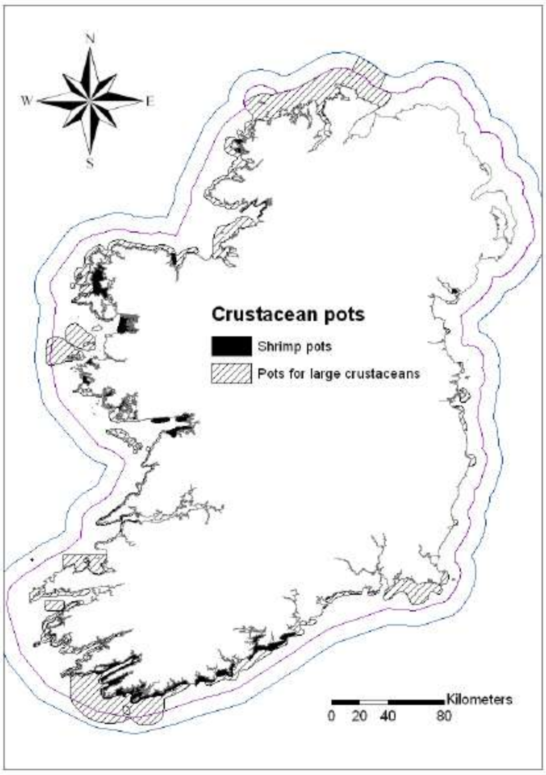


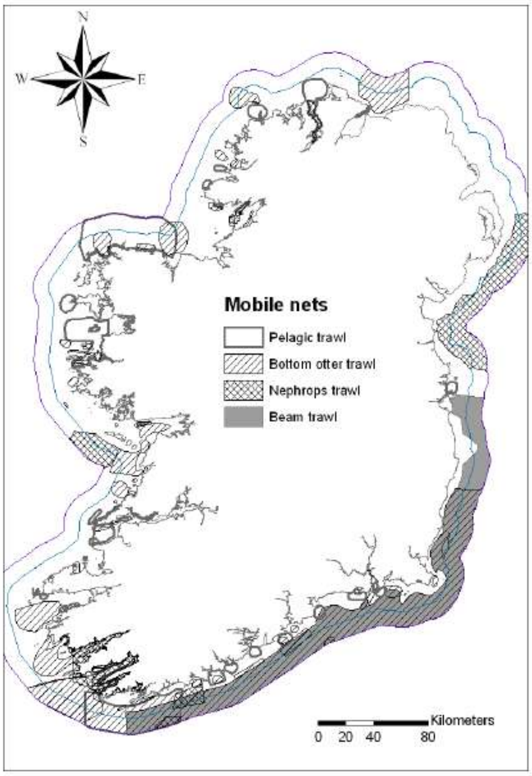
Figure 1.7 Herring landings from the Irish Sea (ICES area VIIa) (Source: MI 2010).

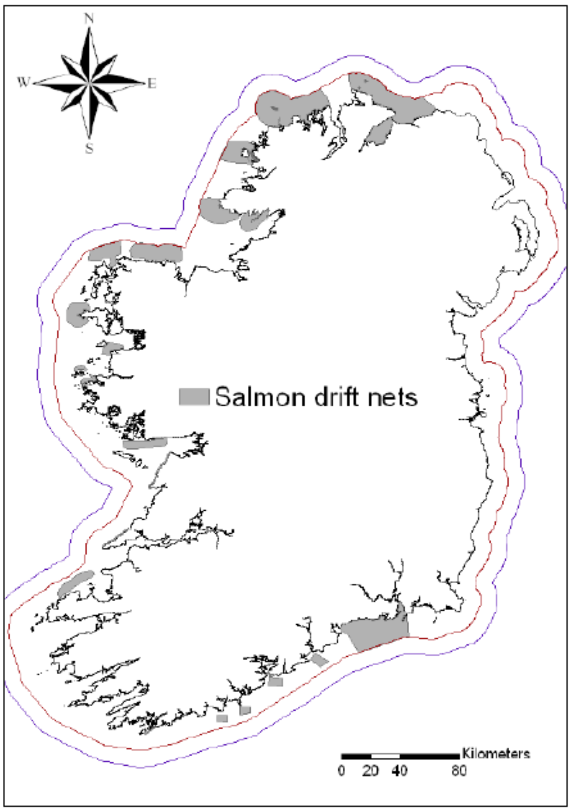
APPENDIX 2 – Fishing effort around Irish coast

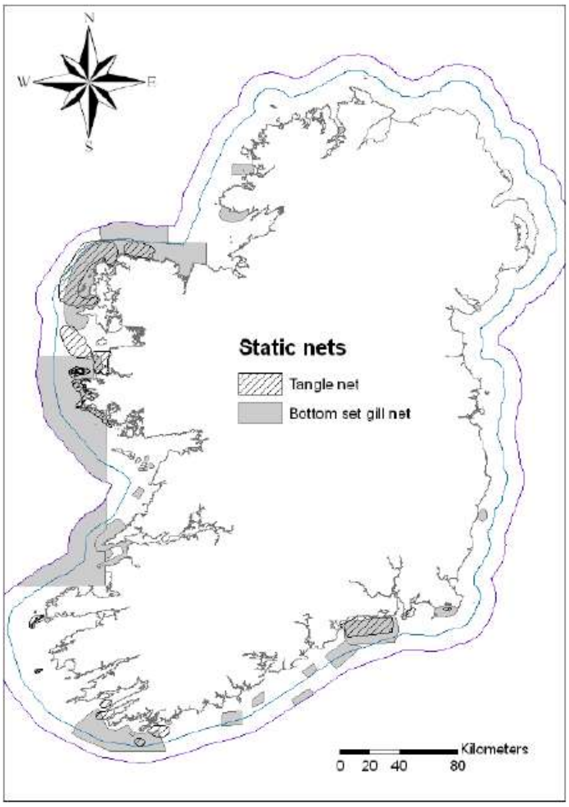


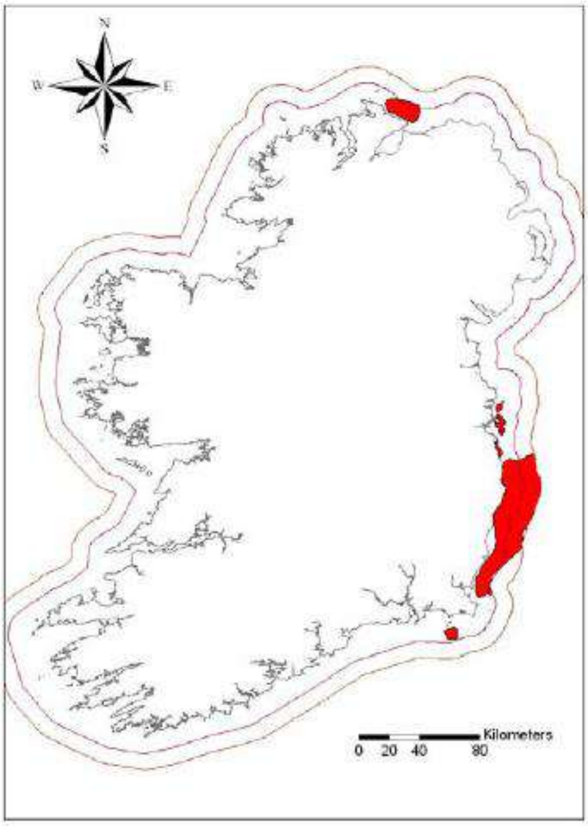


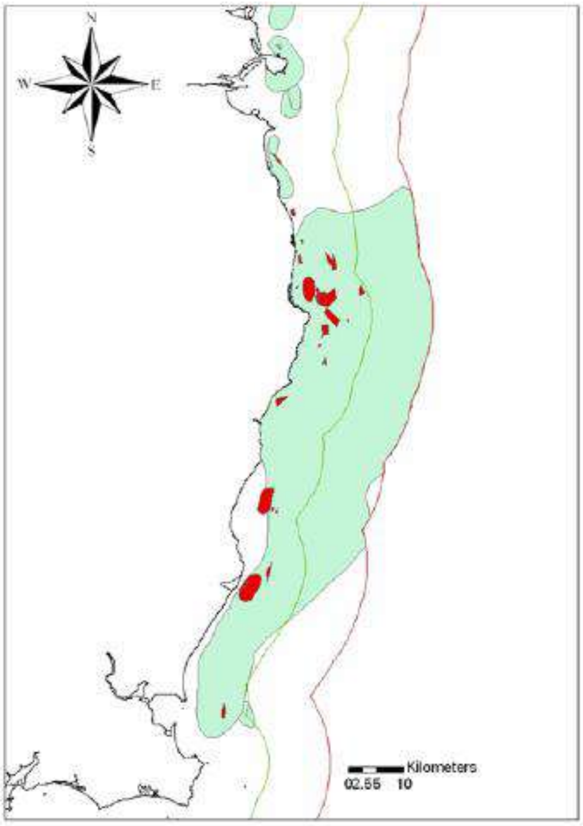






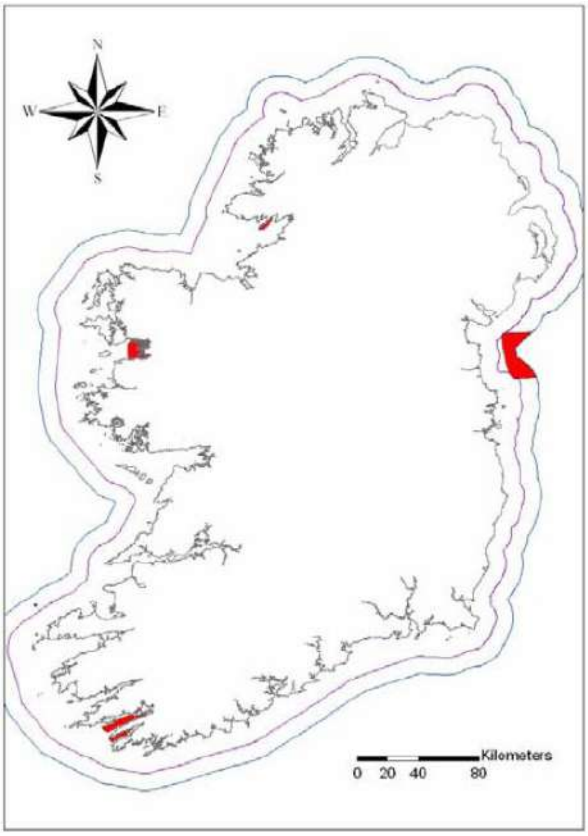




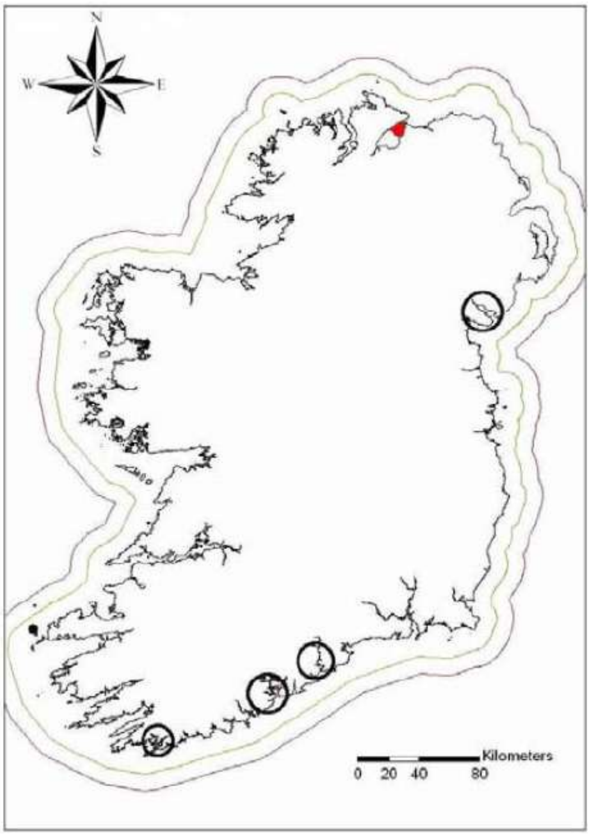


Whelk pot fisheries.

Whelk fishery (green) and dredged seed mussel patches (red) in the south west Irish Sea.

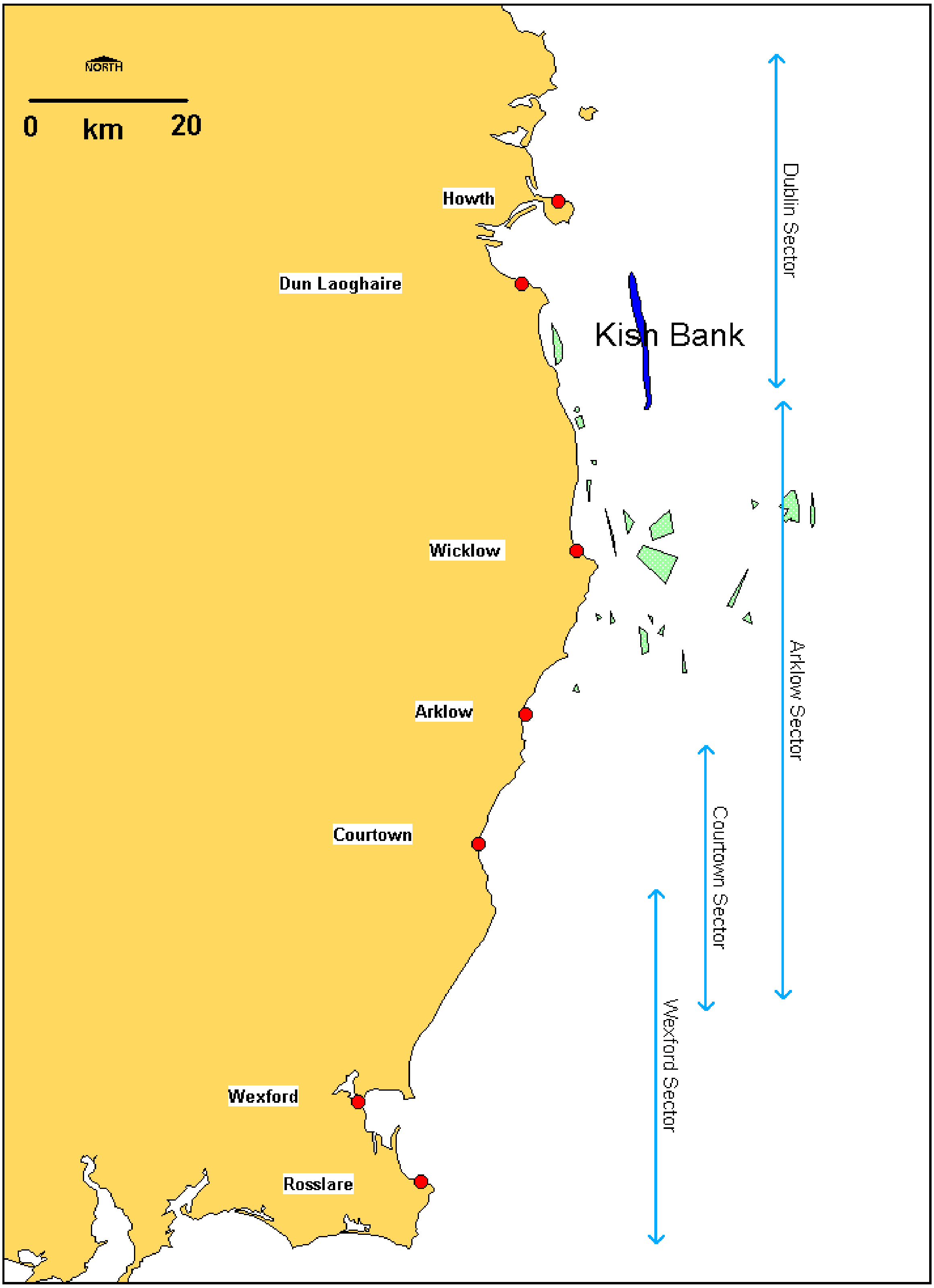


Nephrops pot fisheries



Green crab pot fisheries

(Source: Fahy *et al.*, 2008)



Whelk fishing sectors in the southern Irish Sea (adapted from Fahy *et al*., 2000) and approximate BIM mussel seed locations in green.

APPENDIX 3 – Dún Laoghaire and Howth landings

Table 3.1 Fish landings (live weight in t) into Dún Laoghaire Port from 1997 to 2000 (Source: DCENR).

Species	1997	1998	1999	2000
DEMERSAL				
ray / skate	7.4	4.1	-	-
plaice	7.8	2.4	-	-
cod	3.1	3	-	-
codling	-	0.2	-	-
spotted dog	-	-	5.0	-
spur dog	-	-	0.1	-
whiting	0.2	-	-	-
haddock	1.3	1.4	-	-
monk /angler	-	0.2	-	-
turbot	-	0.1	-	-
saithe	-	0.1	-	-
brill	-	0.1	-	-
mixed boxes	0.2	-	-	-
ling	0.3	0.3	-	-
lemon sole	-	0.2	-	-
dabs	-	0.2	-	-
white pollock	-	0.9	-	-
gurnard	-	0.1	-	-
common sole	-	0.1	-	-
megrim	-	0.2	-	-
various dogfish	-	0.1	-	-
Total demersal	**20.4**	**13.9**	**5.1**	**0.0**
PELAGIC				
mackerel	0.5	-	-	-
Total pelagic	**0.5**	**0**	**0**	**0**
Total wet fish	**20.9**	**13.9**	**5.1**	**0.0**
SHELLFISH				
escallop	0.8	0.4	-	-
crab claws	32.0	58.5	34.5	-
edible crab	7.4	6.8	7.2	22.5
lobster	1.7	1.7	1.8	3.1
squid	0.6	0.6	-	-
velvet crab	1.9	11	6.5	19.5
whelk	339.0	295.0	576.0	611.0
Total shellfish	**383.4**	**374.0**	**626.0**	**656.1**
TOTAL ALL SPECIES	**404.3**	**387.9**	**631.1**	**656.1**

Table 3.2. Shellfish landings (live weight in t) into Dún Laoghaire Port from 2006 to 2007 (Source: SFPA, 2008).

Species	2006	2007
crab edible	1.700	6.615
crab velvet	0.780	2.755
lobster european	0.434	0.358
Nephrops	-	0.2
whelk	19.640	105.322
Total shellfish	**22.554**	**115.25**

Table 3.3. Fish (demersal, pelagic and shellfish) landings (live weight in t) into Howth Port from 1997 to 2000 (Source: DCENR).

Species	1997	1998	1999	2000
DEMERSAL				
ray / skate	609.9	379.7	537.4	394.2
plaice	257.7	327.5	165.2	136.4
cod	574.8	492.4	413.1	243.9
spotted dog	13.5	20.5	35.5	25.8
spur dog	50.2	78.4	38.7	30.9
whiting	262.5	274.6	193.8	158.8
codling	69.0	31.1	7.8	2.8
haddock	599.6	1,375.2	429.0	276.7
monk /angler*	162.1	103.4	118.4	112.6
turbot	19.5	21.1	7.6	11.3
saithe	29.0	26.9	28.4	48.7
brill	8.3	12.5	4.2	4.1
mixed boxes	98.0	57.6	48.2	47.7
ling	32.3	24.6	31.1	29.3
lemon sole	6.2	6.5	8.5	8.0
dabs	6.6	9.8	3.6	1.9
white pollock	16.8	12.9	14.9	49.4
gurnard	11.9	17.3	22.3	25.5
john dory	3.5	4.0	5.1	5.2
witch	23.7	24.5	31.8	21.7
common sole	39.0	46.6	30.0	23.8
hake	4.8	8.3	34.8	41.7
megrim	10.3	9.0	19.6	13.4
sand sole	-	1.1	-	-
slip sole	8.6	11.1	-	0.1
conger eel	18.0	17.6	13.0	11.5

Species	1997	1998	1999	2000
flounder	0.2	2.2	0.3	0.2
mullet	-	-	-	0.3
other flatfish	-	-	0.4	0.2
pouting	-	0.3	-	3.1
rabbit fish	-	-	-	0.9
redfish	-	-	-	4.5
tope	-	-	0.2	-
tusk	-	-	-	7.7
Total demersal	**2,937.5**	**3,397.1**	**2,245.9**	**1,742.8**
PELAGIC				
mackerel	0.6	0.2	1.1	2.5
herring	3.0	-	-	0.2
ocean sunfish	-	-	-	8.1
Total pelagic	**3.6**	**0.2**	**1.1**	**10.8**
SHELLFISH				
blue mussel (seed)	400.0	-	-	-
escallop	0.2	32.7	98.6	82.2
crab claws	86.5	72.0	77.5	4.5
edible crab	15.1	17.5	10.2	87.7
lobster	2.0	2.1	1.0	2.3
Nephrops	778.7	668.0	1,313.3	1,145.5
octopus	1,449.6	0.1	-	0.5
other crab	-	-	-	1.0
prawn tails	-	1,023.6	1,438.5	1,440.9
queen escallop	0.5	2.5	1.4	2.3
razor shell	9.6	8.0	10.0	13.0
squid	3.5	7.1	4.8	6.1
velvet crab	19.2	27.0	26.0	22.5
whelk	256.0	117.9	319.9	471.6
Total shellfish	**3,020.9**	**1,978.5**	**3,301.2**	**3,280.1**
TOTAL FINFISH	**2,941.1**	**3,397.3**	**2,247.0**	**1,753.6**
TOTAL ALL SPECIES	**5,962.0**	**5,375.8**	**5,548.2**	**5,033.7**

**including monk tails*

Table 3.4. Fish (demersal, pelagic and shellfish) landings (live weight in t) into Howth Port from 2004 to 2007 (Source: SFPA, 2008).

Species	2004	2005	2006	2007
DEMERSAL				
brill	2.01	2.42	2.22	1.43
cod atlantic	136.02	163.23	148.7	141.8
conger european	13.08	10.01	5.2	5.08

Species	2004	2005	2006	2007
dabs	1.39	0.48		
dogfish		0.2		0.11
dogfish sharks nei		1.028	2.5	0.53
dogfish sharks, etc. nei				0.1
dogfishes and hounds nei	37.63	29.6	20.9	2.55
dogfishes nei		0.04		
eelpouts				0.05
flounder	0.37	0.8		
forkbeard greater			0.09	
gurnard	38.4	20.9	34.1	16.63
haddock	158.6	139.2	201.56	229.8
hake european	26.7	27.3	19.38	25.13
lemon sole	18.1	11.5	9.8	11.01
ling	35.2	33.8	19.2	34.3
lings nei	1.02			
megrim nei	18.1	12.4	8.9	21.4
mix boxes	33.7	33.5	30.6	36.7
monkfish angler	2.4	0.21	0.12	2.8
monkfish angler nei	86.02	104.7	120.77	137.7
mullets nei	0.08	0.23		0.19
plaice	123.93	96.2	75.8	54.04
pollack	34.7	26.23	12.25	20.05
rays nei	471.9	392.11	328.27	286.5
rays, stingrays, mantas nei		0.916	23.24	26.6
red mullet		2.06	1.54	0.39
saithe	7.7	9.63	1.89	1.4
sand sole			0.46	0.5
skates and rays nei				0.44
sole black	13.4	15.27	14.6	17.6
spurdog	8.7	14.41	6.68	45.73
tope shark	0.04	0.02	0.03	
turbot	6.4	3.95	5.82	6.31
whiting	176.7	254.08	190.47	205.37
witch	20.7	35.63	40.24	33.07
Total demersal	**3476.99**	**3447.054**	**3331.33**	**3372.31**
PELAGIC				
porbeagle	0.04			
atlantic herring	745	1153.255	580.62	
atlantic mackerel	0.155	0.84	0.17	0.25
sardinellas nei				0.04
john dory	6.47	8.6	6.85	3.45

Species	2004	2005	2006	2007
tuna-like fishes nei				0.15
Total pelagic	**751.665**	**1,162.695**	**587.64**	**3.89**
SHELLFISH				
crab edible	0.72	0.59	8.894	15.66
crab velvet		9.52	1.515	
lobster european		1.65	1.725	1.79
Nephrops	1683.49	1861.13	1624.5	1978.041
mussel nei			80	190
razor pod shell		4.61		
razor shells, knife clams nei	0.1	9.65	8.67	13.863
scallop great atlantic	62.15	0.2	0.17	
scallop nei				0.98
scallop queen	0.66	0.25	1.79	0.99
squid common nei	0.37		0.111	1.53
squid northern shortfin	8.03	9.98	0.215	0.12
squid various nei	0.07	0.117	3.7	1.4
whelk	122.56	137.03	150.9	27.115
Total shellfish	**1878.15**	**2034.727**	**1882.19**	**2231.489**
TOTAL FINFISH	**2,347.22**	**2,741.78**	**2,063.87**	**1,396.32**
TOTAL FISH	**4,102.81**	**4,639.477**	**3,795.16**	**3,600.694**

Table 3.5. Summary of live weight (tonnes) of all fish (including shellfish) landings and commercial value (€) into Howth and Dún Laoghaire Ports (Source: DCENR).

Port	1997	1998	1999	2000
HOWTH				
Demersal fish	2,937.5	3,397.3	2,246.0	1,325.2
Pelagic fish	3.6	0.2	1.1	523.5
Shellfish	3,020.7	1,978.5	3,301.1	2,546.4
Total weight (t)	**5,961.8**	**5,376.0**	**5,548.2**	**4,395.1**
Total value (euro €)	**10,088,760**	**9,597,744**	**10,702,257**	**11,229,146**
DÚN LAOGHAIRE				
Demersal fish	20.6	13.8	5.1	0.0
Pelagic fish	0.5	0.0	0.0	0.0
Shellfish	383.4	373.9	626.0	656.1
Total weight (t)	**404.5**	**387.7**	**631.1**	**656.1**
Total value (euro €)	**237,93.36**	**248,416.6**	**389,796.89**	**487,839.72**

Table 3.6. Summary of live weight (tonnes) of all fish (including shellfish) landings and their commercial value into Howth Port (Source: SFPA, 2008).

Year	Live weight of sea fish landings (t)	Value of the sea fish landings (thousands €)
2006	4,323	6,594
2005	4,845	6,543
2004	4,671	6,297
2003	4,473	7,441
2002	4,661	13,392
2001	6,253	15,553

Table 3.7. Summary of live weight (tonnes) of all fish (including shellfish) landings into Howth and Dún Laoghaire Ports and their commercial value (Source: CSO, 2008).

Year	Port	Live weight of sea fish landings (t)	Value of the sea fish landings (thousands €)
2004	Howth	4,491	7,759
2003	Howth	4,196	8,815
2002	Howth	4,662	13,392
2001	Howth	6,257	15,553
2004	Dún Laoghaire	397	308
2003	Dún Laoghaire	1,093	788
2002	Dún Laoghaire	337	264
2001	Dún Laoghaire	387	362

Table 3.8. Landings for whelks from different sectors and ports of Ireland from 1990 –1999. Values in bold indicate the landed weight (in tonnes) of whelks and values underneath indicate the average value (in euro) of the whelk fishery (adapted from Fahy *et al*., 2000).

Port	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
DUBLIN SECTOR										
Greencastle	-	**1**	-	-	**86**	**19**	**15**	-	-	-
		483			36980	11077	9840			
Skerries	-	-	-	-	-	-	**35**	-	-	-
							22960			
Howth	-	**18**	**12**	**24**	**466**	**427**	**555**	**266**	**118**	**320**
		8694	5376	10824	200380	248941	364080	148694	64428	180480
Dún Laoghaire	-	**68**	**109**	**116**	**362**	**538**	**520**	**339**	**295**	**576**
		32844	48832	52316	155660	313654	341120	189501	161070	324864
Greystones	-	**45**	**91**	**86**	**67**	**77**	**1**	**28**	**15**	**104**
		21735	40768	38786	28810	44891	656	15652	8190	58656
Total Dublin		**131**	**212**	**225**	**894**	**1042**	**1076**	**633**	**428**	**1000**
		63273	94976	101926	384850	607486	705856	353847	233688	564000
ARKLOW SECTOR										
Wicklow (when given separately)	-	**60**	**84**	-	-	-	**1717**	**1249**	**1,655**	**2,388**
		28980	37632				820,057	698191	903630	1346832
Arklow (when given separately)	-	**335**	**665**	**1185**	**1780**	-	**736**	**535**	**892**	**371**
		161805	297920	534435	765400		482816	299065	487032	209244
Total Arklow		**395**	**749**	**1185**	**1780**	**1178**	**2453**	**1784**	**2547**	**2759**
		190785	335552	534435	765400	0	1302873	997256	1390662	1556076
COURTOWN SECTOR										
Total Courtown	**56**	**310**	**415**	**285**	**530**	**778**	**864**	**475**	**396**	**568**
	14448	149730	185920	128535	227900	453574	566784	265525	216216	320352
WEXFORD SECTOR										
Cahore Point	-	**52**	**85**	**60**	**82**	**91**	**114**	-	-	--
		25116	38080	27060	35260	53053	74784			
Wexford	-	-	-	**485**	**1008**	**2786**	**1,426**	**890**	**159**	**167**
				218735	433440	1624238	935456	497510	86814	94188
Rosslare	-	-	-	-	-	**25**	**10**	**9**	**87**	**64**
						14575	6560	5031	47502	36096
Carne	-	**29**	**140**	-	-	-	-	-	**36**	-
		14007	62720						19656	
Total Wexford		**81**	**225**	**545**	**1091**	**2901**	**1550**	**899**	**282**	**231**
		39123	100800	245795	468700	1691866	1016800	502541	153972	130284
OTHERS										

Port	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Kilmore quay	-	**81**	**128**	-	-	-	-	**15**	**15**	**2**
		39123	57344					8385	8190	1128
Duncannon / St Helens	**-**	-	-	-	-	-	-	-	-	**0.5**
										282
Castletownbere	**-**	-	-	-	-	-	-	-	-	**0.3**
										169
Fethard and Slade	**-**	**35**	**366**	**190**	**-**	**4**	**15**	**11**	-	**1**
		16905	163968	85690		2332	9840	6149		564
Dunmore East	**-**	**-**	**-**	**3**	**4**	**-**	**525**	**45**	-	-
				1353	1720		344400	25155		
Bantry	-	-	-	-	-	-	**0.1**	-	-	-
							66			
Dingle	-	-	-	-	-	-	**2**	-	-	-
							1312			
Moville	-	-	-	-	-	-	**3**	-	-	-
							1968			
Total		**724**	**1680**	**2149**	**3855**	**3967**	**6,538**	**3,862**	**3,667**	**4,562**
		349692	752640	969199	1657650	2312761	3,982,699	2,158,579	2,002,182	2,572,855
Total for 4 sectors	**56**	**917**	**1601**	**2240**	**4295**	**5899**	**5943**	**3791**	**3652**	**4558**
	14448	442911	717248	1010240	1846850	3439117	3898608	2119169	1993992	2570712
Average annual price per tonne (€)	258	483	448	451	430	583	656	559	546	564

APPENDIX 4 – Spawning and nursery areas

Table 4.1 Spawning periods of shell/fish spawning in the development area. Source Coull *et al.*, 1998.

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
lemon sole												
sprat												
Nephrops norvegicus				*	*	*						

* Peak spawning period

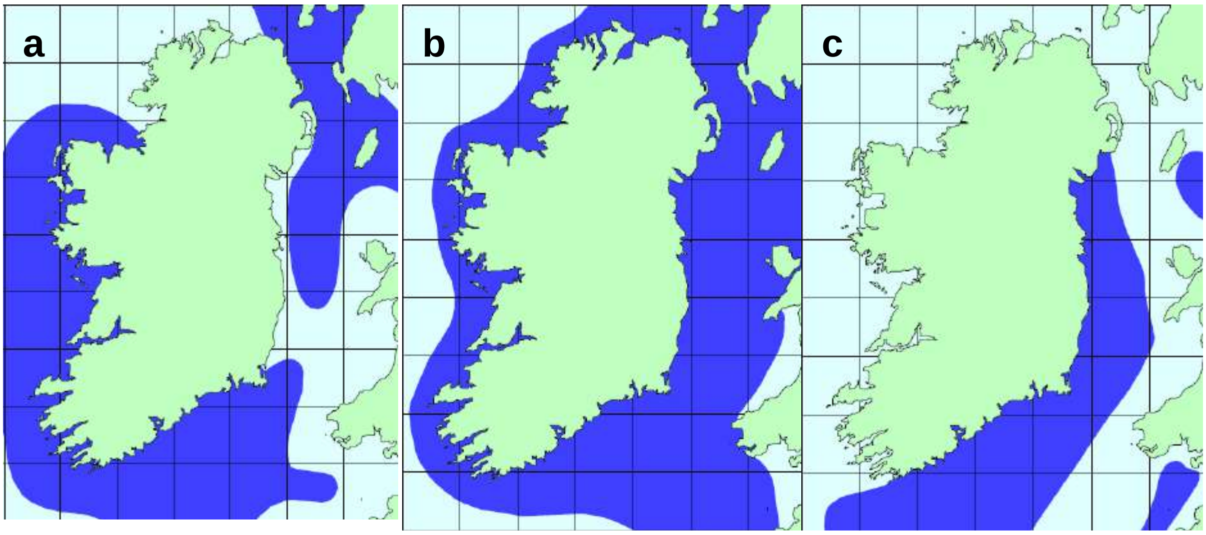


Figure 4.1. Spawning areas of sprat (blue), lemon sole (green) and *Nephrops* (pink) (adapted from Coull *et al.*, 1998).

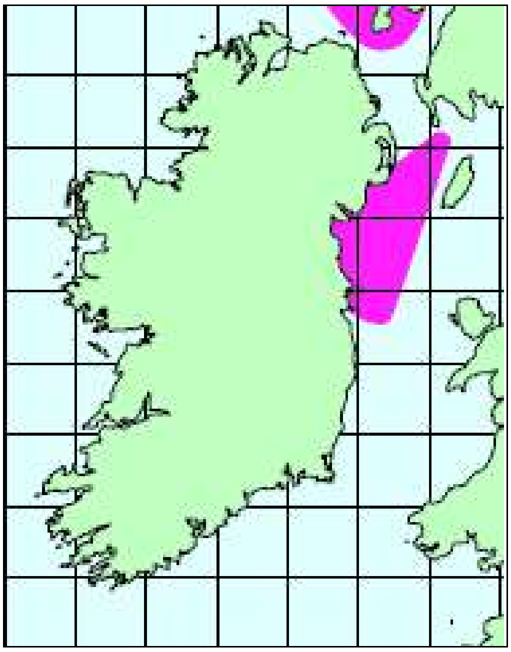


Figure 4.2. Map of a nursery areas for cod (From Coull *et al*., 1998).

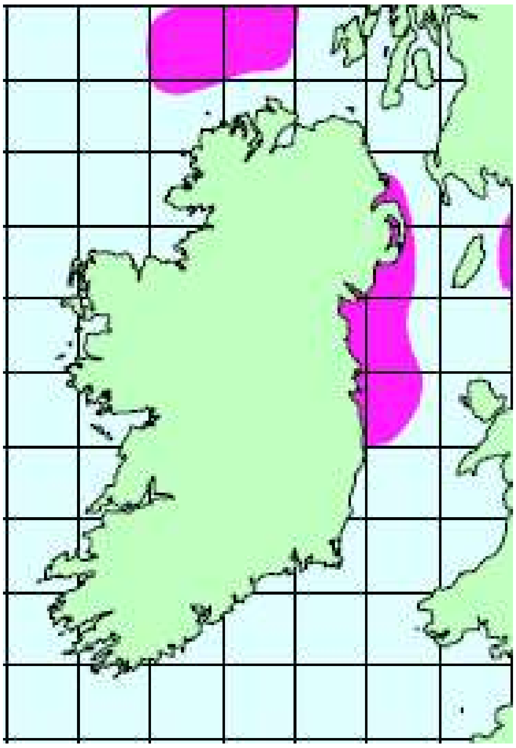


Figure 4.3. Map of a nursery areas for haddock (From Coull *et al*., 1998).

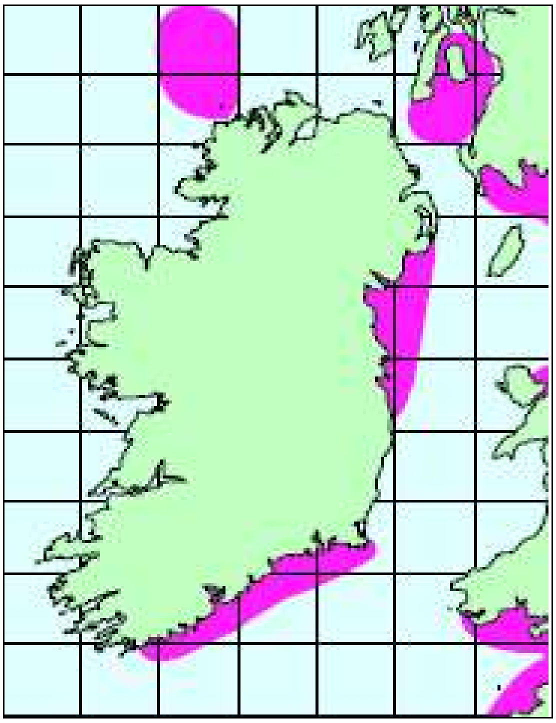


Figure 4.4. Map of nursery areas for whiting (From Coull *et al.*, 1998).

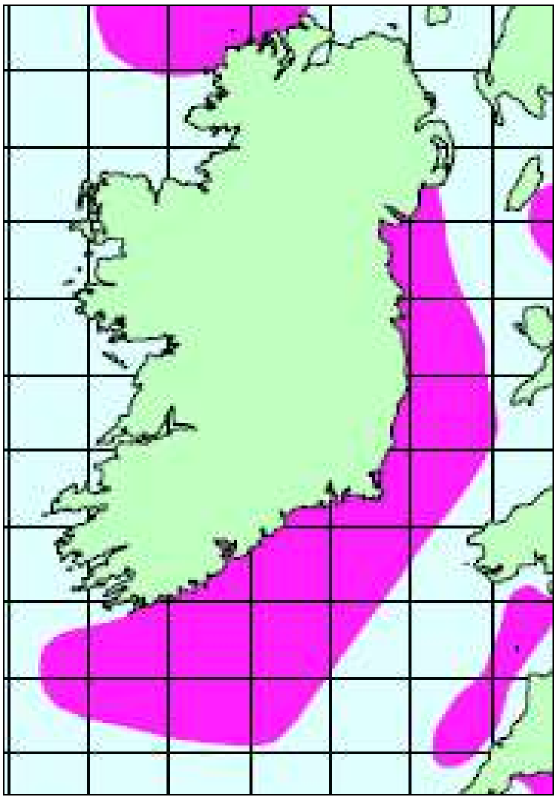


Figure 4.5. Map of nursery areas for lemon sole (From Coull *et al.*, 1998).

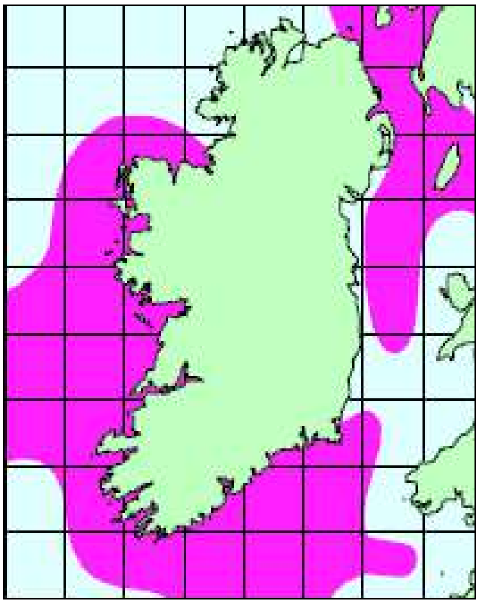


Figure 4.6. Map of nursery areas for N*ephrops* (From Coull *et al*., 1998).

APPENDIX 5 – Recreational angling catches

Table 5.1 Recreational angling catches from the shore (David Byrne, IFI, pers. comm.).

	Howth	**Dun Laoghaire**	**Coliemore Harbour**	**Kiliney Beach**	**Bray harbour**	**Greystones**	**Kilcoole**	**Killiney**	**Newcastle**	**Kiloughter**
bass	✓			✓	✓	✓		✓		
coalfish	✓		✓	✓	✓	✓	✓	✓		
cod									✓	
codling	✓	✓	✓	✓	✓	✓	✓	✓		✓
conger		✓	✓		✓	✓				
dab	✓	✓			✓	✓	✓		✓	
dogfish				✓	✓	✓	✓	✓		✓
dogfish	✓									
gurnard					✓					
mackerel	✓	✓								
mullet	✓	✓								
nursehound										✓
plaice	✓	✓		✓	✓	✓	✓	✓		
pollock	✓	✓	✓	✓	✓	✓		✓		
pouting		✓								
smoothound										✓
sole						✓				
spotted ray										✓
spurdog										✓
thornback ray										✓
tope					✓					
turbot						✓				
whiting	✓	✓				✓	✓			
wrasse	✓				✓					

APPENDIX 6 – Data from fisheries research

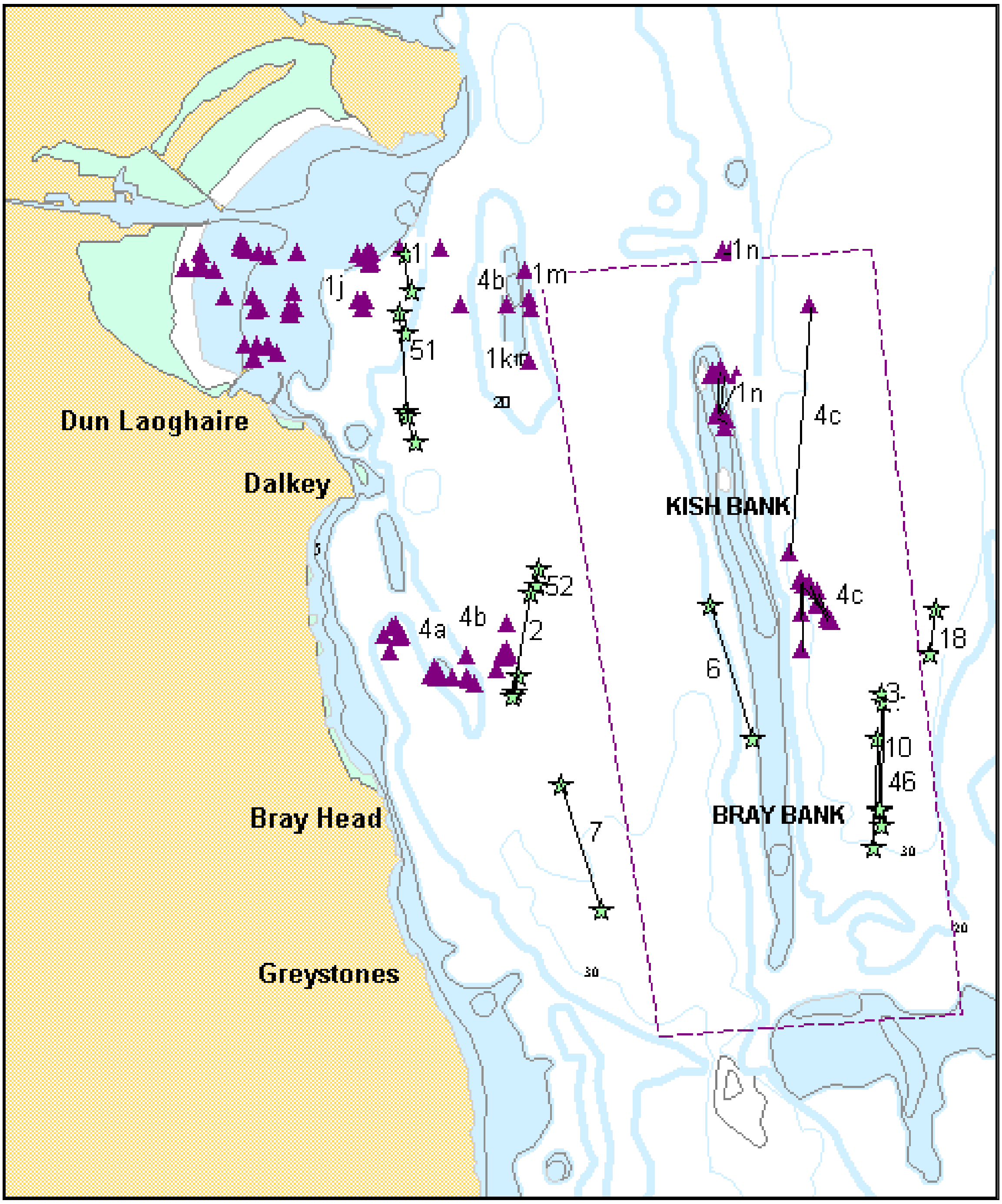


Figure 6.1. Locations of the Irish Sea and Celtic Sea Groundfish Survey sites (1997-2001) (as green stars) and the Juvenile Plaice Survey sites (1992 – 2002) (as purple triangles). Site numbers are given for those in the vicinity of the survey area. Duplicates occur with yearly data.

Table 6.1. Location and duration of the Irish Sea and Celtic Sea Groundfish Survey 1997-2001 (source: Marine Institute).

Site	Date (year)	Position (Start)	Position (End)	Duration (min.)
6	1997	53.2413N 5.9370W	53.2070N 5.9187W	30
7	1997	53.1948N 6.0018W	53.1622N 5.9842W	30
1	1998	53.3123N 6.0697W	53.3327N 6.0697W	30
9	1998	53.9943N 5.7737W	54.0223N 5.7490W	30
18	1998	53.2405N 5.8393W	53.2287N 5.8420W	30
1	1999	53.3230N 6.0670W	53.2920N 6.0695W	30
2	1999	53.2510N 6.0113W	53.2230N 6.0207W	30
46	1999	53.2163N 5.8617W	53.1843N 5.8625W	30
1	2000	53.3120N 6.0692W	53.2838N 6.0652W	30
2	2000	53.2467N 6.0125W	53.2192N 6.0220W	30
3	2000	53.1882N 5.8635W	53.2185N 5.8625W	30
10	2000	53.1788N 5.8658W	53.2068N 5.8645W	30
51	2001	53.2910N 6.0688W	53.3173N 6.0722W	30
52	2001	53.2447N 6.0148W	53.2182N 6.0228W	30
53	2001	53.2167N 5.8585W	53.1885N 5.8632W	30

Table 6.2. Species and numbers of fish caught from the Irish Sea and Celtic Sea Groundfish Survey 1997-2001 (source: Marine Institute).

Year	1997		1998			1999			2000				2001		
Sampling station	**6**	**7**	**1**	**9**	**18**	**1**	**2**	**46**	**1**	**2**	**3**	**10**	**51**	**52**	**53**
horse-mackerel	4	-	-	-	-	-	-	-	-	-	-	-	-	-	2
plaice	205	197	187	121	99	23	80	1	483	136	27	12	67	23	22
sprat	6875	336	-	-	372	-	-	-	55	34	111	49	84	212	96
thornback ray	10	-	-	-	-	-	-	-	63♀,21♂	11♀,8♂	-	-	3♀,5♂	1	-
haddock	-	51	-	2139	62	40	2	2403	8	5	1350	341		9	1983
whiting	-	108	5083	4639	410	13686	7476	15494	2132	1264	11394	1625	2992	2331	732
skates and rays	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-
cod	-	-	-	-	-	62	-	34	7	13	11	9	3	4	1
whiting-pout	-	-	-	-	-	-	-	-	9	-	-	2	3	-	-
common dragonet	-	-	-	-	-	-	-	-	149	41	24	5	6	1	7
dab	-	-	-	-	-	-	-	-	1578	81	98	23	250	26	9
common goby	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-
common ling	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
lesser spotted dogfish	-	-	-	-	-	-	-	-	90	83	98	2	202	100	57

Year	**1997**		**1998**			**1999**			**2000**				**2001**		
Sampling station	**6**	**7**	**1**	**9**	**18**	**1**	**2**	**46**	**1**	**2**	**3**	**10**	**51**	**52**	**53**
poor cod	-	-	-	-	-	-	-	-	321	398	715	324	-	3	2
pogge	-	-	-	-	-	-	-	-	154	3	-	-	1	-	-
dover sole	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-
cuckoo ray	-	-	-	-	-	-	-	-	-	18	27	3	-	-	-
grey gurnard	-	-	-	-	-	-	-	-	-	2	384	21	-	-	2
lemon sole	-	-	4	-	-	-	-	-	-	5	17	1	-	1	1
spotted ray	-	-	-	-	-	-	-	-	-	10	6	-	-	-	1
witch	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
butterfly blenny	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
anglerfish	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
northern squid	-	-	-	-	-	-	-	-	-	-	11	4	-	-	-
thickback sole	-	-	-	-	-	-	-	-	-	-	17	1	-	-	-
herring	4	-	-	-	-	-	-	-	-	-	101	520	2	13	5
norway pout	-	-	-	-	-	-	-	-	-	-	-	30	-	-	12
tub gurnard	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
nurse hound	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
flounder	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
john dory	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
starry smooth hound (♀,♂)	-	-	-	-	-	-	-	-	-	-	-	-	-	2,2	1
spurdog (♀,♂)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,4
No. of species	**5**	**4**	**4**	**3**	**4**	**4**	**3**	**4**	**15**	**17**	**18**	**18**	**11**	**16**	**18**

Table 6.3. Location of the Juvenile Plaice Survey 1994-2002 (source, Marine Institute).

Site	Date (year)	Position (Start)	Position (End)	Site	Date (year)	Position (Start)	Position (End)
1j	1994	53.3198N 6.0863W	53.3293N 6.0840W	4c	1998	53.2440N 5.8897W	53.2363N 5.8840W
1k	1994	53.3040N 6.0152W	53.3175N 6.0142W	1j	1998	53.3173N 6.0865W	53.3295N 6.0835W
1m	1994	53.3203N 6.0147W	53.3275N 6.0163W	1k	1998	53.3082N 6.1382W	53.3175N 6.1315W
1n	1994	53.3010N 5.9355W	53.2913N 5.9325W	1m	1998	53.3337N 6.1383W	53.3315N 6.1572W
4a	1994	53.2328N 6.0702W	53.2243N 6.0563W	1j	1999	53.3173N 6.0877W	53.3308N 6.0852W
4b	1994	53.2237N 6.0287W	53.2358N 6.0245W	1k	1999	53.3075N 6.1288W	53.3175N 6.1193W
4c	1994	53.2408N 5.8898W	53.2287N 5.8970W	1m	1999	53.3330N 6.1402W	53.3280N 6.1582W
1j	1995	53.3195N 6.0865W	53.3292N 6.0838W	1n	1999	53.3003N 5.9335W	53.2908N 5.9330W
1k	1995	53.3042N 6.1348W	53.3172N 6.1340W	4a	1999	53.2223N 6.0578W	53.2327N 6.0777W
1m	1995	53.3280N 6.1652W	53.3207N 6.1468W	4b	1999	53.2270N 6.0255W	53.2218N 6.0478W
1n	1995	53.2907N 5.9325W	53.3002N 5.9358W	4c	1999	53.2450N 5.8923W	53.2380N 5.8850W
4a	1995	53.2320N 6.0708W	53.2242N 6.0562W	1j	2000	53.3177N 6.0863W	53.3303N 6.0872W
4b	1995	53.2237N 6.0288W	53.2358N 6.0243W	1k	2000	53.3060N 6.1242W	53.3158N 6.1188W
4c	1995	53.2465N 5.8980W	53.2407N 5.8895W	1m	2000	53.3217N 6.1177W	53.3312N 6.1280W
1j	1996	53.3195N 6.0865W	53.3292N 6.0838W	1n	2000	53.3008N 5.9313W	53.2895N 5.9332W
1k	1996	53.3042N 6.1342W	53.3172N 6.1340W	4a	2000	53.2215N 6.0545W	53.2320N 6.0715W
1m	1996	53.3275N 6.1517W	53.3207N 6.1348W	4b	2000	53.2272N 6.0233W	53.2218N 6.0420W
1n	1996	53.2907N 5.9325W	53.3002N 5.9358W	4c	2000	53.2458N 5.8963W	53.2383N 5.8965W
4a	1996	53.2320N 6.0708W	53.2233N 6.0562W	1j	2001	53.3323N 6.0847W	53.3197N 6.0893W
4b	1996	53.2237N 6.0288W	53.2358N 6.0243W	1k	2001	53.3080N 6.1330W	53.3157N 6.1187W
4c	1996	53.2465N 5.8977W	53.2407N 5.8895W	1m	2001	53.3337N 6.1400W	53.3280N 6.1570W
1j	1997	53.3197N 6.0867W	53.3320N 6.0835W	1n	2001	53.2888N 5.9288W	53.3022N 5.9317W
1k	1997	53.3073N 6.1278W	53.3175N 6.1165W	4a	2001	53.2220N 6.0575W	53.2347N 6.0743W
1m	1997	53.3348N 6.1405W	53.3285N 6.1565W	4b	2001	53.2273N 6.0260W	53.2202N 6.0383W
1n	1997	53.3010N 5.9328W	53.2865N 5.9303W	4c	2001	53.2472N 5.8972W	53.2367N 5.8852W
4a	1997	53.2217N 6.0552W	53.2283N 6.0755W	1j	2002	53.3317N 6.0838W	53.3318N 6.0898W
4b	1997	53.2287N 6.0245W	53.2272N 6.0422W	1k	2002	53.3320N 6.1323W	53.3322N 6.1155W
4c	1997	53.2460N 5.8933W	53.2543N 5.9022W	1m	2002	53.3323N 6.1573W	53.3325N 6.1380W
1n	1998	53.3003N 5.9245W	53.2900N 5.9327W	1n	2002	53.3327N 5.9305W	53.3328N 5.9270W
4a	1998	53.2233N 6.0542W	53.2352N 6.0727W	4a	2002	53.3330N 6.0710W	53.3332N 6.0535W
4b	1998	53.2277N 6.0262W	53.2210N 6.0413W	4b	2002	53.3183N 6.0447W	53.3184N 6.0245W
				4c	2002	53.3184N 5.8935W	-

***Note: no positions given for 1992 and 1993.**

Table 6.4. Species and numbers of fish caught from the Juvenile Plaice Survey, 1992 – 1996 (source: Marine Institute). P=present.

Year	**1992**							**1993**							**1994**							**1995**							**1996**						
Sampling station	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**
plaice	43	90	14	7	9	7	13	41	1	14	8	25	56	17	5	9	1	52	6	10	5	135	43	16	35	18	5	3	56	27	13	1	1	-	1
dab	-	-	p	-	1	-	-	p	-	-	-	2	p	-	1	p	1	p	p	p	-	p	-	-	-	-	-	-	p	p	p	1	p	-	-
lemon sole		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p
herring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flounder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	p	-	-	-	p
sprat	-	-	-	-	-	-	-	-	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
whiting	-	-	p	-	-	-	-	-	2	15	-	p	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		p
sand eel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
turbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
weaver			p	p	p	p	p	-	-	-	-	-	-	-	-	p	2	p	-	p	-	-	-	5	-	-	-	-	-	-	-	-		p	p
blenny	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
grey gurnard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
codling	-	-	-	-	-	-	-	-	-	1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
poorcod	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
scaldfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pipefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
monkfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sprat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
thornback ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
spotted ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pogge	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	-	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Year	**1992**							**1993**							**1994**							**1995**							**1996**						
Sampling station	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**
smooth hound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
brill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	p	p	-	-	-	-	-
dogfish: lesser	-	-	-	-	-	1	-	p	-	p	-	p	p	-	-	p	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dragonet	-	-	-	-	-	-	-	p	p	-	-	p	p	-	-	-	-	-	p	p	-	-	-	-	-	-	-	-	p	p	-	-	-	-	
rockling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
goby	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
solenette	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
haddock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No. of species	**1**	**1**	**4**	**2**	**3**	**3**	**2**	**4**	**3**	**5**	**2**	**6**	**5**	**3**	**2**	**6**	**3**	**4**	**5**	**9**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**6**	**3**	**3**	**2**	**2**	**1**	**5**

Table 6.5. Species and numbers of fish caught from the Juvenile Plaice Survey, 1997 – 2002 (source: Marine Institute). P=present.

Year	**1997**							**1998**							**1999**							**2000**							**2001**							**2002**						
Sampling station	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**
plaice	6	46	46	2	22	10	13	81	54	19	37	-	-	3	19	3	1	-	-	1	14	188	41	35	13	5	1	1	72	38	19	27	25	15	7	12	76	8	46	1	3	-
dab	1	1	1	1	1	1	1	1	1	1	-	-	-	p	51	18	2	6	-	1	6	148	105	39	7	1	-	4		87	17	27	10	2	12	12	259	36	13	1		2
lemon sole	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
herring	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flounder	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sprat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	1	-	-	-	3	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
whiting	-	-	-	2	1	3	8	-	-	-	6	-	-	1	-	-	-	-	-	3	2	1	-	1	-	-	-	2	1	2	-	-	4		3	1	-	-	-	-	-	7
sand eel	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	1	1	-	-
turbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Year	**1997**							**1998**							**1999**							**2000**							**2001**							**2002**						
Sampling station	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**	**1j**	**1k**	**1m**	**1n**	**4a**	**4b**	**4c**
weaver	-	-	-	-	1	1	-	-	-	-	-	-	1	p	-	-	-	-	-	1	12	-	-	-	-	-	2	-	-	-	-	1	-	2	1		-	-	2	-	-	-
blenny	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
gurnard: grey	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	-	-	9	2	-	-	-	-	1	-	-	-
cod	1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
codling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
poorcod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
scaldfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pipefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	-	1	5	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
monkfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sprat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
thornback ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1f	-	-	66	-	-	-	-	-
spotted ray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		-	-	-	-	-	-	-	-	-	-	-	-
ray	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
pogge	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
smooth hound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
brill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dogfish: lesser	1	1	1	-	1	-	1	-	-	-	-	-	1	p	3	1	1	-	-	-	-	-	-	2	-	-	1	1	-	-	1 m	-	4♀,2♂	1♀	2♂	1♂	121♂ 53♀	-	1♂	-	-	2
dragonet	-	1	-	-	-	1	-	1	1	1	-	-	-	-	3	-	1	-	1	-	-	11	16	6	-	1	-	2	10	1	2	2	2	6	2	10	29	3	1	2		1
rockling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
goby	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	4	15	4	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
solenette	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
haddock	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
No. of species	**4**	**6**	**5**	**3**	**7**	**7**	**7**	**5**	**3**	**4**	**2**	**1**	**2**	**5**	**5**	**3**	**7**	**2**	**1**	**7**	**5**	**7**	**6**	**8**	**3**	**4**	**3**	**5**	**7**	**6**	**5**	**5**	**6**	**8**	**7**	**5**	**5**	**4**	**7**	**4**	**1**	**5**

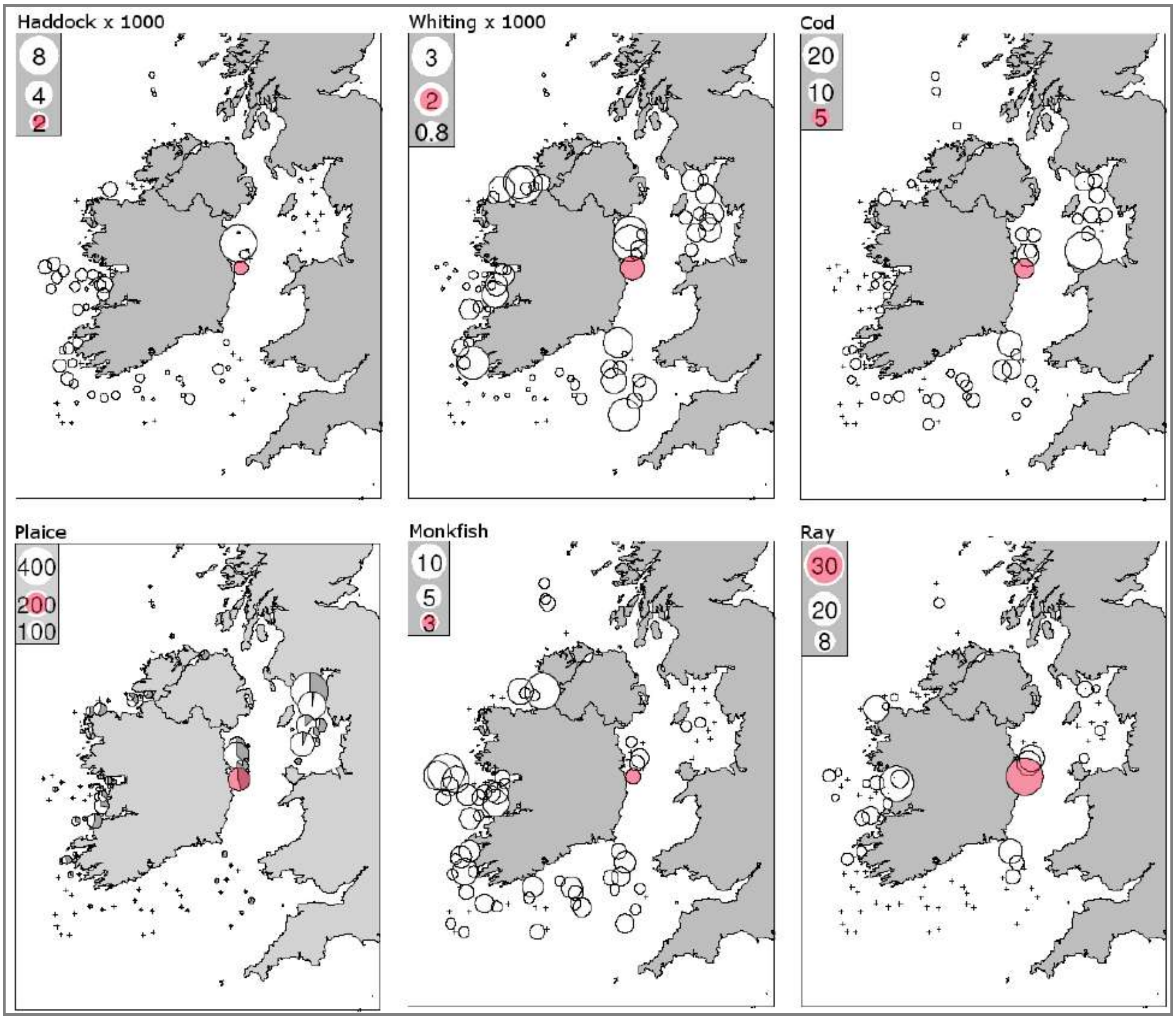


Figure 6.2. Fish species recorded around Irish coast during a 2004 Marine Institute survey (modified from Marine Institute, 2004); Kish and Bray banks area in red.

APPENDIX 7 – Common and scientific names of fish and shellfish species

Table 7.1. List of fish/shellfish mentioned in this report and their common and scientific names.

Common Name	*Scientific Name*
Shellfish	
blue mussel	*Mytilus edulis*
edible crab	*Cancer pagurus*
escallop (great scallop)	*Pecten maximus*
lobster (common)	*Homarus gammarus*
Nephrops (Dublin Bay prawn)	*Nephrops norvegicus*
queen escallop	*Aequipecten opercularis*
razorfish	*Ensis sp*
velvet crab	*Necora puber*
whelk	*Buccinum undatum*
octopus	*Octopodidae indet.*
squid	*Loliginidae indet.*
Finfish	
bib/pouting	*Trisopterus luscus*
brill	*Scophthalmus rhombus*
butterfly blenny	*Blennius ocellaris*
cod	*Gadus morhua*
codling	*Gadus morhua*
common dragonet	*Callionymus lyra*
common goby	*Pomatoschistus microps*
common sole	*Solea solea*
conger eel	*Conger conger*
cuckoo ray	*Raja naevus*
dab	*Limanda limanda*
dover/slip sole	*Solea solea (S.vulgaris)*
flounder	*Platichthys flesus*
grey gurnard	*Eutrigla gurnardus*
haddock	*Melanogrammus aeglefinus*
hake	*Merluccius merluccius*
herring	*Clupea harengus*
horse-mackerel	*Trachurus trachurus*
john dory	*Zeus faber*
lemon sole	*Microstomus kitt*

Common Name	***Scientific Name***
lesser spotted dogfish	*Scyliorhinus canicula*
ling	*Molva molva*
mackerel	*Scomber scombrus*
megrim	*Lepidorhombus whiffiagonis*
monkfish/anglerfish	*Lophius piscatorius*
mullet	*Mullidae*
norway pout	*Trisopterus esmarkii*
nurse hound	*Scyliorhinus stellaris*
ocean sunfish	*Mola mola*
pipefish	*Syngnathus sp.*
plaice	*Pleuronectes platessa*
pogge/hooknose	*Agonus cataphractus*
poor cod	*Trisopterus minutus*
rabbit fish	*Chimaera monstrosa*
red fish	*Sebastes sp.*
rockling	*Gaidropsarus sp.*
saithe	*Pollachius virens*
sand eel	*Ammodytes tobianus*
sand sole	*Pegusa lascaris*
scaldfish	*Arnoglossus sp.*
skates and rays	*Rajidae*
solenette	*Buglossidium luteum*
spotted ray	*Raja montagui*
sprat	*Sprattus (Clupea) sprattus*
spur dog	*Squalus acanthias*
starry smooth hound	*Mustelus asterias*
thickback sole	*Microchirus variegatus*
thornback ray (skate)	*Raja clavata*
tope	*Galeorhinus galeus*
tub gurnard	*Trigla lucerna*
turbot	*Scophthalmus maximus*
tusk	*Brosme brosme*
weaver	*Trachinidae indet.*
white pollock	*Pollachius pollachius*
whiting	*Merlangius merlangus*
witch	*Glyptocephalus cynoglossus*
whiting-pout	*Trisopterus luscus*

APPENDIX 8 – List of consultees

Table 8.1. List of persons and organisations consulted with regard to the commercial fishery around the Kish and Bray banks (years: 2004, 2008 and 2011)

Person	Organisation
David Stokes	Marine Institute
Edward Fahy	Marine Institute
Helen McCormick	Marine Institute
Colm Lordan	Marine Institute
Andrew Kinneen	Dep. of Communications, Marine and Natural Resources
John Hickey	Bord Iascaigh Mhara
Patricia Comiskey	Bord Iascaigh Mhara
Terence O'Carroll	Bord Iascaigh Mhara
Frank Doyle	Irish Fishermans Organisation
John Lynch	Howth Fishermans Organisation
Charley Robinson	Sea angler
Mike Thrussel	Reporter
David Byrne	Inland Fisheries Ireland
Josie Mahar	Eastern Regional Fisheries Board (currently IFI)
Norman Dunlop	Central Fisheries Board (currently IFI)
Anthony Keohane	Sea Fisheries Protection Authority

dublin array

An Offshore Wind Farm
on the Kish and Bray Banks

Environmental Impact Statement

January 2012 - Revision 1

Reviewed and Updated by

MRG CONSULTING ENGINEERS LIMITED

Prepared by

SAORGUS | ENERGY LTD

Volume 3 of 5 - Appendix F
Marine Ecology Impact Assessment

A marine ecological study of the Kish and Bray banks for a proposed offshore wind farm development: Re-characterisation survey

Report for:
Saorgus Energy Ltd,
Kerry Technology Park,
Listowel Road,
Tralee,
Co. Kerry.

July 2008

Report by:
Ecological Consultancy Services Ltd (EcoServe)
B19 KCR Industrial Estate
Kimmage,
Dublin 12
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EcoServe

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Authorised by:	Róisín Nash, PhD, MIEEM

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INTRODUCTION

Saorgus Energy Ltd is preparing an Environmental Impact Statement (EIS) for a proposal to establish a wind farm on the Kish and Bray banks in the Irish Sea off the coasts of Co. Dublin and Co. Wicklow. This will involve the siting of wind turbines on the seabed along the Kish Bank and Bray Bank. Ecological Consultancy Services Ltd (EcoServe) has been contracted by Saorgus Energy Ltd to update the baseline assessment of the marine ecology originally carried out in 2002 and to provide recommendations and mitigation measures to minimise the impact of the proposed wind farm on the marine ecology of the bank and its surrounds.

The Kish Bank and Bray Bank are submarine banks consisting mainly of sand and gravel. The northern 10-12 km is called the Kish Bank and is located 10 km east of Dun Laoghaire, Co. Dublin. South of this point the bank extends a further 10 km as the Bray Bank. It is approximately 2.2 km wide at its widest point. The area of the bank shallower than 20 m BCD (below chart datum) is 28 km^2, of which half is shallower than 10 m BCD. The shallowest part of the bank is 1.6 m BCD and slopes down to depths exceeding 40 m BCD to the east and steadily shallows towards the land to the west. The main shipping channel into Dublin Bay runs close to the north end of the bank (Appendix 1).

Aims of the study

The aim of this study was to conduct a littoral and a sub-littoral survey of the proposed development area in order to:

- update data on fauna and flora of the Kish and Bray banks area,
- assess the benthic habitat, flora and fauna of the proposed off-shore cable route and the two proposed landfall sites,
- assess changes, if any, to the benthic marine environment of the Kish/Bray banks since the original survey,
- make an assessment of likely impacts of the proposed wind farm on the existing environment,
- provide recommendations and mitigation measures to minimise any potential impacts of the proposed wind farm on the existing environment.

Background

Sand banks comprise of sloping plains of sediment. They are primarily composed of sandy sediments permanently covered by water. The diversity of communities associated with this habitat is determined particularly by sediment type together with a variety of other physical and chemical factors. Sandbanks in Irish waters are found predominantly in the Irish Sea (NPWS, 2008). Sandbanks which are slightly covered by seawater all the time are listed under Annex I of the EU Habitats Directive (92/43/EEC). Annex I highlights natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation (SAC). To date, Ireland has only transmitted two sandbanks for SAC designation, which do not include the Kish and Bray banks.

Shallow sandy sediments are typically colonised by a burrowing polychaete worms (*Glycera lapidum*, *Nephtys* spp., *Spiophanes bombyx*, etc.), crustaceans (*Pontocrates arenarius*, *Bathyporeia elegans*, etc.), bivalve molluscs (*Abra alba*, *Fabulina fabula*, etc.) and echinoderms. Epifauna at the surface of the sandbank may include mysid shrimps, gastropods, crabs and fish. Sand-eels (*Ammodytes* spp.), an important food for birds, often live in sandy sediments, whereas coarse stable material, such as shells or stones is inhabited by hydroids, bryozoans and ascidians (NPWS, 2008)

Shallow sandy sediments are often important nursery areas for fish and consequently can provide feeding grounds for seabirds (especially puffins *Fratercula arctica*, guillemots *Uria aalge* and razorbills *Alca torda*) and sea-duck (e.g., common scoter *Melanitta nigra*) (NPWS, 2008). Kish and Bray banks were surveyed on a number of occasions since 1996 (Table 1).

Table 1. Previous marine surveys conducted in the Kish and Bray bank area.

Survey	Reference	No. of stations	Sampling technique
BioMar, 1996	Picton & Costello, 1998	9	Biological dredge
SensMap, 1999	EcoServe, 2001	11	Biological dredge
Windfarm Baseline Study, 2002	EcoServe, 2004	41, 4, 3	Biological dredge, Agassi trawl, Plankton survey
Benthic surveys of sandbanks in the Irish Sea, 2005	Roche et al., 2007	12	Day grab

<u>Sublittoral benthic invertebrates</u>

The BioMar project surveyed nine sites on and around the Kish and Bray bank areas using a rock dredge and recorded 66 macroinvertebrate species or higher taxa with an average of 15 species per site (Picton & Costello, 1998). During the SensMap project 11 sublittoral sites located between the banks and the shore were characterised with a total of 77 macroinvertebrate species recorded with an average of 13 species per site (EcoServe, 2001). A more comprehensive marine survey (41 sites) conducted by EcoServe for a baseline study in relation to the proposed offshore wind farm development on Kish and Bray banks recorded 107 macroinvertebrate species with an average of 12 species per site (EcoServe, 2004). The differences in total number of benthic invertebrate taxa recorded were likely to be attributable to the different sampling effort (number of samples) rather than to species richness, with more comprehensive studies covering a greater diversity of microhabitats. Full species lists from the 2002 EcoServe survey are included in Appendix 3. More recently, Roche *et al*. (2007) sampled 12 sites on Kish bank and found a total of 101 species. This was considerably richer than species diversity recorded from the Blackwater sand bank, where 35 species were recorded.

The species composition recorded by Roche *et al*. (2007) was dominated by oligochaete worms (>50% taxa recorded), which is different to previous studies. Macrobenthic fauna from the baseline study samples were dominated by molluscs, whereas the SensMap and BioMar surveys recorded more even proportions of different taxonomic groups (Figure 1). These differences are most likely a result of different sampling methodology, with grab samples recording a greater abundance of smaller (<1 cm) infaunal species compared to biological dredge method.

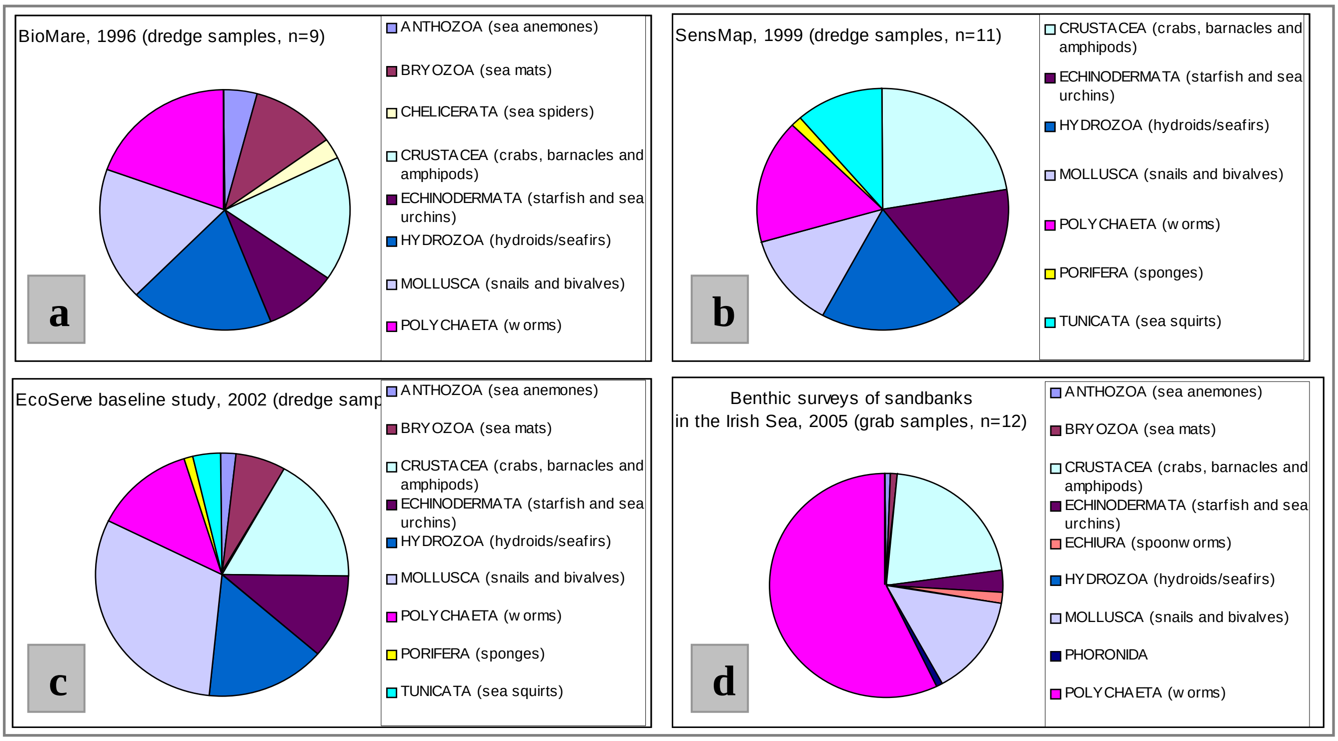

Figure 1. Relative proportion of different taxonomic groups in benthic invertebrate samples from Kish and Bray banks area. Based on data from: (a) Picton & Costello, 1998 (b) EcoServe, 2001 (c) EcoServe, 2004 (d) Roche *et al.*, 2007.

The highest species diversity was recorded in areas of coarse shell, pebbles and cobbles in the southwest, south and east of the banks, whereas very few species were recorded from the fine sand on the banks (EcoServe, 2004).

The polychaete worm, *Sabellaria spinulosa*, was recorded at one location in 1996 (Picton & Costello, 1998). *S. spinulosa* is an occasionally gregarious segmented worm that builds tubes from sand or shell fragments and was recorded in the area during BioMar survey. It is mostly found individually, but may form thin crusts or large biogenic reefs under some conditions and occurs on all British and Irish coasts (Jackson & Hiscock, 2008). The species is noted as important by the Marine Conservation Society (Gubbay, 1988) and Nature Conservancy Council (Davidson *et al.*, 1991) and is included in the UK Biodiversity Action Plan. To date there is no statutory conservation status assigned to *S. spinulosa* in Ireland.

During the baseline study (EcoServe, 2004), the following distinct faunal assemblages (biotopes) were identified in the sublittoral zone of the study area:

- (IGS) Infralittoral gravels and sands
- (IGS.Mob) Sparse fauna in infralittoral mobile clean sand
- (IGS.ScupHyd) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral cobbles or pebbles in coarse sand
- (IMS.EcorEns) *Echinocardium cordatum* and *Ensis* spp. in lower shore or shallow sublittoral muddy fine sand

- (CMS.AbrNucCor)*Abra alba*, *Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment
- (MCR.FaAlC.Abi) Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum*, *Abietinaria abietina* and other grazing-tolerant fauna on moderately exposed circalittoral rock
- (ECR.PomByC) *Pomatoceros triqueter*, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles
- (ECR.Alc) *Alcyonium*-dominated communities (tide-swept/vertical)

<u>Fish fauna</u>

Four trawls were taken during the 2002 Baseline survey: one to the north, south, east and west of the Bank. Eight species of fish were caught, all of which were bottom feeding species. Numbers of fish recorded during the 2002 trawl survey were generally low and species included flatfish such as plaice (*Pleuronectes platessa*), dab (*Limanda limanda*) and lemon sole (*Microstomus kitt*) as well as Thornback Ray (*Raja clavata*), Whiting (*Merlangius merlangus*), Grey gurnard (*Eutrigla gurnardus*), Lesser Weever fish (*Echiichthys vipera*) and Butterfish *(Pholis gunnellus*). In addition, herring (*Clupea harengus*), two-spotted clingfish (*Diplecogaster bimaculata*), lesser sand eel (*Ammodytes tobianus*), greater sand eel (*Hyperoplus lanceolatus*) witch flounder (*Glyptocephalus Cynoglossus*) and dab (*Limanda limanda*) were recorded from dredge samples.

A Marine Institute survey, conducted in the area in 2004, recorded haddock, whiting, cod, plaice, monkfish and ray (Marine Institute, 2004). Fish fauna of the study area is covered in detail in the Fisheries Report.

<u>Plankton community</u>

Two zooplankton and phytoplankton samples were taken during September 2002 survey: one to the north and one to the south of the Kish Bank. During November 2002 survey it was only possible to take plankton samples from the north of the Banks due to poor weather conditions. Two replicates were taken at each site.

Two sites were examined in September 2002, one to the north of the Kish Bank and one to the south of the Bray Bank and a total of 20 zooplankton species or higher taxa were recorded from samples. Calanoid copepods were the dominant fauna. The analysed samples showed plankton composition typical of coastal temperate regions in autumn. The presence of numerous diatoms *Coscinodiscus* spp., *Biddulphia* spp., *Eucampia zodiacus*, *Chaetocerous* spp. and the dinoflagellate *Noctiluca* spp. in the net samples, particularly at the stations, indicated that an autumnal phytoplankton bloom was occurring at the time of sampling. Small calanoid copepods were the dominant zooplankton representing 80-90% of total. *Temora longicornis* was the best represented species (38 - 54%) followed by *Centropages hamatus* (27 - 43%). Station to the north of Kish Bank recorded a higher proportion of larval stages, particularly of polychaetes and bivalves reflecting more coastal characteristics than the station south of Bray Bank. No fish eggs or fish larvae were found at any of the stations examined.

One site located to the north of Kish Bank was examined in November 2002**,** and a total of 14 zooplankton species or higher taxa were recorded from the sample. The samples analysed presented a large amount of macro-algal debris and fine to large sand grains indicating that water column was thoroughly mixed at the time of sampling. The plankton composition was similar to that observed in September with few exceptions. The large diatoms particularly *Coscinodiscus* spp., *Biddulphia* spp., which were found two months earlier, had largely disappeared leaving behind few broken cell remains. The zooplankton assemblage was still dominated by copepods (43 % - 58 %), although their proportion had substantially decreased. Among the copepods, *C. hamatus* (22 % - 26 %) was still well-represented whereas *T. longicornis* had been replaced by *Pseudo-paracalanus* spp. (13 %-27 %), a species more tolerant of winter conditions. Bivalve and brittle-star larvae were better represented and had achieved a larger size suggesting that environmental conditions (i.e. food sources and temperature) were still favourable for the growth of these organisms. A thorough screening of the complete samples indicated that no fish eggs or their larvae were present.

A total of 19 and 17 species or higher phytoplankton taxa were recorded in September and November 2002 surveys respectively (EcoServe, 2004).

<u>Physical environment</u>

Temperature and dissolved oxygen data collected during the baseline study showed little variation between depth and site and showed that the waters in the top 20 m around the Kish Bank were well mixed (EcoServe, 2004). Roche *et al*. (2007) reported that the sediment was dominated by fine and medium sand with very low organic carbon fraction.

METHODOLOGY

Littoral survey

A characterisation survey of the species and biotopes of the intertidal area of the proposed development was carried out on 6th May 2008 during low spring tide. The survey was based around the two proposed landfall sites. Species and biotopes along the stretch of the shore up to 500 m north and south of each landfall site were identified and mapped, with the exception of southern Landfall B study section, which ended on the north Bray Harbour wall. Two core samples of the sediment were taken along the proposed cable route at each landfall location to be analysed for infauna. Epifauna and flora species were identified and recorded *in situ*. Species difficult to identify were retained for microscopic examination.

Sublittoral survey

A re-characterisation survey of the benthic biotopes of the Kish/Bray Bank area identified in 2002, and the cable route on the seabed between the Kish/Bray Bank and the coast was carried out on 14th May 2008. The survey was based around the sites of the original survey, representing a subset of eight sites on the Kish and Bray banks and three new sites along the cable route. Sites were selected within the previously identified subtidal biotopes that were likely to be representative of the current environmental conditions, i.e. tidal streams, wave action and substratum, thus covering the range of species and habitats likely to occur in the area (EcoServe, 2004) (Figure 4).

Samples were collected using a biological dredge sampler, with a rectangular opening of 0.5 x 0.25 m equipped with a 1 cm mesh bag for collecting sample material. A 0.1 m^2 Van Veen Grab could not be successfully deployed due to an abundance of coarse material in the sediment (mainly coarse shell and some pebbles). The duration of the dredge sample was adjusted based on expected substratum in order to keep the sample volume at representative yet manageable size. Site 8 was dredged twice as the first sample returned very little material.

Samples from the biological dredge were passed through a 1 mm mesh sieve. Where feasible, material was sorted on board. Large and conspicuous fauna was identified on board and returned to the water.

Sample processing

Collected sample material was preserved using 4% formalin solution and returned to laboratory. After 48 hours samples were transferred into 70% Industrial Methylated Spirit (IMS) for further processing. Samples with a large amount of fine material were stained using Rose Bengal for sorting. Organisms were then identified to species level, where possible, using standard keys and enumerated. Colonial and encrusting organisms were not counted. Species nomenclature followed the European Register of Marine Species (ERMS). The results were compared to the existing data and interpreted using the marine biotope classification (Connor *et al*., 2004). Notes on the substratum type were recorded and a photographic record of the material returned by the dredge was taken. All sample sites were geo-referenced using a hand-held GPS for mapping and future monitoring.

Biotope mapping

A biotope is a term which describes the physical ‘habitat’ of an area with its biological ‘community’. Using the list of species recorded from each site and information on the habitat type each sample site was assigned to a biotope following the descriptions from Connor *et al.* (2004) and applying the principal of best fit to each site. Dredging tends to record many neighbouring biotopes. As a result, data collected may display characteristics of more than one biotope and the final selection was based upon best fit image. Biotope maps of the survey area were then produced.

Biotope codes used for characterisation of marine habitats have been revised since the 2002 survey. This study follows the most recent biotope classification from Connor *et al.* (2004), while the biotope codes used in the 2002 survey were from Connor *et al*. (1997).

RESULTS

Littoral zone

Altogether eight biotopes represented by 50 species of marine fauna and flora were recorded from the intertidal zone within the study area. Full species lists and biotopes are provided in Appendix 2, while full biotope descriptions are found in Appendix 4.

Landfall A

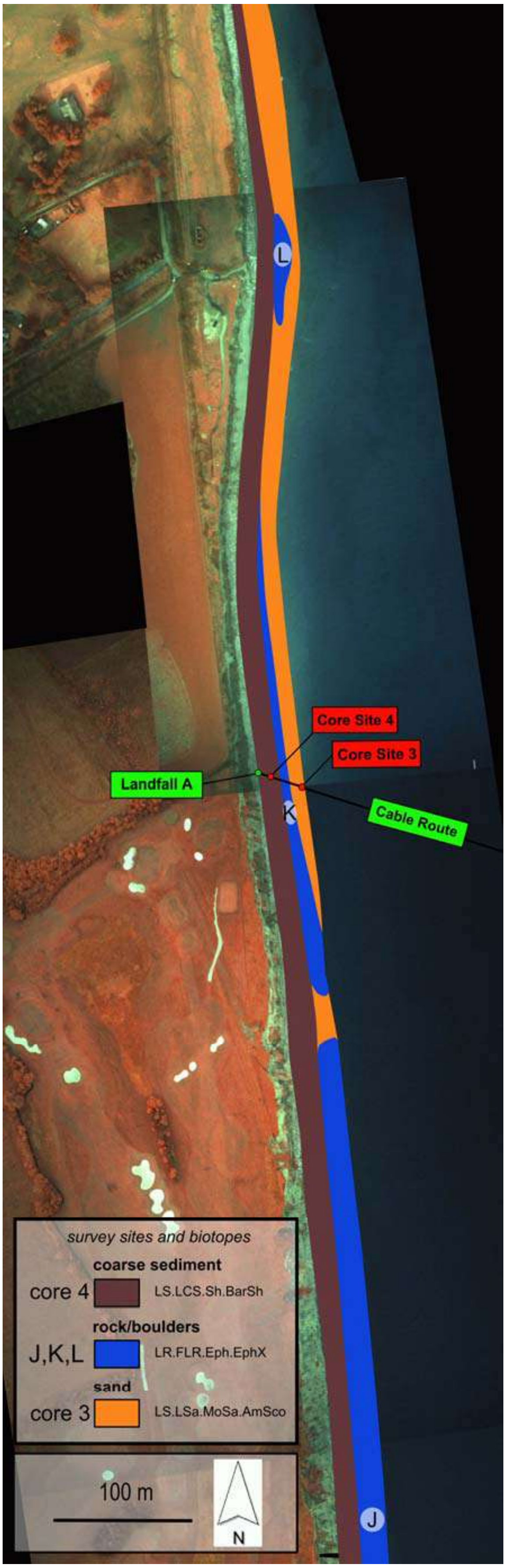

Figure 2. Biotope map of the Landfall A area, showing littoral survey sites.

The upper shore at the Landfall A location was composed of approximately 10-20 m zone of pebbles and cobbles with occasional pockets of coarse mobile sand and gravel. No apparent fauna or flora was recorded from this zone. Core sample (Core Site 4) taken from a sediment pocket contained only one unidentified Polychaete worm in one of the replicate samples. This barren shingle (**LS.LCS.Sh.BarSh)** zone constituted the upper shore of the whole Landfall A study area. This zone was backed by soft cliffs approximately 5 – 8 m high.

The mid-shore at the Landfall A location was composed of an approximately 10 m zone of boulders covered with ephemeral green algae (*Enteromorpha* spp.) and foliose red algae (*Porphyra* spp.) Sparse fauna was recorded from boulders at Site J (*Semibalanus balanoides, Actinia equina, Nucella lapillus* and *Patella* spp.) while Site K and Site L were devoid of epifauna. This zone was classified as ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (**LR.FLR.Eph.EphX**).

The sublittoral fringe zone at the Landfall A location was composed of fine sand. No redox potential discontinuity layer was visible within the depth of the core sampler penetration (25 cm) indicating well-drained and oxygenated sediment. Core samples of the sediment (Core Site 3) revealed amphipod and polychaete dominated species community typical of clean, mobile sand (**LS.LSa.MoSa.AmSco**). This zone of fine sand continued to the north of the Landfall A location, gradually replacing the boulders.

Landfall B

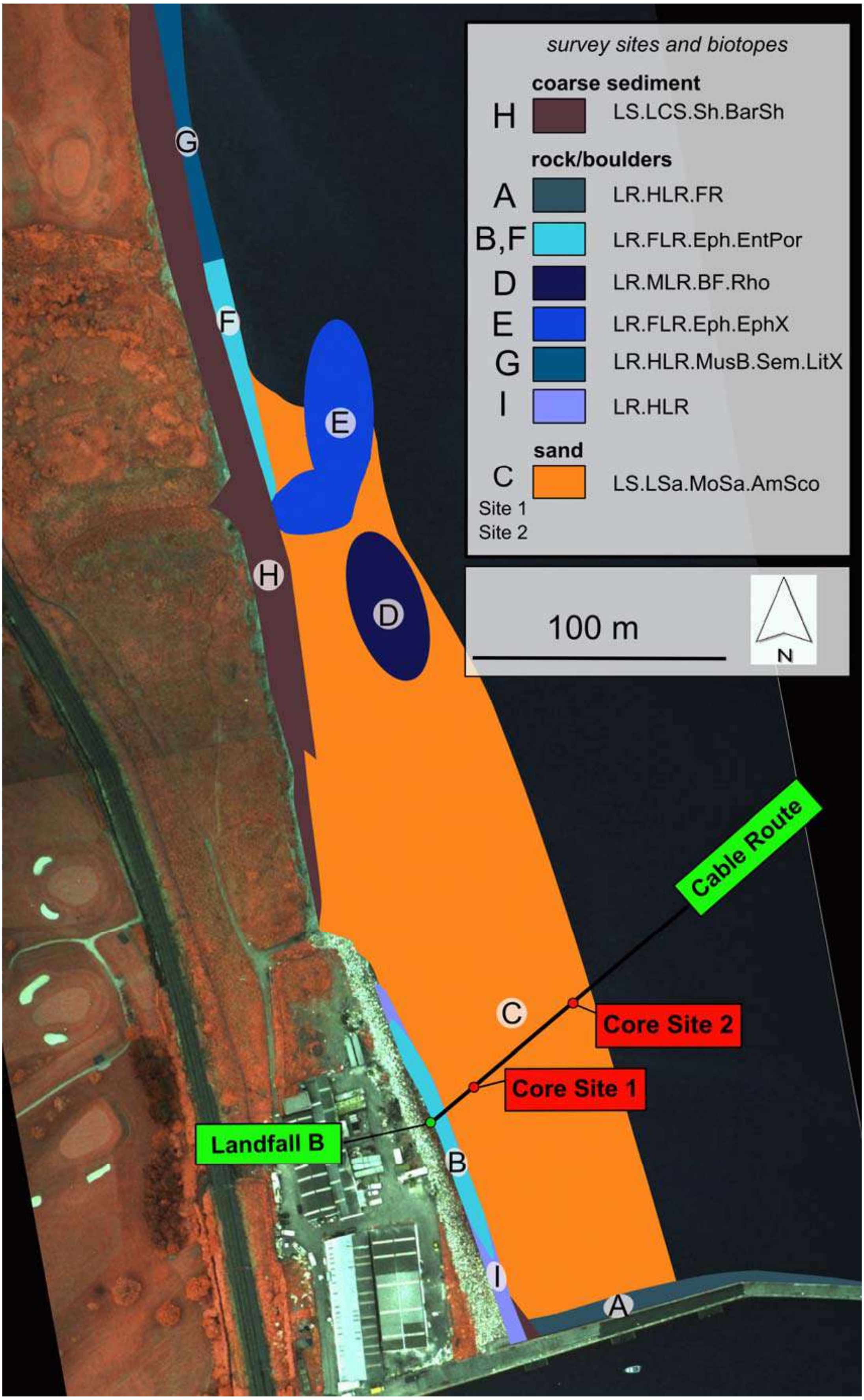

Figure 3. Biotope map of the Landfall B area, showing littoral survey sites.

The upper part of the shore at Landfall B site was approximately 15 m wide zone of stable boulders. Lower section of the boulders (Site B) was partly covered by green ephemeral algae (*Enteromorpha* spp.) with some foliose red algae (*Porphyra* spp.) and fucoids (*Fucus serratus* and *F.* spiralis) and was classified as the biotope *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock (**LR.FLR.Eph.EntPor**). The upper part of the boulders (Site I) was devoid of macroscopic life and was classed as High energy littoral rock (**LR.HLR**).

The lower section of the shore was composed of fine rippled sand (Site C). No redox potential discontinuity layer was visible within the depth of the core sampler penetration (25 cm) indicating well-drained and oxygenated sediment. Some *Arenicola* spp. casts were noted, but little else. Core samples of the sediment (Core Site 1 and Site 2) revealed amphipod and polychaete dominated species community typical of clean, mobile sand and the zone was assigned to the biotope Amphipods and *Scolelepis* spp. in littoral medium-fine sand (**LS.LSa.MoSa.AmSco**).

The southern end of the Landfall B study area was delineated by boulder zone with a robust community of fucoid and/or red algae (Site A, **LR.HLR.FR**). The lower shore featured some *Laminaria digitata*. This section was backed by the northern wall of Bray Harbour. Some lichens were recorded on the wall (*Verrucaria marina* and *Caloplaca marina*).

Approximately 100 m to the north of the Landfall B location, the upper shore was composed of mobile coarse sand with some gravel, pebbles and cobbles (Site H, Barren littoral shingle - **LS.LCS.Sh.BarSh**). No fauna or flora were recorded from this biotope and this barren shingle zone constituted the upper shore of the remaining part of the Landfall B study area. This zone was backed by soft cliffs approximately 5 – 8 m high.

The zone of mobile sand continued for approximately 250 m north of the Landfall B location, where it narrowed down; gradually giving place to rocky features. Site D was an area of large boulders/bedrock covered by turf-forming red algae *Rhodothamniella floridula* (Plate 4 in Appendix 5) forming the biotope *Rhodothamniella floridula* on sand-scoured lower eulittoral rock (**LR.MLR.BF.Rho**). In places the *R. floridula* turf was covered with dense community of sandtube-dwelling polychaete worms *Fabricia stellaris* and *Polydora* spp.

Further to the north, a more elevated boulder zone was found (Site E). Higher sections held high densities of the limpet *Patella vulgata* and the acorn barnacle *Semibalanus balanoides*, while the lower parts were dominated by brown, red and ephemeral green algae community (**LR.FLR.Eph.EphX**).

Site F was a boulder zone similar in species composition to Site B, with green ephemeral algae (*Enteromorpha* spp.) with some foliose red algae (*Porphyra* spp.) and fucoids (*Fucus serratus* and *F. spiralis*) and was assigned the biotope Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (**LR.FLR.Eph.EntPor**).

Site G was a boulder zone and it featured algae as well as considerable densities of gastropods *Littorina litorea*, *Nucella lapillus* and *Patella* spp. and was classified as the biotope *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles (**LR.HLR.MusB.Sem.LitX**).

Sublittoral zone

Altogether eight biotopes represented by 180 species of marine fauna and flora were recorded from the sublittoral zone within the study area. Full species list and biotopes are provided in Appendix 2 while full biotope descriptions are found in Appendix 4.

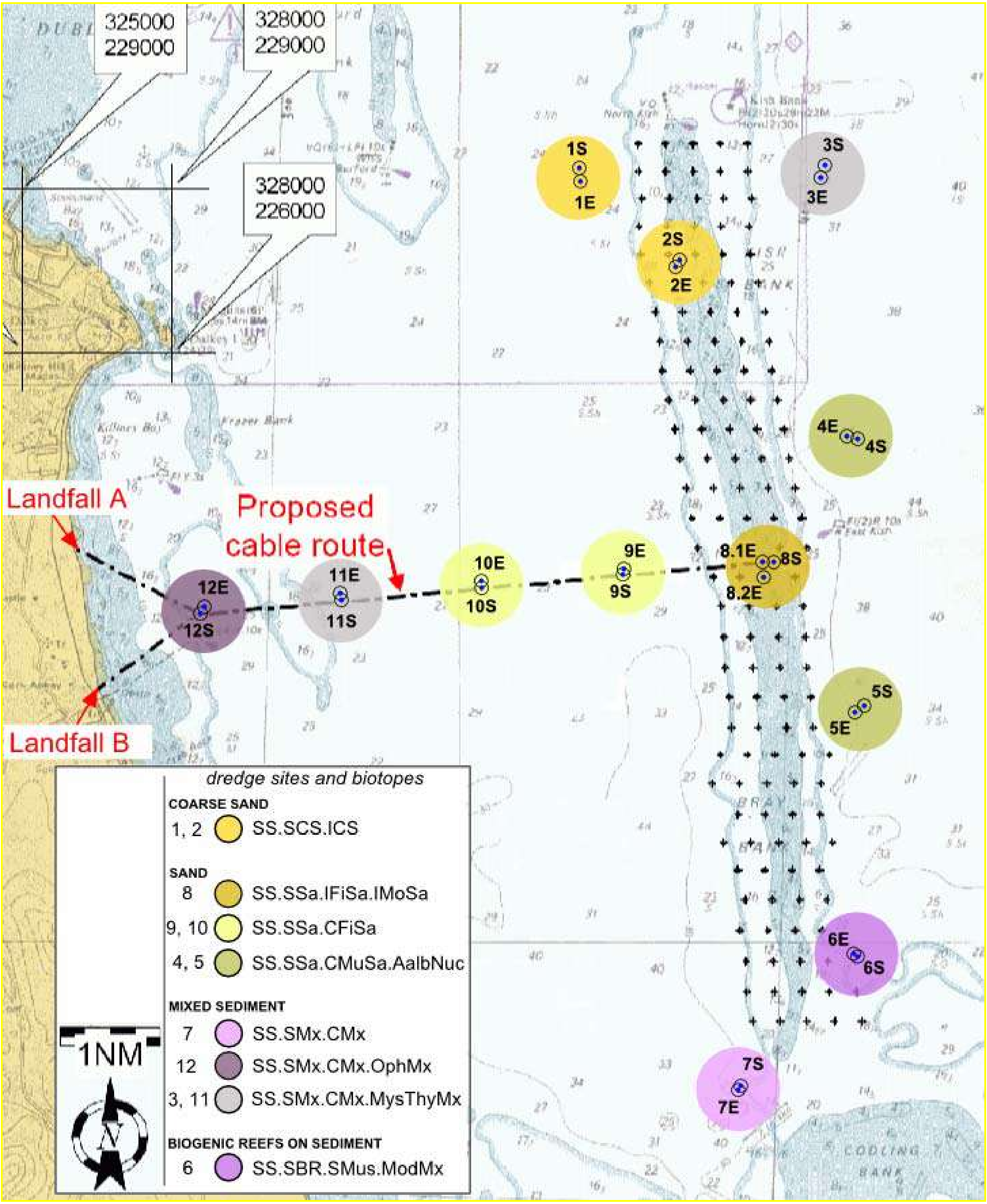

Figure 4. Sublittoral biotopes identified within the survey area. Blue dots in black circles are dredge survey sites (S – start, E – end). Sample 8 comprised of two dredges originating at the same point.

Dredge sample number 8 was taken from the **centre** of the sandbank at the proposed origin of the cable route. The sample retained very little material. As a result the dredge was deployed twice at this station. The two sub-samples originated at the same point (8E) but ended at two different locations (8.1E and 8.2E). **Site 8** recorded very little fauna (one hermit crab *Pagurus bernhardus* and several species of Hydrozoa). No mud or stones were recorded in the sample material. The site was classified as infralittoral mobile clean sand with sparse fauna biotope (**SS.SSa.IFiSa.IMoSa**).

The **northern** part of the study area was represented by sample Site 1, Site 2 and Site 3. Site 1 was located on the landward side (north-west) of the bank, Site 2 was located on the sandbank, while Site 3 was located to the east of the sandbank. **Site 1** and **Site 2** recorded fauna typical of a coarse sand biotope complex. Macroinvertebrate community appeared to be dominated by polychaete worms with some crabs, amphipod crustaceans, bivalve molluscs, with echinoderms also present. No mud or stones were recorded in the sample material. Site 1 showed a somewhat richer fauna assemblage, similar to the *Glycera lapidum* in impoverished infralittoral mobile gravel and sand biotope (SS.SCS.ICS.Glap). However, as only two individuals of *Glycera lapidum* were recorded at this site, both stations were classified as infralittoral coarse sediment biotope (**SS.SCS.ICS**). **Site 3** was located to the north-east of the sandbank. Some mud was visible in the sample material. Large number of epibenthic species recorded (predominantly hydrozoans) indicated presence of some stable substratum. Among the remaining fauna, there was no clear dominant species and the species composition could be most accurately classified as that of the biotope *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (**SS.SMx.CMx.MysThyMx**).

The **eastern** part of the study area was represented by sample **Site 4** and **Site 5**. Material recovered from Site 5 contained some mud. In addition, it contained large quantity of *Mytilus edulis* shells, but only one living individual. Both samples recorded similar fauna composition with the highest species diversity recorded in the study area (50 and 68 species in sites 4 and 5 respectively). Relatively large numbers of polychaete worms were recorded in both. Other well-represented groups in both samples included amphipod crustaceans, crabs and bivalve molluscs (including the horse mussel, *Modiolus modiolus*). In addition, Site 5 recorded a diverse fauna of gastropod molluscs and echinoderms and contained some mud among the shell debris. One individual reef-building sabellid worm *Sabellaria spinulosa* was recorded from Site 5. Based on the fauna composition, both sites were identified as the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (**SS.SSa.CMuSa.AalbNuc**).

The **southern** part of the study area was represented by sample Site 6 and Site 7. Sample material from both stations contained some large pebbles. Both stations contained a diverse fauna with significant abundance of epifauna, including Anthozoa (*Alcyonium digitatum*, *A. glomeratum* and Actiniaria), acorn barnacles (*Balanus balanus* and *B. hameri*) and tube-building polychaetes (*Pomatoceros* spp.) indicating presence of some stable substratum. Also, both stations contained a diverse community of polychaete worms, crabs and bivalve molluscs. A significant number of the horse mussel *Modiolus modiolus* and a high abundance of the barnacle *B. hameri* (on coarse shell debris) were recorded at Site 6. Also recorded at Site 6 was a diverse gastropod fauna, including reasonable numbers of *Buccinum undatum*. Based on the fauna composition, **Site 6** was identified as the biotope *Modiolus modiolus* beds on open coast circalittoral mixed sediment (**SS.SBR.SMus.ModMx**). Despite high species richness, **Site 7** fauna had no clear dominant species and the biotope was identified as the circalittoral mixed sediment biotope complex (**SS.SMx.CMx**).

The **western** part of the study area was represented by four sites (Sites 9 – 12) arranged in a transect line along the proposed cable route. Sample material from **Site 9** and **Site 10** showed similar characteristics. Both dredge tows retained little material indicating large proportion of fine, non-cohesive sediment. No clear dominant species were recorded from the samples, although both contained high densities of the epifaunal polychaete worm *Pomatoceros* spp. Even though Site 10 recorded a somewhat greater diversity of polychaete worms and bivalve molluscs, both sites were identified as the circalittoral fine sand biotope (**SS.SSa.CFiSa**). A high diversity of polychaete worms was recorded from **Site 11**. Other taxonomic groups were poorly represented. The species composition could be most accurately identified as that of the *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment biotope (SS.SMx.CMx.MysThyMx). The fauna composition recorded at **Site 12** was distinctively different to the rest of the study area. The macrofauna community was strongly dominated by echinoderms, with the brittlestars *Ophiothrix fragilis* and *Ophiura sarsi* particularly abundant. Other well-represented groups included polychaete worms, bivalve molluscs and hydrozoans. Overall fauna composition was indicative of the biotope *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (**SS.SMx.CMx.OphMx**).

DISCUSSION

None of the species or habitats recorded in the intertidal part of the study area are of specific conservation importance. *Rhodothamniella floridula* on sand-scoured lower eulittoral rock biotope (LR.MLR.BF.Rho) is considered uncommon (Riley, 2002). All other species and habitats recorded from the littoral zone are common around Irish coast.

None of the sublittoral species or higher taxa recorded in the survey area are uncommon, rare or are protected and all have been previously recorded on the east coast of Ireland (EcoServe unpublished data, Picton & Costello, 1998). However, as stated above, sandbanks which are slightly covered by seawater all the time are listed under Annex I of the EU Habitats Directive. Species diversity was highest in areas of coarse shell, pebbles and cobbles in the southwest, south and east of the banks whereas very few species were recorded from the fine sand on the banks.

Most re-visited sites did not differ significantly to the previous characterisation. However, some differences in sample composition were observed:

- Site 12 markedly different with a rich echinoderm community that was not recorded in 2002 (Hydrozoa-dominated in 2002).
- Site 3 was previously characterised as *Alcyonium*-dominated communities but no *Alcyonium* spp. was recorded from the site during this study.
- Site 6 had a similar fauna composition, but no *Modiolus modiolus* was recorded in 2002.

These differences could represent a habitat shift. Alternatively they could result from seabed heterogeneity and different microhabitat range sampled within one dredge tow.

All the remaining sites showed fauna variability within the error margin expected from characterisation of biotopes using dredge sampling technique.

Of interest was the presence of the ross worm, *Sabellaria spinulosa*, recorded at site 5. *Sabellaria spinulosa* is an occasionally gregarious segmented worm that builds tubes from sand or shell fragments and occurs on all British and Irish coasts. It is mostly found individually but may form thin crusts or large reefs under some conditions (Jackson & Hiscock, 2008). No statutory conservation status has been assigned to *S. spinulosa*, although it is noted as important by the Marine Conservation Society (Gubbay, 1988) and Nature Conservancy Council (Davidson *et al*., 1991) and is included in the UK Biodiversity Action Plan. *S. spinulosa* was recorded from the northern section of the bank (BioMar survey site 2). Roche *et al.* (2007) reported another reef-building polychaete worm *S. alveolata* from the north-west of the bank but this record is questionable as *S. alveolata* typically occurs on hard substratum on the shore and shallow sublittoral (Jackson, 2008).

POTENTIAL IMPACTS

The construction of an offshore wind farm has the potential to adversely impact the immediate and adjacent habitats. Such impacts include loss of habitats and species, sedimentation, alteration of the hydrology, vibrations, noise and electromagnetic fields and pollution of the water and seabed. Impacts may be divided up into those that may occur during the construction phase (short term impacts), and those that may occur during the operational phase (long term impacts). The cumulative impacts of offshore wind farms are also investigated.

Construction phase

- Loss or alteration of habitat

Seabed habitats are likely to be lost in the short term during the construction of the turbines, cable trenches of the turbine network and connection to the grid. In addition, these habitats are likely to be unavailable for feeding or spawning during this period. This loss of habitat is likely to be temporary and restricted to a narrow corridor of habitat which is expected to be back filled, returning the habitats to its natural state. The habitats on the banks consist of coarse sand and shell which naturally shift with the currents and tides. The habitats likely to be impacted by the development are widespread, both in the survey area and in Ireland, and the percentage loss in area is expected to be minimal.

- Loss of species

There will be a direct loss of species during the construction phase of the turbines and cable trenches through the removal of habitat both for sessile species and species with less mobile stages of their life cycles (such as eggs and larvae). There may be an indirect loss of species through the loss of feeding and spawning grounds available. However, once the habitat has been reinstated through back-filling of the trenches, it is expected that species will readily re-colonise the area from the surrounding habitat. The loss of species due to loss of feeding and spawning grounds is likely to be negligible due to the small area of seabed likely to be impacted in relation to the wide area of similar feeding and spawning habitat available in the area.

- Increased turbidity

A short term increase in the turbidity of the water column during the construction of the cable trenches and turbines will occur as increased suspended solids enter the water column. The increase in turbidity could result in increased siltation, smothering of organisms and a reduction of light for phytoplankton and seaweed over the construction period. High levels of suspended solids settling on the seabed can alter habitat resulting in a potential loss of feeding and spawning grounds. Mobile species may move away from unfavourable conditions, however sessile, benthic fauna and flora may be smothered and lost.

However impacts are likely to be minimal as there is a high degree of naturally suspended solids on the Kish and Bray banks due to the high tidal current regime and sedimentary nature of the area. Additional suspended solids are likely to be rapidly dispersed by the strong currents. Few seaweeds were recorded on the survey which is a reflection of the lack of available substratum for colonisation and low light levels present.

- Noise and vibration

Noise and vibrations from activities such as drilling or piling equipment during the construction phase of the wind farm may disturb the surrounding marine fauna, particularly during spawning, nursery or migratory periods. This impact is however likely to be minimal and short term and is mainly restricted to the construction phase. Impacts are most likely restricted to marine mammals and fish which are not dealt with in this report.

- Pollutants and waste

Pollutants and chemicals used during the construction phase of the wind farm could contaminate the area. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials from the foundations may occur. This material could be toxic to marine organisms whilst the grout is wet, while potentially contaminating the seabed sediments and inhibiting recolonisation of the area after construction. Chemical contamination could also occur from accidental spillages, such as oil and other chemicals through poor operational management, non-removal of spillages, storage, handling and transfer of oil and chemicals. However, if suitable precautions are taken and best practice for the storage, handling and disposal of such material are followed, this should be minimal.

Operation phase

- Loss or alteration of habitat

There will be a permanent, direct loss of seabed habitat under the ‘footprint’ of the turbine foundations as a result of the direct removal and disturbance of sediments. As a result non-mobile species occurring in the ‘footprint’ will be lost by smothering and clogging and mobile species utilising these habitats for feeding and spawning will lose this resource. However, the total area of the turbine ‘footprints’ is likely to be low compared to the total available habitat in the area.

Habitat may also be altered due to a change in water movement both locally around the base of the turbines and perhaps at a larger scale (see alteration of hydrology).

The addition of the turbine foundations will provide areas of hard substrata, providing a new habitat within the area, similar to an artificial reef. Areas of hard substrata are limited on the Kish and Bray banks and it is predicted that the additional habitat may result in the colonisation by species new to the bank. The turbine bases could quickly become colonised by a new suite of hard substrata species.

There may be local changes in the morphology of the immediate area and reduction of local water depths. If spoil from the cable trenches and turbine foundations is deposited on the seabed changes in species composition may occur. Due to the high current velocity in the area it is predicted that the sediments on the banks are highly mobile and that the impact would be minimal.

- Loss of species

There will be a permanent, direct loss of species under the ‘footprint’ of the turbine foundations. Indirectly, species will also be lost as feeding and spawning grounds will be reduced. However, the turbines will be sited in areas with low numbers of species and of low abundance minimising the impact.

Species composition may alter as a result of alteration of water movements, the addition of new habitats in the form of hard substrata and potential changes in seabed morphology and water depth. However, it is predicted that these impacts will be minimal as the existing environment is already a dynamic one.

- Alteration of hydrology

The physical presence of the turbines may alter the diffraction and focus of waves and currents over the bank, both locally and on a wider scale. This may result in a change in sediment deposition and erosion patterns creating changes in the substratum and habitat at these locations resulting in an alteration in species composition.

It is recommended that any potential alteration of hydrology resulting from the development be assessed fully.

- Noise and vibrations

Noise and vibrations generated by the operation of the wind turbines may disturb marine fauna in the area, particularly fish and marine mammals. It is known that both fish and marine mammals are sensitive to noise in the marine environment, with sensitivity depending upon the noise frequency, power level and duration. If adversely affected by noise or vibration, fish and marine mammals could move from an area permanently. The noise and vibrations will differ depending on the foundation design. Some information on the effects of vibrations and noise on benthic communities is known from the Vindeby offshore wind farm in Denmark, however the data is somewhat sparse, and more research is needed in this area.

- Electromagnetic fields

The installation of offshore wind turbines will transport electricity via submarine cables between turbines and to the shore. The current flow within submarine cables causes electromagnetic fields around the cables which could potentially have an effect on electrosensitive marine fauna. Fish and marine mammals, which use the electric outputs of organisms in saltwater to detect their prey and use the Earth’s magnetic field for navigation may be particularly sensitive. However information on electromagnetic fields emanating from underwater power cables used for offshore windfarms is very limited. Preliminary research on the effects of electromagnetic fields produced by undersea cables on fish demonstrated that the dogfish *Scyliorhinus canicula* avoids electric fields at 1000 µV/m, which are the maximum predicted to be emitted from 3-core undersea 150 kV, 600 A cables. The same species were attracted to a current of 8 µA (representing an electric field of 0.1 µV/cm at 10 cm from the source), which is consistent with the predicted bioelectric field emitted by prey species (Gill & Taylor 2001). However a longer term study is required to ascertain the relevance of avoidance or attraction behaviour by elasmobranchs from an ecological perspective. More recently elevated species diversity (as measured by the Shannon diversity index) was recorded along the cable route of the Arklow Bank wind farm (Fitch *et al*., 2008).

There is also a potential for heat emissions from the cables while conducting currents. However it is thought that this will generally dissipate into the immediate sediment covering the cable and not increase the temperature at the surface of the seabed.

- Pollutants and waste

Contamination of the area due to accidental spillage of pollutants or waste from vessels maintaining the turbines, may occur during the operational phase of the wind farm. However, if suitable precautions are taken this should be minimal

Cumulative impacts of offshore windfarms

When assessing the cumulative impacts it is necessary to also consider the effect of other developments that together with the current project will have a cumulative impact on the marine environment. This impact could be at a regional level (within the immediate geographic area of the development), but also in terms of the resource that is being impacted, in the case of the current development, the sandbanks along the east coast of Ireland.

The sand bank habitat resource along the east coast of Ireland is finite and the cumulative impact on it should be assessed. Within the immediate geographic area, the Arklow Bank wind farm is currently operating, while the Codling Bank wind farm has been granted a foreshore lease licence. Further consideration should also be given to the cumulative effects of proposed wind farm developments on the Blackwater Bank and other areas if licences to develop are granted and also to any sand and gravel extraction that may take place on the offshore banks.

The main impacts of offshore wind farms on marine benthos are the loss of habitat and species under the 'footprint' of the turbine foundations and cable laying, the alteration of the hydrology and the effects of vibration, noise and electromagnetic fields emanating from the cables.

- Loss of habitats and species

It is predicted that the total area of habitats lost by cumulative developments is likely to be low compared to the total available habitat along the east coast of Ireland. In addition cumulative species loss is likely to be low as the sand banks are low in species diversity due to the mobile nature of the substratum. The increase in areas of hard substratum in areas of mobile sand may increase the species diversity along the banks over time as new species colonise the turbine foundations.

- Alteration of hydrology

The siting of wind turbines on the sand banks may alter the water movements locally and on a wider scale. It is unlikely that the cumulative effect of the developments along the east coast of Ireland will have a significant effect on the hydrology thus affecting the benthos however detailed hydrological assessments should be conducted.

- Noise and vibrations

The effects of noise and vibrations emanating from the cables and turbine foundations on marine benthos are largely unknown. As such it is difficult to quantify the impact of cumulative developments along the east coast of Ireland. Further research is required in this area.

- Electromagnetic fields

The effects of electromagnetic fields created by the submarine cables on marine benthos are largely unknown and poorly researched. As such it is difficult to quantify the impact of cumulative developments along the east coast of Ireland. Further research is required in this area.

Overall, it is expected that the cumulative effect of the Arklow Bank and Codling Bank wind farm developments and the Kish and Bray banks development on the marine benthos of the sand banks along the east coast of Ireland will be minimal. However, further consideration should be given to the accumulative effects of additional developments if they are granted leases.

MITIGATION MEASURES

- Loss or alteration of habitats and loss of species

To minimise habitat and species loss and disturbance, efforts should be made to keep the area of seabed disturbed by the cable trench and turbine foundations to a minimum and sensitive periods such as spawning and migration should be avoided. Following construction of the cable trenches, efforts should be made to restore habitats to their current condition, if impacted upon. Cable trenches should be filled to their pre-construction level, minimising changes in the water flow regime, and with material of a similar particle size to allow re-colonisation of benthic species. The siting of the turbine foundations and cable trenches in low species diversity habitats will minimise the loss of species.

Should a gravity caisson design be used for the turbine foundations, the design should consider the criteria used in the development of artificial reefs. This would maximise the potential of the foundation to be colonised by marine life including species of nature conservation and economic importance.

- Increased turbidity

To minimise the amount of suspended solids released into the water column during construction, efforts should be made to minimise the area of seabed disturbed. Where possible, construction works should be carried out over periods of low tidal flow velocity to minimise the dispersion and removal of material from the area. Alternatively, an increase in turbidity over high tidal flow periods could be ameliorated by restricting the scope of work. Where possible, work should not be carried out on a large number of foundations or trenches at once. Should more than one foundation be installed at a time, they should be carried out in as restricted area as possible.

- Noise and vibration

Should dredging, blasting and piling be required the area of seabed impacted upon should be kept to a minimum and should avoid sensitive periods such as spawning and migration seasons. Noise pollution should be kept to a minimum and follow the guidelines developed by the UK Joint Nature Conservation Committee to minimise the impacts.

Information on the underwater noise and vibrations (frequency and sound power level) generated by the offshore wind farm should be estimated in order to enable better understanding of the likely effects on the marine benthos.

- Electromagnetic fields

Information on the impacts of the electromagnetic currents generated by the submarine cables should be estimated in order to enable better understanding of the likely effects on the marine benthos. Detailed studies are required to ascertain the impacts of these fields on the marine benthos. Cables should avoid sensitive areas such as those used for spawning or nursing.

- Pollutants and waste

Contractors installing turbines should use chemicals that have been approved for use in the marine environment and employ methods that minimise the release of polluting materials into the water column.

To minimise the impact of pollution and waste from maintenance and boat traffic it is necessary to minimise the likelihood of any spillage or contamination. Potential contaminants should be stored in suitable storage facilities, such as bonded containers while at sea.

Waste and litter generated during construction should be returned to the shore for authorised disposal at suitable facilities. Utmost care and vigilance should be followed to prevent accidental contamination of the site and surrounding environment during the construction of the wind farm. Construction and on site operating procedures should be followed to the highest standard to minimise unnecessary disturbance and prevent accidental spillage of contaminants.

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APPENDIX 1 – STUDY AREA

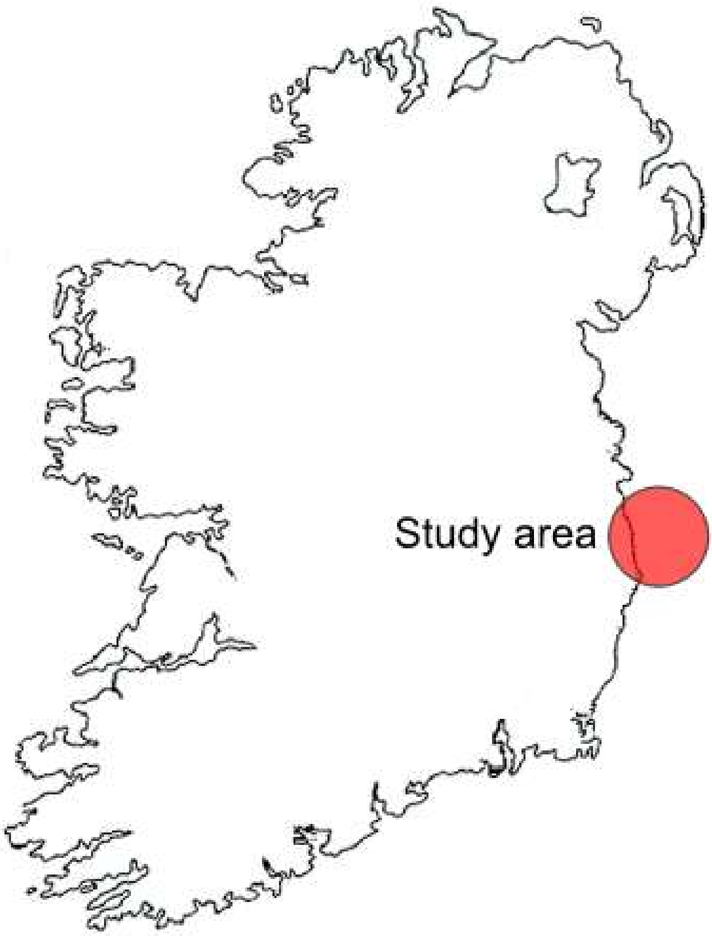

Figure 1.1. Study area showing proposed wind farm location.

Table 1.1. Coordinates of the proposed cable route (as of 02nd May 2008 – may be subject to further adjustments).

	Geodetic (WGS84)		Irish Grid	
Site	Latitude	Longitude	Easting	Northing
Cable Origin	53° 14.0' N	05° 54.7' W	339426	222360
Cable Fork	53° 13.4' N	06° 04.5' W	328552	220942
Landfall A	53° 13.635' N	06° 06.465' W	326354	221319
Landfall B	53° 12.599' N	06° 06.154' W	326751	219407

APPENDIX 2 – SURVEY DATA

Table 2.1. Littoral (core) sampling locations.

Study area	Core sample site	Latitude	Longitude	No. of replicates taken	Sample area (m2)	Substratum	Redox layer depth	Surface features
Landfall B	Site 1	53° 12.605'N	6° 6.135'W	3	0.03	fine sand	>25 cm	
Landfall B	Site 2	53° 12.622'N	6° 6.097'W	3	0.03	fine sand	>25 cm	*Arenicola* casts
Landfall A	Site 3	53° 13.639'N	6° 6.440'W	5	0.05	fine sand	>25 cm	
Landfall A	Site 4	53° 13.636'N	6° 6.459'W	5	0.05	coarse sand, gravel and pebbles	>25 cm	

Table 2.2. Species recorded from littoral core samples (numbers per m^2).

	Landfall A		**Landfall B**	
Taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**
ANNELIDA				
Polychaeta				
Capitella capitata	67	0	20	0
Eumida sanguinea	0	67	0	0
Malacoceros fuliginosus	0	0	40	0
Nephtys cirrosa	0	33	0	0
Scolelepis squamata	67	100	140	0
Polychaeta indet.	0	0	0	20
CRUSTACEA				
Cumacea indet.	0	33	0	0
Amphipoda				
Bathyporeia pelagica	0	33	80	0
Haustorius arenarius	33	0	0	0
Pontocrates altamarinus	33	0	0	0
Pontocrates arenarius	0	0	20	0
MOLUSCA				
Bivalvia				
Angulus tenuis	0	233	0	0
Total organisms	200	500	300	20
Total species	4	6	5	1
Biotope code	**LS.LSa.MoSa.AmSco**	**LS.LSa.MoSa.AmSco**	**LS.LSa.MoSa.AmSco**	**LS.LCS.Sh.BarSh**

Table 2.3. Species recorded in-situ from the littoral zone (SACFOR abundance scale).

	Landfall B									Landfall A		
Taxa	**Site A**	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Site I**	**Site J**	**Site K**	**Site L**
PORIFERA (sponges)												
Porifera indet.	-	-	-	r	-	-	-	-	-	-	-	-
CNIDARIA												
Actinia equina	a	o	-	r	a	-	c	-	-	o	-	-
CRUSTACEA												
Cirripedia (barnacles)												
Semibalanus balanoides	c	o	-	-	f	s	s	-	-	a	-	-
MOLUSCA												
Gastropoda (snails and limpets)												
Patella spp.	a	r	-	-	a	a	a	-	-	a	-	-
Nucella lapillus	c	r	-	-	-	-	a	-	-	r	-	-
Littorina littorea	o	-	-	-	-	-	r	-	-	-	-	-
Littorina obtusata	-	r	-	-	-	-	-	-	-	-	-	-
Bivalvia												
Mytilus edulis	-	o	-	-	-	-	-	-	-	-	-	-
INSECTA												
Collembola (springtails)												
Anurida maritima	o	-	-	-	-	-	-	-	-	-	-	-
Lichens												
Verrucaria marina	o	-	-	-	-	-	-	-	-	-	-	-
Caloplaca marina	o	-	-	-	-	-	-	-	-	-	-	-
Chlorophyta (green algae)												
Enteromorpha spp.	o	s	-	c	c	a	a	-	-	a	-	c
Ulva lactuca	-	-	-	f	-	-	-	-	-	-	-	-
Cladophora spp.	-	-	-	o	-	-	o	-	-	-	o	-
Heterokontophyta (brown algae)												
Fucus serratus	o	o	-	o	f	o	f	-	-	o	r	c
Fucus spiralis	o	c	-		-	-	o	-	-	-	-	-
Fucus vesiculosus	-	-	-	r	-	-	o	-	-	-	-	-
Laminaria digitata	c	-	-	r	-	-	-	-	-	o	-	-
Osmundea pinnatifida						f			-			
Rhodophyta (red algae)												
Porphyra spp.	-	o	-	-	-	a	-	-	-	f	o	f
Rhodothamniella floridula	-	-	-	s	-	-	-	-	-	-	-	-
Palmaria palmata	o	-	-	-	r	-	o	-	-	-	-	-
Mastocarpus stellatus	-	-	-	a	o	-	o	-	-	r	-	-
Chondrus crispus	-	-	-	o	o	-		-	-	-	-	-

Polysiphonia spp.	-	-	-	-	-	-	o	-	-	-	-	-
encrusting coralline algae	-	-	-	-	o	-	-	-	-	-	-	-
Other features												
Arenicola marina casts	-	-	o	-	-	-	-	-	-	-	-	-
Lanice conchilega tubes	-	-	-	o	o	-	-	-	-	-	-	-
Biotope code	**LR.HLR.FR**	**LR.FLR.Eph.EntPor**	**LS.LSa.MoSa.AmSco**	**LR.MLR.BF.Rho**	**LR.FLR.Eph.EphX**	**LR.FLR.Eph.EntPor**	**LR.HLR.MusB.Sem.LitX**	**LS.LCS.Sh.BarSh**	**LR.HLR**	**LR.FLR.Eph.EphX**	**LR.FLR.Eph.EphX**	**LR.FLR.Eph.EphX**

Table 2.4. Sublittoral sampling (biological dredge) locations.

Site Code	Latitude	Longitude	Latitude	Longitude	Dredge duration (min)	Average depth	Revisited sites - most recent surveys
1	53°18.222'N	5°58.673'W	53°18.074'N	5°58.612'W	5	27	Dredge site 4 in Baseline 2002
2	53°17.239'N	5°56.719'W	53°17.163'N	5°56.784'W	5	20	Dredge site 8 in Baseline 2002
3	53°18.270'N	5°54.350'W	53°18.136'N	5°54.394'W	5	33	Dredge site 6 in Baseline 2002
4	53°15.321'N	5°53.265'W	53°15.353'N	5°53.457'W	4	39	Dredge site 15 in Baseline 2002
5	53°12.453'N	5°52.637'W	53°12.381'N	5°52.799'W	4	40	Dredge site 27 in Baseline 2002
6	53°09.758'N	5°52.288'W	53°09.787'N	5°52.364'W	4	21	Dredge site 36 in Baseline 2002
7	53°08.352'N	5°54.117'W	53°08.313'N	5°54.156'W	3	20	Dredge site 41 in Baseline 2002
8.1	53°13.989'N	5°54.514'W	53°14.000"N	5°54.700'W	5	10	Dredge site 20 in Baseline 2002
8.2	53°13.989'N	5°54.514'W	53°13.828'N	5°54.653'W	7	10	Dredge site 20 in Baseline 2002
9	53°13.851'N	5°57.154'W	53°13.910'N	5°57.119'W	2	29	Dredge site 19 in Baseline 2002
10	53°13.701'N	5°59.606'W	53°13.767'N	5°59.628'W	3.5	29	no previous data
11	53°13.551'N	6°02.055'W	53°13.628'N	6°02.077'W	3.5	27	no previous data
12	53°13.400'N	6°04.500'W	53°13.466'N	6°04.451'W	3.5	26	Dredge site 4 in SensMap 1999

Table 2.5. Species recorded from sublittoral (dredge) samples (numbers per dredge).

Taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**	**Site 12**
CNIDARIA												
Hydroida - Athecata												
Hydractinia echinata						x						
Hydroida - Thecata												
Abietinaria abietina	x		x	x		x	x	x				
Calycella spp.	x			x								
Campanulariidae indet.		x										
Campanularia volubilis			x									

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Clytia gracilis					x							
Clytia hemisphaerica					x							
Diphasia spp.		x										x
Diphasia rosacea			x									
Hydrallmania falcata		x	x	x	x		x	x				x
Nemertesia antennina				x	x							
Obelia spp.								x				
Obelia dichotoma		x	x		x				x			x
Obelia longissima			x	x								x
Sertularella spp.			x					x				
Sertularella polyzonias				x	x							
Sertularia argentea				x						x		
Sertularia cupressina	x	x	x	x	x				x			x
Sertularia gayi				x								
Thecata indet.				x	x			x				
Anthozoa												
Actiniaria indet.			1			1	1					1
Alcyonium digitatum					3	8	1			1		
Alcyonium glomeratum						2	1					
CTENOPHORA (comb jellies)												
Ctenophora indet.									1	3		
NEMERTEA (ribbon worms)												
Nemertea indet.							1					
PLATYHELMINTHES (flatworms)												
Platyhelminthes indet.										1	1	
ANNELIDA												
Polychaeta												
Aonides paucibranchiata											1	
Aphroditoidea indet.					1							
Ampharetidae indet.	4					1						1
Ampharete lindstroemi					1							3
Capitella capitata												
Cirratulidae indet.	1											1
Eumida sanguinea	6	2		3	13	2	3			2		1
Eunice pennata			1	5	1							1
Flabelligeridae indet.												2
Gattyana amondseni					3							
Glycera lapidum	2				1						3	
Glycera tesselata						1						
Glycinde nordmanni	1										3	2
Harmothoe spp.				1	2							
Harmothoe lunulata					1							

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Harmothoe viridis							1					
Heteromastus filiformis	1											
Lepidonotus squamatus			2	1		7	2			2		
Lumbrineris spp.												1
Lumbrineris aniara					2						1	
Lumbrineris latreilli	1											
Malacoceros fuliginosus												
Maldanidae indet.												2
Malmgrenia arenicolae	1	2								1		
Malmgrenia sp.	1											
Nicolea venustula				2	1					1		
Nephtys caeca	2											6
Nephtys cirrosa	2	1									2	
Nereimyra punctata				1	5	1	2					
Nereis zonata			1	2	1	3						
Nicomache lumbricalis												1
Nothria conchylega				1								1
Notomastus latericeus	1										5	
Ophelia acuminata												1
Ophelia limacina	8										3	
Owenia fusiformis												5
Pectinaria auricoma	1			1	1							3
Pholoe inornata					5		1			2		
Phyllodocidae indet.					2							
Pomatoceros sp.		1		1	15	7	25		37	96		
Sabellaria spinulosa					1							
Scolelepis squamata												
Scoloplos armiger	12											
Sthenelais boa					2							
Sthenelais limicola		1		1								2
Terebellidae indet.					1		1					
Tharyx killariensis											1	
Thelepus cincinnatus				3	4		1					
Syllis spp.	2								1	2	1	1
Polychaeta indet.			1	1	10	1	1				3	
CRUSTACEA												
Cirripedia (barnacles)												
Balanus sp.										x		
Balanus balanus						x	x					
Balanus crenatus				x	x							
Balanus hameri			x	x	x	x	x			x		
Cumacea												
Cumacea indet.											2	

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Isopoda												
Lekanesphaera hookeri												1
Amphipoda												
Ampelisca brevicornis												3
Ampelisca spinipes					1							
Atylus swammerdami		1										
Atylus vedlomensis									1			
Bathyporeia pelagica		1										
Corophium sextonae	1				2	8	4					
Ericthonius brasiliensis				1	1							2
Gammaropsis maculata				3	18		3					
Gammaropsis nitida		12		1								
Haustorius arenarius												
Liljeborgia pallida						2						
Maera othonis					1							
Melinna elisabethae												1
Melita obtusata	1		1	2	3							
Pontocrates altamarinus												
Pontocrates arenarius	1											
Pontocrates arenarius												
Stenothoe marina		2										
Urothoe elegans	1										3	
Decapoda												
Atelecyclus rotundatus							1					
Cancer pagurus					1							
Ebalia cranchii					2							
Ebalia tuberosa							1					
Eurynome spinosa					3							
Hyas araneus					1							
Hyas coarctatus				1		1	2					1
Inachus dorsettensis	2	1										
Liocarcinus depurator	2											
Liocarcinus holsatus				1								1
Liocarcinus pusillus	1				2	1				1		
Macropodia rostrata				1								
Majidae indet.			1									
Pagurus sp.			3			3						
Pagurus bernhardus	1	2		4	2	15	10	1	1			1
Pagurus variabilis					2							
Pinnotheres pisum							2					
Pisidia longicornis				3	48	16	50				1	
MOLUSCA												
Polyplacophora (chitons)												

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Leptochiton asellus					8		6		14	1		
Gastropoda (snails, slugs and limpets)												
Buccinum undatum					1	17						
Calliostoma zizyphinum						6						
Coryphella sp.							1					
Emarginula fissura							1					
Gibbula magus					1							
Hinia incrassata					4	2						
Neptunea antiqua						1						
Opisthobranchia indet.		1										
Polinices spp.	1		4	3	2	1						
Turritella communis					1							1
Bivalvia												
Abra sp.					6							2
Aequipecten opercularis				1		1	1		1	1		
Anomiidae indet.						14						
Chlamys varia						2						
Cochlodesma praetenue		1										
Phaxas pellucidus												1
Ensis sp.	1											
Gari fervensis	1		8	2								
Hiatella arctica						2	2					
Modiolus modiolus				1	2	19	2					
Musculus marmoratus				5	4							
Mya spp.	1			1	1							
Mytilus edulis					1		1					
Nucula nitidosa			3									
Nucula nucleus				30	130					6		32
Ostrea edulis				2	2	1						
Ostreidae indet.							14			1		
Spisula elliptica	7	5									3	
Tapes rhomboides					2	1						
Venerupis spp.						2						
Venus casina							3					1
Venus ovata				2	1							
Bivalvia indet.				1						1		2
BRYOZOA												
Alcyonidium spp.		x	x	x								
Anguinella palmata			x	x								x
Electra spp.				x								
Escharella spp.							x					
Flustra foliacea			x									
Membraniporidae indet.												x

Taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**	**Site 12**
Microporellidae indet.							x					
Cheilostomatida indet.							x		x			
Bryozoa indet.												x
ECHINODERMATA												
Amphiura filiformis												1
Antedon bifida						1						
Asterias rubens		1				2	4					2
Echinocardium spp.		2	1			1					1	
Echinocardium cordatum	6											21
Echinocardium flavescens					1							
Echinus esculentus						1						
Ocnus spp.			1									2
Ophiothrix spp.												4
Ophiothrix fragilis				1	5	30						194
Ophiura spp.	1										3	4
Ophiura albida				1	6		2				1	
Ophiura ophiura							1					19
Ophiura robusta										1		
Ophiura sarsi												201
Psammechinus miliaris	1				1	11	71		1			
Ophiuroidea indet.					11	1	1					
HEMICHORDATA												
Ascidiacea (sea-squirts)												
Ascidiella aspersa				1	4	1						
Ascidiacea indet.					2		0					
Total species	**35**	**22**	**25**	**50**	**68**	**43**	**43**	**6**	**11**	**20**	**18**	**48**
Biotope code	**SS.SCS.ICS.Glap**	**SS.SCS.ICS**	**SS.SMx.CMx.MysThyMx**	**SS.SSa.CMuSa.AalbNuc**	**SS.SSa.CMuSa.AalbNuc**	**SS.SBR.SMus.ModMx**	**SS.SMx.CMx**	**SS.SSa.IFiSa.IMoSa**	**SS.SSa.CFiSa**	**SS.SSa.CFiSa**	**SS.SMx.CMx.MysThyMx**	**SS.SMx.CMx.OphMx**

APPENDIX 3 – PREVIOUS DATA

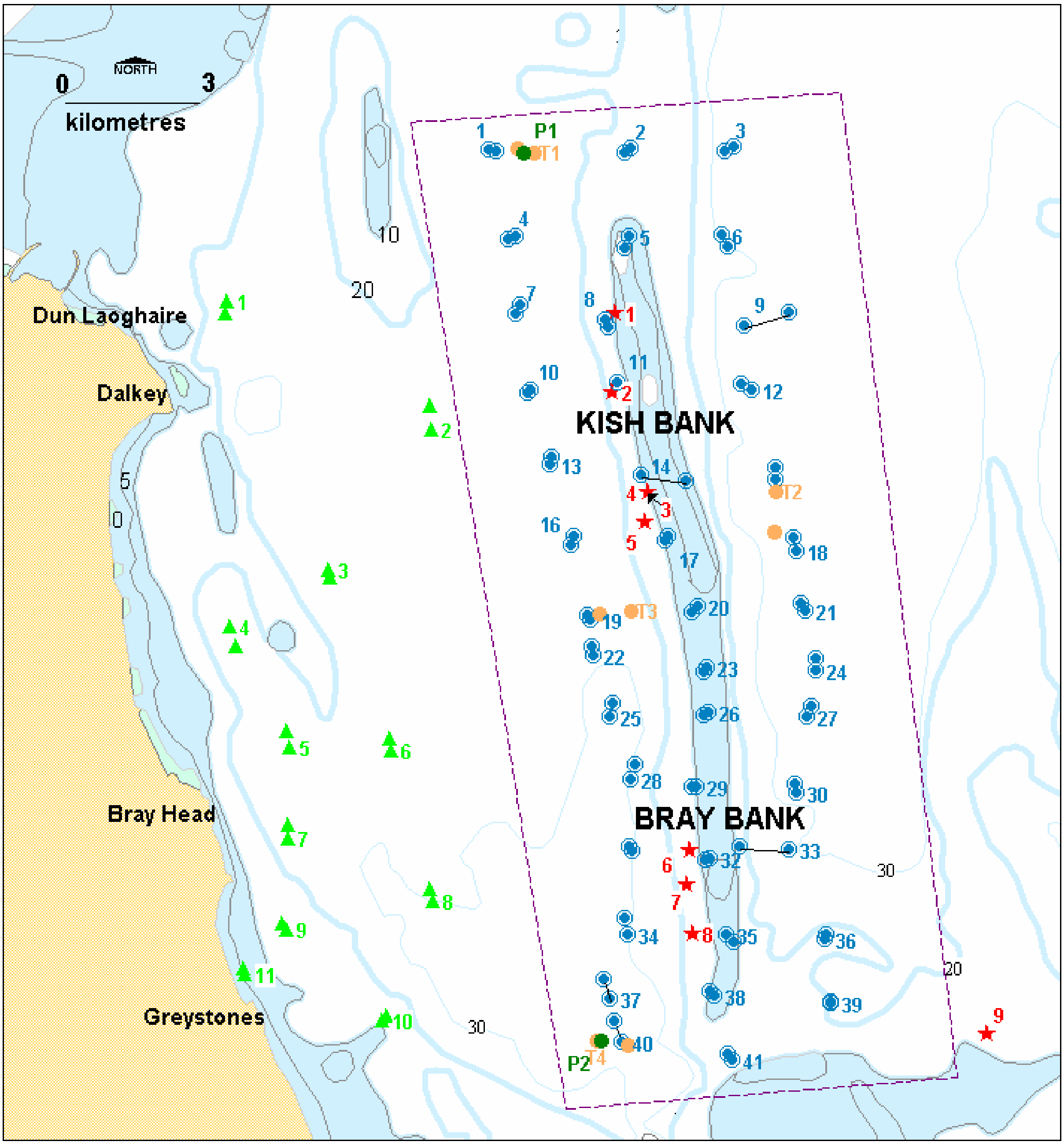

Figure 3.1. Map showing the locations of the July 2002 survey dredge sampling stations (1-41 in blue), trawl stations (T1-T4 in orange), plankton sites (P1-P2 in green), BioMar stations (1-9 in red) and SensMap sites (1-11 in green) in and around the Kish and Bray banks. The areas in blue show the 5, 10, 20 and 30 m depth contours and the purple dashed line indicates the survey area (EcoServe, 2004).

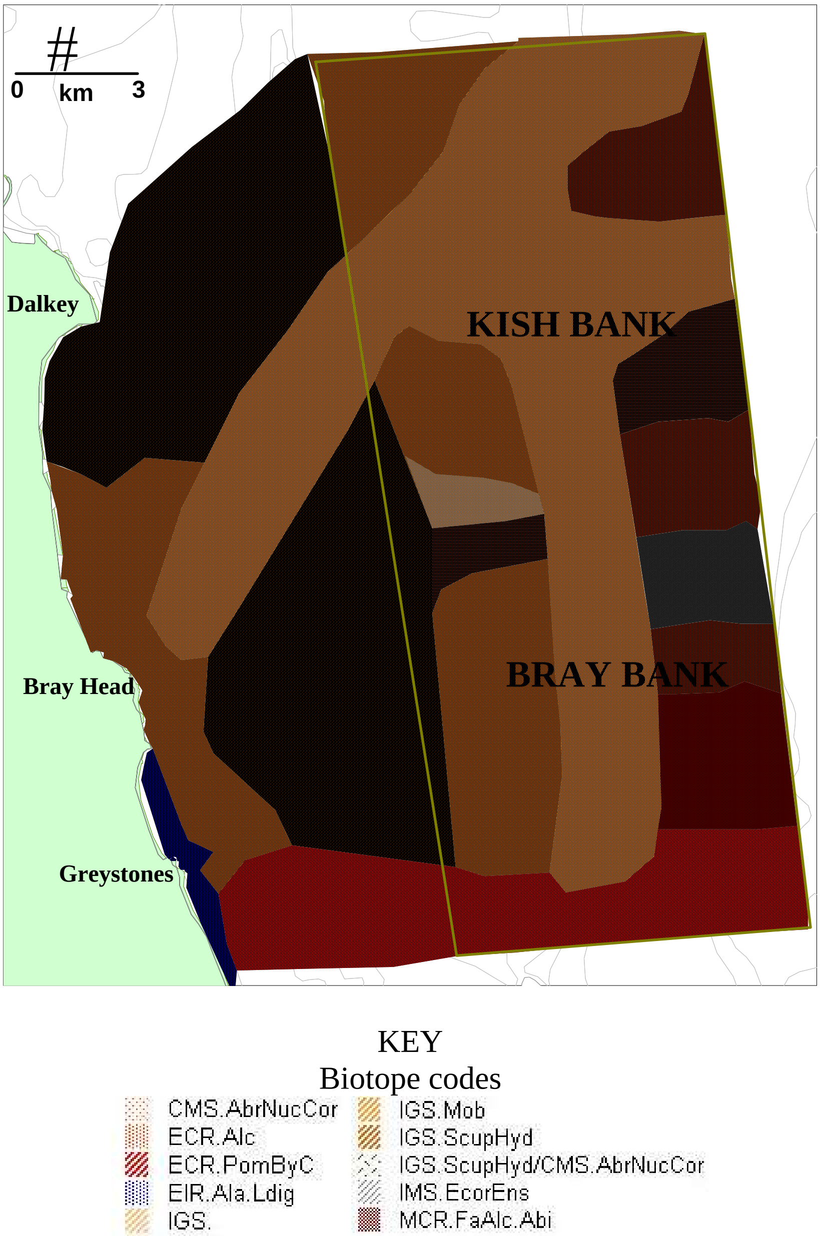

Figure 3.2. Map showing the main biotopes of the Kish and Bray Banks using data from the July 2002 dredge samples for the Banks and SensMap data for the surrounding area. The purple dashed line indicates the proposed wind farm area. Colours indicate the higher biotope codes (EcoServe, 2004).

Table 2.1. List of species or higher taxa recorded from each site, July 2002 (EcoServe 2004). The list is arranged in taxonomic order. P = present.

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
PORIFERA (sponges)																																									
Porifera indet.	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	P	-	-	-	-	-	-	P	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-
HYDROZOA (hydroids/sea firs)																																									
Hydrozoa indet.	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Hydractinia echinata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halecium beanii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Halecium halecium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Nemertesia antennina	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-		-	-	-	P
Abietinaria abietina	P	P	-	P	-	P	-	-	-	-	P	-	-	P	P	P	-	-	P	P		P	P	-	P	-	-	P	-	-	P		P	P	-	P	P	-	P	P	P
Hydrallmania falcata	P	P	-	P	-	P	-	-	P	P	-	P	P	P	-	P	-	-	-	P	P	P	P	-	P	-	-	P	-	-	P	P		P	-	-	P	-	-	P	P
Thuiaria articulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Sertularella spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Sertularella polyzonias	-	-	-	P	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	P
Sertularia argentea	P	-	-	P	-	P	P	-	-	P	-	-	P	-	P	-	-	P	-	-	-	P	-	-	P	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-
Campanularia hincksii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clytia hemisphaerica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obelia spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obelia longissima	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhizocaulus verticillatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P		P	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-
ANTHOZOA (sea anemones)																																									
Anthozoa indet.	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alcyonium digitatum	P	-	-	P	-	P	-	-	-	-	-	P	-	-	P	P		P	-	-	P	P		P	P		P	-	-	P	P	-	P	P	-	P	-	-	P	-	P
CTENOPHORA (comb jellies)																																									

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Ctenophora indet.	-	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POLYCHAETA (worms)																																									
Polychaeta indet.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-
Aphrodita aculeata	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polynoidae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Glyceridae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Sphaerodoridae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-
Nereidae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	P	-	-	P	-	-	-	-	-	-	-
Nephtys spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	P	-	-	P	-	-	-	-	-	-		-	-	-	-	P	-	-
Eunicidae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-
Orbiniidae spp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Opheliidae spp.	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lanice conchilega	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-
Sabella pavonina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	P	-	-	-	-		-	-	-	-	-
Pomatoceros triqueter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	P	-	-	P	P		P	P	-	P	P	-	P	P	P	-	-	P	P	P	-	-	P	P
Balanus crenatus	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	P	-	P	-	-	-	-	-	P	P	-	P	P	P
CRUSTACEA (crabs, barnacles and amphipods)																																									
Amphipoda indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palaemonoidea indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Pandalus borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pandalus montagui	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Crangon crangon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pagurus bernhardus	-	-	-	P	-	-	-	-	-	-	-	-	P	-	P	P	-	P	P	-	P	P	-	P	P	-	P	P	-	-	P	-	-	P	-	-	P	-	-	P	-
Pisidia longicornis	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	P	-	P	P	-	-	P	-	-	P	-	-	-	-	-	P	-	-	P	P

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Ebalia spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Ebalia tuberosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyas coarctatus	-	-	-	-	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	P	-	P	P	-	-	P	P
Macropodia rostrata	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-
Eurynome aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Atelecyclus rotundatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Liocarcinus spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liocarcinus depurator	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liocarcinus holsatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Liocarcinus pusillus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	P	-	P	P	-	P	-	-	-	-	-	-	-	-	-	P	-	-	-	P
Pinnotheres pisum	-	-	-	-	-	-	-	P		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOLLUSCA (snails and bivalves)																																									
Polyplacophora indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Lepidochitona cinerea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	P	-
Gibbula cineraria	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Calliostoma zizyphinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Turritella communis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P			-	-	-	-	-	-	-	-	-	-	-	-
Polinices polianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buccinum undatum	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	P	-	-	P	-	P	P	-	P	-	-	-	P	-	-	P	-	-	P	-	-	P	-	-	-	-
Neptunea antiqua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Colus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P		-	-	-	-	-	-	-	-	-	-	-	-	-
Colus gracilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P		P	-	-	P	-	-
Pelecypodia indet.	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Nucula sulcata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	-	P	-	-	P	-	P	-	-	P	-	-	-	-	-	P	-	-	P	-	P
Mytilidae sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Mytilus edulis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modiolus modiolus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	P	-	-	-	-
Aequipecten opercularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Anomia ephippium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-
Mactra stultorum	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spisula elliptica	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	P	P	P	-	P	-	-	P	-	-	-	-	P	-	-	P	P	-	P	-	-	-	-	-	-	-
Spisula subtruncata	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensis spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phaxas pellucidus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax vittatus	-	P	-	-	P	-	-	P	-	P	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gari fervensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gari tellinella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Abra spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Abra alba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Circomphalus casina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Dosinia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tapes rhomboides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamelea gallina	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clausinella fasciata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	P	P	-
Hiatella arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BRYOZOA (sea mats)																																									
Bryozoa indet.	-	-		P	-	-	-	-	-	P	-	P	P	P	P	P	P	P	-	P	P	-	P	P	P	-	-	-	-	P	P	-	-	P	-	P	P	-	P	P	P
Alcyonidium sp.	-	-	-	P	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Alcyonidium diaphanum	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Alcyonidium gelatinosum	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Alcyonidium parasiticum	-	-	-	P	-	P	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vesicularia spinosa	-	-	-	-	-	P	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucratea loricata	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
ECHINODERMATA (star fish, sea urchins and sea cucumbers)																																									
Crossaster papposus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-
Asterias rubens	P	P	P	P	P	P	P	-	-	-	-	P	-	P	P	P	-	P	P	P	P	P	-	P	P	-	-	-	P	-	P	-	-	P	-	-	P	-	P	-	P
Ophiothrix fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Amphiura chiajei	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiura albida	P	-	-	P	-	-	-	-	-	-	-	P	-	-	P	P	-	P	P	-	-	P	-	P	P	-	P	-	-	P	-	-	P	-	-	-	-	-	-	-	-
Ophiura ophiura	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psammechinus miliaris	-	-	-	P	-	-	-	-	-	-	-	P	-	-	P	P		P	P	-	P	P	-	-	P		P	P		P	P		P	P		P	P			P	P
Echinus esculentus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P			P	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	P	P
Spatangus purpureus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P		
Echinocardium sp.	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinocardium flavescens	-	-	-	-	-		-	-	-	-	-	-	-	-	P	-	-	P	P	-	-	-	-	P	-	-	P	-	-	-	P	-	-	P	-	P	-	-	P	-	P
Holothuroidea indet.	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (sea squirts)																																									
Tunicata indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Ciona intestinalis	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	P
Ascidiella scabra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-
Dendrodoa grossularia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P		P	P	-	-	-	-	-	-	-	-	-	-	-	P	-	P	P	P
OSTEICHTHYES (fish)																																									
Clupea harengus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Diplecogaster bimaculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Ammodytes tobianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	P	-	-	P	-	-	P	-	P	-	-	-	-	-	-	P	-	-	-

	Dredge stations																																								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Hyperoplus lanceolatus	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyptocephalus cynoglossus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Limanda limanda	-	-	-		P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RHODOPHYCOTA (red algae)																																									
Corallinaceae indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P		P
No. of species or higher taxa	**6**	**7**	**1**	**21**	**3**	**16**	**4**	**3**	**3**	**6**	**8**	**11**	**9**	**9**	**17**	**16**	**5**	**22**	**10**	**10**	**17**	**20**	**7**	**22**	**29**	**1**	**20**	**18**	**2**	**12**	**22**	**4**	**5**	**23**	**1**	**17**	**20**	**1**	**18**	**21**	**23**
Biotope number	**3**	**2**	**2**	**3**	**2**	**8**	**2**	**2**	**2**	**2**	**2**	**1**	**2/3**	**2**	**5**	**3**	**2**	**8**	**1**	**2**	**8**	**5**	**2**	**4?**	**3**	**2**	**4?**	**-**	**2**	**8**	**3**	**2**	**2/6?**	**3?**	**2**	**6?**	**3?**	**2**	**7**	**7?**	**7?**

APPENDIX 4 – BIOTOPE DESCRIPTIONS

LITTORAL

LR.HLR - High energy littoral rock
Extremely exposed to moderately exposed or tide-swept bedrock and boulder shores. Extremely exposed shores dominated by mussels and barnacles, occasionally with robust fucoids or turfs of red seaweed. Tide-swept shores support communities of fucoids, sponges and ascidians on the mid to lower shore. Three biotope complexes have been described: Communities on very exposed to moderately exposed upper and mid eulittoral bedrock and boulders dominated by the mussel *Mytilus edulis*, barnacles *Chthamalus* spp. and/or *Semibalanus balanoides* and the limpets *Patella* spp. (MusB); red and brown seaweeds able to tolerate the extreme conditions of exposed rocky shores, primarily the physical stresses caused by wave action (FR), and tide-swept shores in more sheltered areas (such as narrow channels in sea loch) with canopy forming fucoids and a rich filter-feeding community (FT).

LS.LCS.Sh.BarSh - Barren littoral shingle
Shingle or gravel shores, typically with sediment particle size ranging from 4 - 256 mm, sometimes with some coarse sand mixed in. This biotope is normally only found on exposed open coasts in fully marine conditions. Such shores tend to support virtually no macrofauna in their very mobile and freely draining substratum. The few individuals that may be found are those washed into the habitat by the ebbing tide, including the occasional amphipod or small polychaete.

LR.HLR.FR - Robust fucoid and/or red seaweed communities
This biotope complex encompasses those seaweeds that are able to tolerate the extreme conditions of very exposed to moderately exposed rocky shores. The physical stresses caused by wave action often results in dwarf forms of the individual seaweeds. The strong holdfasts and short tufts structure of the wracks *Fucus distichus* and *Fucus spiralis f. nana* allow these fucoids to survive on extremely exposed shores in the north and north-west (Fdis). Another seaweed able to tolerate the wave-wash is the red seaweed *Corallina officinalis*, which can form a dense turf on the mid to lower shore (Coff). The wrack *Himanthalia elongata* occurs on the lower shore and can extend on to moderately exposed shores (Him). The red seaweed *Mastocarpus stellatus* is common on both exposed and moderately exposed shores, where it may form a dense turf (particularly on vertical or overhanging rock faces, Mas). Very exposed to moderately exposed lower eulittoral rock can support a pure stand of the red seaweed *Palmaria palmata*. It is found either as a dense band or in large patches above the main sublittoral fringe (Pal). Exposed to moderately exposed lower eulittoral rock characterised by extensive areas or a distinct band of *Osmundea pinnatifida* (Osm). Outcrops of fossilised peat in the eulittoral are soft enough to allow a variety of piddocks, such as *Barnea candida* and *Petricola pholadiformis*, to bore into them (RPid). This biotope is rare. Other species such as the anemone *Halichondria panicea*, the barnacle *Semibalanus balanoides*, the limpet *Patella vulgata*, the mussel *Mytilus edulis* and the whelk *Nucella lapillus* can be present as well, but they are never dominant as in the MusB-complex. There is also a higher number of seaweeds present including the red *Palmaria palmata*, *Lomentaria articulata*, *Ceramium* spp. and the brown seaweeds *Laminaria digitata* and *Fucus*

serratus. The green seaweeds *Enteromorpha intestinalis, Ulva lactuca* and *Cladophora rupestris* are occasionally present.

LR.HLR.MusB.Sem.LitX - *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles
Large patches of boulders, cobbles and pebbles in the eulittoral zone on exposed to moderately exposed shores colonised by the barnacle *Semibalanus balanoides* and, on larger rocks, the limpet *Patella vulgata*. The winkles *Littorina littorea* and *Littorina saxatilis* and the whelk *Nucella lapillus* are typically found in high numbers on and around cobbles and smaller boulders, while the anemone *Actinia equina* occurs in damp areas between and underneath larger boulders. Between the cobbles and pebbles, the mussel *Mytilus edulis* occasionally occurs, but always at low abundance, as do the crab *Carcinus maenas* and gammarid amphipods. Ephemeral green seaweeds such as *Enteromorpha intestinalis* may cover cobbles and boulders. The foliose red seaweeds *Chondrus crispus*, *Mastocarpus stellatus* and *Osmundea pinnatifida* as well as the wrack *Fucus vesiculosus* may also occur in low abundance on cobbles and boulders. The top shells *Gibbula cineraria* and *Gibbula umbilicalis* can, on more sheltered shores, be found among the seaweeds or underneath the boulders. The barnacle *Elminius modestus* is present on some shores.

LR.FLR.Eph.EntPor - *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock
Exposed and moderately exposed mid-shore bedrock and boulders occurring adjacent to areas of sand which significantly affects the rock. As a consequence of sand-abrasion, wracks such as *Fucus vesiculosus* or *Fucus spiralis* are scarce and the community is typically dominated by ephemeral red or green seaweeds, particularly the foliose red seaweed *Porphyra purpurea* and green seaweeds such as *Enteromorpha* spp. Under the blanket of ephemeral seaweeds, the barnacles *Semibalanus balanoides* or *Elminius modestus* and the limpet *Patella vulgata* may occur in the less scoured areas, along with the occasional winkles *Littorina littorea* and *Littorina saxatilis*. Few other species are present.

LR.FLR.Eph.EphX - Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata
Eulittoral mixed substrata (pebbles and cobbles overlying sand or mud) that are subject to variations in salinity and/or siltation, characterised by dense blankets of ephemeral green and red seaweeds. The main species present are *Enteromorpha intestinalis*, *Ulva lactuca* and *Porphyra* spp., along with colonial diatoms covering the surface of the substratum. Small numbers of other species such as barnacles *Semibalanus balanoides* and *Elminius modestus* are confined to any larger cobbles and pebbles or on the shells of larger individuals of the mussel *Mytilus edulis*. The crab *Carcinus maenas* and the winkle *Littorina littorea* can be present among the boulders, cobbles and seaweeds, while gammarids can be found in patches underneath the cobbles. In common with the other biotopes found on mixed substrata, patches of sediment are typically characterised by infaunal species including bivalves, for example, *Cerastoderma edule* and the polychaete *Arenicola marina* and the polychaete *Lanice conchilega*.

S.LSa.MoSa.AmSco - Amphipods and *Scolelepis* spp. in littoral medium-fine sand

Mobile clean sandy beaches on exposed and moderately exposed shores, with sediment grain sizes ranging from medium to fine, often with a fraction of coarser sediment. The sediment contains little or no organic matter, and usually no anoxic layer is present at all. It tends to be well-drained, retaining little water at low tide, though the sediment of the AmSco.Pon sub-biotope may remain damp throughout the tidal cycle. These beaches usually occur under fully marine conditions, though the AmSco.Eur sub-biotope may occur under moderately exposed lower estuarine conditions. The mobility of the sediment leads to a species-poor community, dominated by polychaetes, isopods and burrowing amphipods. *Scolelepis* spp. can tolerate well-drained conditions, and are often present in well-draining, coarser sand. Burrowing amphipods that often occur in this biotope include *Bathyporeia* spp., *Pontocrates arenarius*, and *Haustorius arenarius*. The isopod *Eurydice pulchra* is also often present. On semi-exposed beaches with a moderate tide range where there is a marked high-shore berm, there can be a marked seepage at the foot of the berm that probably carries the products of the organic matter derived from strand line breakdown. Here in a narrow zone, exceptionally high populations of *Bathyporeia pilosa*, sometimes above 10000 per square metre, may occur. The zone may be narrower than the strandline and could easily be missed on surveys were only a few levels are sampled. Three sub-biotopes are described for this biotope, based principally on differences in infaunal species composition.

LR.MLR.BF.Rho - *Rhodothamniella floridula* on sand-scoured lower eulittoral rock

Lower eulittoral and sublittoral fringe bedrock and boulders subject to mild sand-scouring characterised by a canopy of the wracks *Fucus serratus* or *Fucus vesiculosus*, beneath which a mat of the sand-binding red seaweed *Rhodothamniella floridula* occurs. These mats can form distinct areas without *F. serratus*. The small hummocks of *R. floridula* also contain a diversity of other red seaweeds tolerant of sand scour, e.g. *Palmaria palmata*, *Chondrus crispus*, coralline crusts and *Mastocarpus stellatus*. The brown seaweed *Cladostephus spongiosus* or the ephemeral green seaweed *Enteromorpha intestinalis*, *Ulva lactuca* or *Cladophora rupestris* may occur. The hydroid *Dynamena pumila* can form colonies on the *F. serratus* fronds. The barnacle *Semibalanus balanoides*, the limpet *Patella vulgata*, the anemone *Actinia equina* and the polychaete *Pomatoceros triqueter* may be present where bedrock are available along with a few winkles such as *Littorina littorea*. In addition, polychaetes and amphipods may burrow into the *R. floridula* mat, while the mussel *Mytilus edulis* is restricted to small crevices in the bedrock. The species diversity of this biotope is normally low and there can be much variation in the species composition from site to site.

SUBLITTORAL

SS.SSa.IFiSa.IMoSa - Infralittoral mobile clean sand with sparse fauna

Medium to fine sandy sediment in shallow water, often formed into dunes, on exposed or tide-swept coasts often contains very little infauna due to the mobility of the substratum. Some opportunistic populations of infaunal amphipods may occur, particularly in less mobile examples in conjunction with low numbers of mysids such as *Gastrosaccus spinifer*, the polychaete *Nephtys cirrosa* and the isopod *Eurydice* *pulchra*. Sand eels *Ammodytes* sp. may occasionally be observed in association with this biotope (and others). This biotope is more mobile than SSA.NcirBat and may be closely related to LSa.BarSa on the shore. Common epifaunal species such as *Pagurus bernhardus*, *Liocarcinus depurator*, *Carcinus maenas* and *Asterias rubens* may be encountered and are the most conspicuous species present.

SS.SSa.CFiSa - Circalittoral fine sand
Clean fine sands with less than 5% silt/clay in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20m. The habitat may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the pea urchin *Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community.

SS.SSa.CMuSa.AalbNuc - *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment
Non-cohesive muddy sands or slightly shelly/gravelly muddy sand characterised by the bivalves *Abra alba* and *Nucula nitidosa*. Other important taxa include *Nephtys* spp., *Chaetozone setosa* and *Spiophanes bombyx* with *Fabulina fabula* also common in many areas. The echinoderms *Ophiura albida* and *Asterias rubens* may also be present. The epibiotic biotope EcorEns may overlap this biotope. This biotope is part of the Abra community defined by Thorson (1957) and the infralittoral etage described by Glemarec (1973).

SS.SBR.SMus.ModMx - *Modiolus modiolus* beds on open coast circalittoral mixed sediment
Muddy gravels and coarse sands in deeper water of continental seas may contain venerid bivalves with beds of *Modiolus modiolus*. The clumping of the byssus threads of the *M. modiolus* creates a stable habitat that attracts a very rich infaunal community with a high density of polychaete species including *Glycera lapidum*, *Paradoneis lyra*, *Aonides paucibranchiata*, *Laonice bahusiensis*, *Protomystides bidentata*, *Lumbrineris* spp., *Mediomastus fragilis* and syllids such as *Exogone* spp. and *Sphaerosyllis* spp. Bivalves such as *Spisula elliptica*, *Timoclea ovata* and other venerid species are also common. Brittlestars such as *Amphipholis squamata* may also occur with this community. This biotope is very similar to SMX.PoVen and the 'boreal off-shore gravel association' and the 'deep Venus community' described by previous workers (Ford 1923; Jones 1951). Similar *Modiolus* beds (though with a less diverse infauna) on open coast stable boulders, cobbles and sediment are described under MCR.ModT.

SS.SCS.ICS.Glap - *Glycera lapidum* in impoverished infralittoral mobile gravel and sand
In infralittoral mixed slightly gravelly sands on exposed open coasts impoverished communities characterised by the polychaete *Glycera lapidum* (agg.) may be found. *Glycera lapidum* is a species complex and as such some variability in identification may be found in the literature. It is also quite widespread and may occur in a variety of coarser sediments and is often present in other SCS biotopes. However, it is rarely considered a characteristic species and where this is the case it is normally due to the exclusion of other species. Consequently it is considered that habitats containing this

biotope may be subject to continual or periodic sediment disturbance from wave action, which prevents the establishment of a more stable community. Other taxa include spionid polychaetes such as *Spio martinensis* and *Spiophanes bombyx*, *Nephtys* spp. and in some areas the bivalve *Spisula elliptica*. It is possible that SCS.Glap it is not a true biotope, rather an impoverished, transitional community, which in more settled conditions develops into other more stable communities.

SS.SMx.CMx - Circalittoral mixed sediment

Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities. Coarser mixed sediment communities may show a strong resemblance, in terms of infauna, to biotopes within the SCS complex. However, infaunal data for this biotope complex is limited to that described under the biotope MysThyMx, and so are not representative of the infaunal component of this biotope complex.

SS.SMx.CMx.MysThyMx - *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment

In moderately exposed or sheltered, circalittoral muddy sands and gravels a community characterised by the bivalves *Thyasira* spp. (often *Thyasira flexuosa*), *Mysella bidentata* and *Prionospio fallax* may develop. Infaunal polychaetes such as *Lumbrineris gracilis*, *Chaetozone setosa* and *Scoloplos armiger* are also common in this community whilst amphipods such as *Ampelisca* spp. and the cumacean *Eudorella truncatula* may also be found in some areas. The brittlestar *Amphiura filiformis* may also be abundant at some sites. Conspicuous epifauna may include encrusting bryozoans *Escharella* spp. particularly *Escharella immersa* and, in shallower waters, maerl (*Phymatolithon calcareum*), although at very low abundances and not forming maerl beds.

SS.SMx.CMx.OphMx - *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment

Circalittoral sediment dominated by brittlestars (hundreds or thousands m-2) forming dense beds, living epifaunally on boulder, gravel or sedimentary substrata. *Ophiothrix fragilis* and *Ophiocomina nigra* are the main bed-forming species, with rare examples formed by *Ophiopholis aculeate*. Brittlestar beds vary in size, with the largest extending over hundreds of square metres of sea floor and containing millions of individuals. They usually have a patchy internal structure, with localized concentrations of higher animal density. *Ophiothrix fragilis* or *Ophiocomina nigra* may dominate separately or there may be mixed populations of the two species. *Ophiothrix* beds may consist of large adults and tiny, newly-settled juveniles, with animals of intermediate size living in nearby rock habitats or among sessile epifauna. Unlike brittlestar beds on rock, the sediment based beds may contain a rich associated epifauna (Warner, 1971; Allain, 1974; Davoult & Gounin, 1995). Large suspension feeders such as the octocoral *Alcyonium digitatum*, the anemone *Metridium senile* and the hydroid *Nemertesia antennina* are present mainly on rock outcrops or boulders protruding above the brittlestar-covered substratum. The large anemone *Urticina feline* may be quite common. This species lives half-buried in the substratum but is not smothered by the brittlestars, usually being surrounded by a 'halo' of clear space (Brun, 1969; Warner, 1971). Large mobile animals commonly found on *Ophiothrix* beds include the starfish *Asterias rubens*, *Crossaster papposus* and *Luidia ciliaris*, the urchins *Echinus esculentus* and *Psammechinus miliaris*, edible crabs *Cancer pagurus*, swimming crabs *Necora puber*, *Liocarcinus* spp., and hermit crabs *Pagurus bernhardus*. The underlying sediments also contain a diverse infauna including the bivalve *Abra alba*. Warner (1971) found that numbers and biomass of sediment dwelling animals were not significantly reduced under dense brittlestar patches.

APPENDIX 5 – SELECTED IMAGES

dublin array

An Offshore Wind Farm
on the Kish and Bray Banks

Environmental Impact Statement

January 2012 - Revision 1

Reviewed and Updated by

MRG CONSULTING ENGINEERS LIMITED

Prepared by

SAORGUS | ENERGY LTD

Volume 3 of 5 - Appendix G
Seabirds: Baseline Study (2001-2002)

Kish Bank Proposed Offshore Wind Farm

Progress Report No. 2 on Seabird Surveys Sept 2001- Sept 2002

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December 2002

Contractor: Kish Bank Consortium

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Kish Bank Proposed Offshore Wind Farm: Seabird Surveys September 2001-September 2002

Introduction

An initial desk study was carried out in April 2001 to identify the potential ornithological issues that the proposed Kish Bank offshore wind farm is likely to raise and made recommendations on the field surveys required for the ornithological components of the EIA that the development would require (Percival, 2001b). A preliminary report was produced in July 2002 (Percival *et al*. 2002) on the field data that were collected between September 2001 and May 2002. This current report updates that information for the surveys carried out through t the end of September 2002, and present the full year's data. It also updates the initial assessment made in the first progress report of the importance of the possible wind farm area and its surrounds, now based on a full year's data.

The potential offshore wind farm site includes all of the shallower water (<10m) around the Kish and Bray Banks (see Figure 1). The main study area was determined to include all of the area that could possibly be affected by a wind farm at this site, and an area around this to enable the relative importance of the site itself to be assessed in a local and regional context. As the effects of offshore wind farms on birds generally are poorly known (Percival, 2001a), it will be important in the assessment process to be able to identify all the important populations that may be affected. It is likely that different species will vary in their relative sensitivity to a wind farm development, and hence in the distance over which they may be affected.

The existing information identified during the desk study shows that the Kish Bank supports important bird populations. These main interests include:

- Post-breeding terns – August-September (possibly pre-breeding too, April). Both the Seabirds at Sea surveys and BirdWatch Ireland data have indicated that the Kish Bank is used by large numbers of terns, particularly in early autumn. These include large numbers of the endangered roseate tern.
- Breeding seabirds – April–July. There are numerous SPAs in the study area that have been notified for their breeding seabirds. It is likely that a substantial number of these will make at least some use of the Kish Bank for foraging.
- Wintering common scoter – September-February. Several wintering flocks have been noted from onshore counts in the study area. Given the sea depth around the Kish Bank and this species' preference for feeding in comparatively shallow waters, it is possible that nationally important numbers (>120) may use the proposed wind farm site.

- Other wintering seabirds – September-February. These could potentially include nationally important red-throated diver and cormorant, and possibly internationally important numbers of little gulls.

As a result a comprehensive year-round baseline monitoring programme commenced in September 2001. This provides the detailed data required to assess the potential effects of the proposed offshore wind farm.

These surveys have been carried out over a full year, to quantify the seabird populations using the site. Additional survey effort is being made at the keys times of year highlighted above, when there are likely to be important bird populations in the area. This report also assesses whether further year(s) field data may be required (if sensitive species are present and the initial studies indicate that significant impacts are likely to occur).

A range of survey techniques is being used to provide the required baseline data. **Boat transect** surveys were carried out to provide the main year-round dataset on the distribution and abundance of seabirds in the potential wind farm area and its surrounds (covering a total area of 159km^2). **Fixed point** surveys from a boat were used to obtain further data on bird flight movements through the potential wind farm area and on bird behaviour. Thirdly, **aerial surveys** have been undertaken to verify the distribution and abundance of seabirds in the study area, and to ensure that the boat surveys had not missed any important bird populations, and to obtain data from a wider area to enable the results from the main study area to be put into context (covering a total area of 1,226km^2).

Methods

Boat Transect Surveys

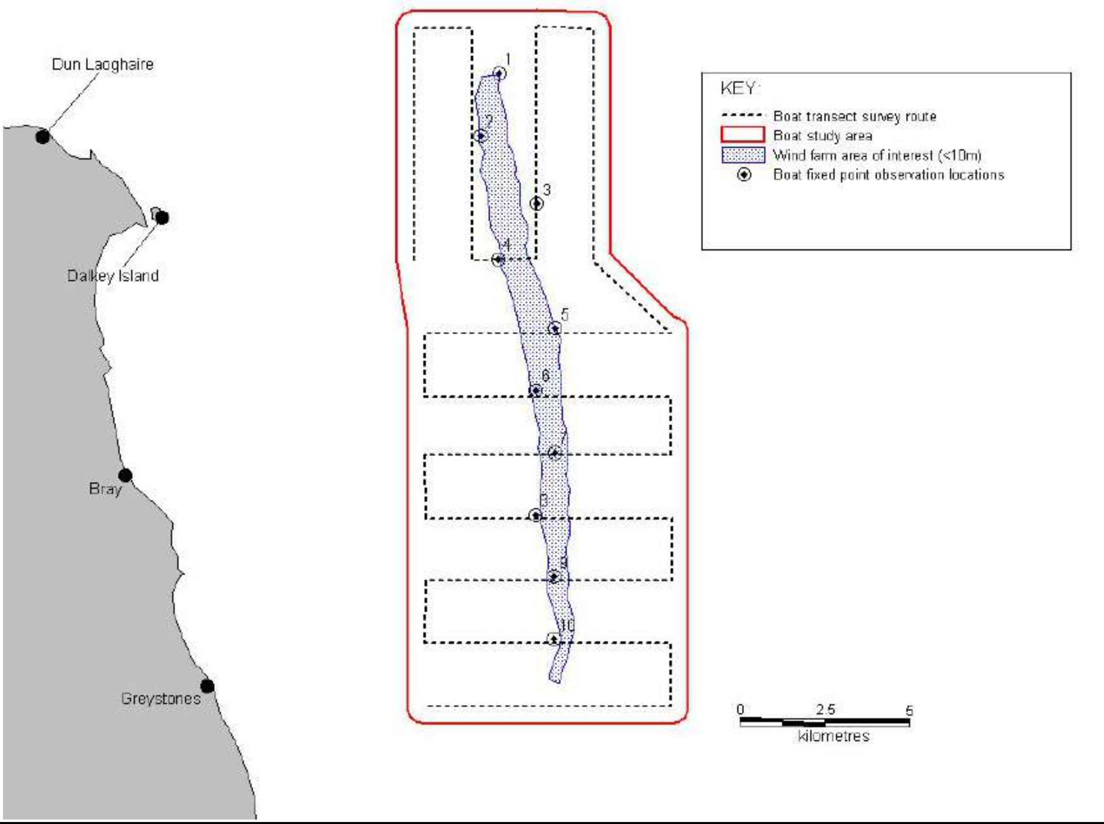
The methods employed for the boat transect surveys followed the standard Seabirds at Sea methodology (Komdeur *et al.*, 1992). The scan method with band transect using the snapshot technique is being used, though recording is being done continuously (rather than in 10-minute blocks), recording the precise time of each observation, which can then be linked to the GPS data to give a more precise location of each bird/flock encountered. This improves the spatial resolution of the data collected, making analysis of the factors affecting the birds' distribution more precise.

The survey methods for both the boat transect and the aerial transect surveys are based on distance sampling protocols (Buckland *et al.*, 2001). These allow differences in bird detectability at different distances and in different observation conditions to be taken into account (see aerial survey section below for full details).

Boat transect survey area

The boat transect study area was chosen to include all the area in which wind turbines might be located (i.e. the potential wind farm site), the area around these in which birds might possibly be affected by the development (taken conservatively as 2km; the greatest distance at which existing wind farms have been shown to affect birds is only 5-800m (Percival, 2000)). In addition, a further zone around this (up to 4km from the possible turbine locations) was also included to enable the context of the wind farm site to be better determined. The extent of these areas is shown in Figure 1.

Figure 1. Main boat study area, showing the transect route and the fixed point observation locations.



Transect positioning

A survey route has been designed to provide approximately a 2km interval between transects (see Figure 1). From a statistical analysis perspective the ideal would have been for all of these to have run perpendicular to the Bank. However, the north end of the Kish Bank was too shallow to allow this, so the transects in this part of the study area were run parallel to the Bank. The same route is being used for each of the surveys. The 2km-separation gave the best compromise to give as high a resolution as possible but avoiding double-counting as result of birds being disturbed from one transect to another. The total length of boat survey transect was 98km.

Boat specifications

The vessel used for the boat surveys was the 'MV Beluga', a 14m-length boat capable of cruising at 18 knots. A viewing platform was constructed on wheel house roof to give a viewing height of 5m.

Navigation

A global positioning system (GPS) record of the precise route is being taken at 30-second intervals, so that the location at all times is known. A handheld GPS is being used for this purpose, in conjunction with a ship-board GPS as back-up. The precise location of each bird record is being noted.

Recording protocol

The observation team included two surveyors and a recorder. This enabled a wide transect width (1km) to be covered, with one observer covering each side of the boat, and data to be collected on any sea mammals encountered. All surveyors are experienced ornithologists able to identify all the species encountered accurately, and recommended by BirdWatch Ireland. Observations were recorded onto standard paper data recording sheets.

As well as, bird species, number of individuals present, flight height, behaviour, distance from the ship, in transect or not in transect, plumage, age, sex, moult, flight direction, notes on whether the bird is oiled and associations between or within species, the ship's position will be recorded, speed and course, and presence of other vessels. The location of each bird was determined by recording the observer position and the distance and direction from the ship. These were allocated to one of three distance bands on each side of the boat: A = <100m, B = 1-200m and C = 2-500m.

Hydrographic and biological data will be incorporated into analyses from the other surveys being carried out for the ES.

Data transcription and validation

The data from the record sheets were input onto computer and then checked for data entry errors back to the original records.

Dates of Surveys

It was planned at the outset of the project to carry out surveys at least monthly for a full year, with additional surveys in April-May and August-September, to give a total of 16 surveys. However, weather conditions prevented surveys being taken during October, January and February. A total of 14 boat transect surveys were undertaken between September 2001 and September 2002, on the following dates: 13 September, 2 November, 11 December, 26 March, 8 April, 2 June, 10 July, 5 August, 6 August, 20 August, 28 August, 2 September, 17 September and 24 September.

Data analysis and presentation

The first step in the analysis was to determine the distance correction factors. For each species the total numbers in each transect band were summed. The distance method works on the basis that the detection rate in the closest band is 100% (i.e. all birds were seen in that band) (Buckland *et al.*, 2001). The correction factor for each species was then calculated as the value required to convert the bird density in the other bands to the same as that for the closest band, taking into account the width of each band. The correction factors were applied to each raw data record, to give the distance-adjusted count. These data were used to calculate the overall bird density, and hence to estimate the populations in the whole study area (multiplying the bird density by the total area).

This was repeated for the proposed wind farm area, but using the correction factors for the whole study area (to provide a larger sample), to estimate the bird density and total numbers.

Boat Fixed Point Surveys

These were made in order to obtain more detailed information on one of the site's main bird interests (terns) and on general rates of seabird movement through the proposed wind farm site. Observations are being made from a series of 10 fixed points within the potential wind farm site (see Figure 1), and bird flight movements through the potential wind farm area were recorded. The survey vessel (the same one as used for the boat transect surveys) was anchored at each of ten points for a 30-minute period during each survey, and all birds seen recorded together with their flight height, direction and behaviour. This sampling methodology follows that developed in the USA specifically for the purpose of assessing the potential impacts of wind farms (Anderson *et al.*, 1999; Morrison, 1998).

A total of 7 boat fixed point surveys were undertaken between September 2001 and May 2002, on the following dates: 3 November, 25 March, 23 April, 5 May, 16 August, 3 September and 16 September.

Aerial Surveys

The methods employed for the aerial surveys followed those developed by NERI in Denmark in recent years, which were designed specifically around the requirement to provide accurate spatial data for seaducks and associated species, but particularly scoter (Kahlert *et al.*, 2000).

As for the boat transect surveys, the survey methods are based on distance sampling protocols. Because the ability to detect a bird decreases with increasing distance from the observer, any counts constitute only a proportion of the total number of birds present in the survey area. If, however, the distance of the bird from the transect is recorded, a correction factor (which may differ according to species, flock size, weather conditions and observer) can be calculated and applied to the data.

The use of a GPS enables the spatial arrangement of individual birds or flocks of birds to be determined with a high degree of precision. Combined with a survey design that ensures appropriate sampling of the area, a number of additional benefits arise from this technique: statistically rigorous methods can used to generate distribution patterns and density estimates with confidence intervals; when linked with other appropriate data sources, the data will enable more precise analysis of the factors affecting local distribution and abundance; and given appropriate replication of the survey, spatial and temporal patterns in abundance and distribution can be defined.

Aerial survey area

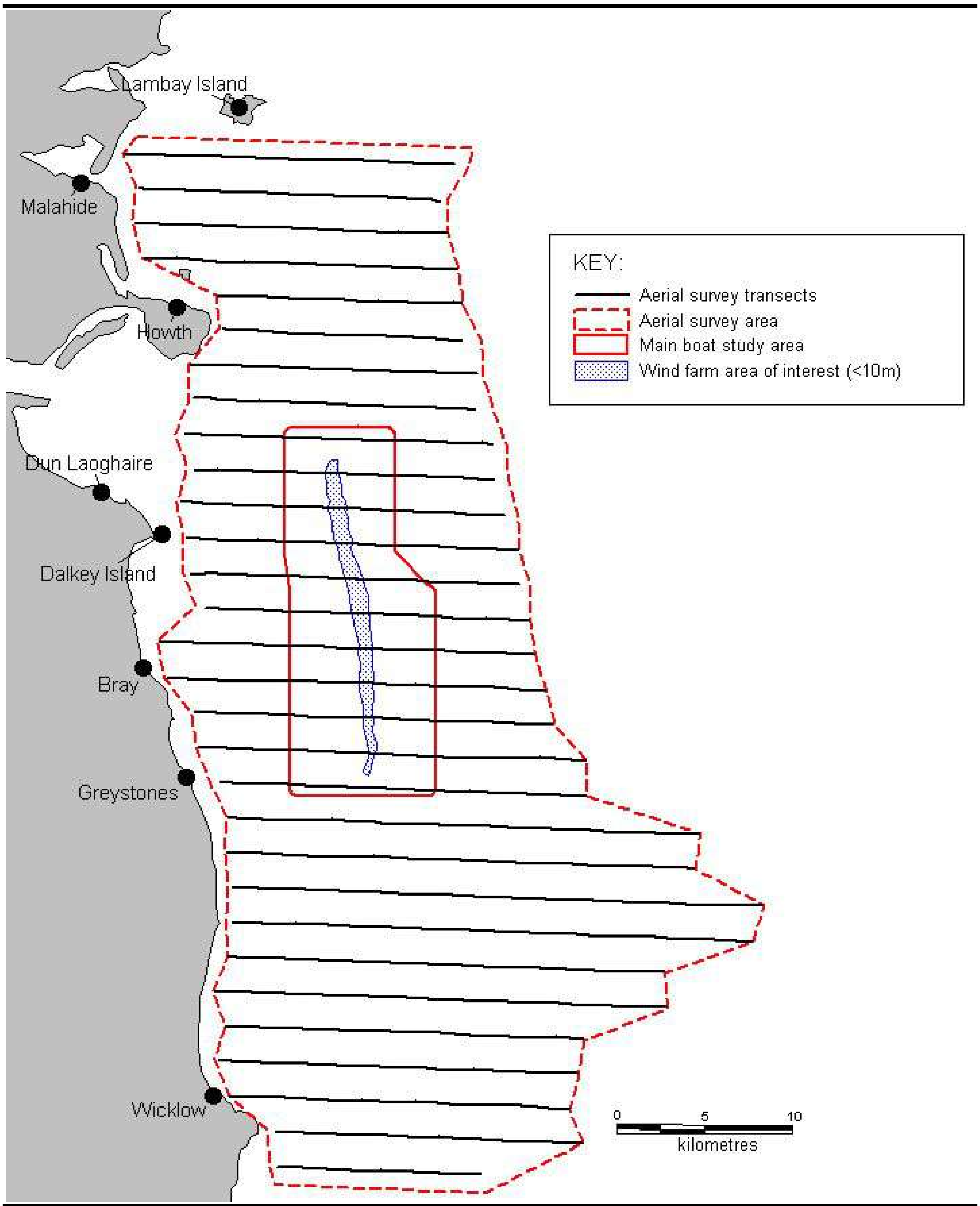
The aerial survey area was chosen to include all of the boat survey area, plus a further area around this to provide additional information on the regional distribution of seabirds. The extent of the survey area is shown in Figure 2.

Transect positioning

The sampling design comprised a grid of systematically spaced line transects, randomly placed within the study area. The most statistically efficient study design is a set of line transects running perpendicular to major environmental axes. In this study therefore transects were selected running perpendicular to the shore.

To provide as high resolution as possible, but to avoid double-counting as a result of birds disturbed by the aircraft moving into the search area for adjacent transects (aerial survey in Denmark has suggested that scoter rarely fly more than 1km when disturbed), transects were flown at 2km separation.

Figure 2. Aerial survey area, showing the transect route and the main Kish Bank study area.



Aircraft, survey height and speed

A high-winged, twin-engined plane is essential to conform to legal requirements and provide optimal viewing. A Partenavia PN68 was used. Following test flights in the Kattegat, Denmark, in August 1999 using this type of plane, flight altitude during surveys was standardised at 78m (250 feet) at a cruising speed approximately 185 km (100 knots, Kahlert *et al.* 2000). This enables rapid approach to birds sitting on the sea, causing minimal disturbance. Identification of most species on the sea surface can be made from this height. The flight speed is sufficiently low to allow a reasonable time to identify and count birds, but sufficiently fast for those species prone to disturbance by the plane such that the point at which any displaced birds are first detected will not be greatly different from the location from which they were displaced.

Navigation

A navigator sat alongside the pilot and guides the pilot along the intended transect route and advises the observers of the points at which to begin and stop counting along each transect (it is not possible to count during turns between transects due to the angle of tilt of the plane).

Navigation was achieved using a Garmin 12XL or 195 GPS. The navigator advised the pilot of any notable deviation from the transect route (the plane can normally be kept within 50m of the intended route unless, for example, ships or oil rigs dictate temporary detours) and ensured the pilot kept to the intended survey altitude. The precise location was downloaded from the GPS onto a laptop computer every 5 seconds as an accurate record of the precise flight path taken.

On a small number of occasions satellite coverage by the handheld GPS was lost preventing an accurate positional fix. The backup system employed was to navigate between the end points of the transects using the plane's onboard GPS (which was always functional, although it operated using latitude/longitude co-ordinates and data were not downloadable). The navigator identified, using the GPS, the point at which the start and end points of the transect were crossed and these times were recorded by the observers. Thus, the flight path could still be interpolated but with a lesser degree of accuracy than provided by 5 second intervals.

Recording protocol

Two observers were used, each covering one side of the aircraft. All observations were recorded onto a dictaphone. The general objective was to obtain as accurate position for all birds encountered as possible under the circumstances. The position of each record was determined in two ways:

Firstly, the perpendicular distance of the bird or group of birds from the line of the transect was determined. Because birds are encountered so rapidly, it is simply not possible to estimate and record the precise distance for each record. Consequently, records were assigned to distance classes for simplicity (a minimum of three distance categories are required to meet the requirements of distance sampling techniques). In studies carried out by NERI in Denmark, where very high densities of common scoter are encountered, this technique is used based on three standardised distance intervals out from the track-line taken by the aircraft: 49-174m (band A), 175-459m (band B) and 460m (band C). Observers cannot observe a band of width 49 m on either side of the flight track since this is obscured by the body of the plane. The limits of each band were determined using a clinometer which enabled the measurement of predetermined angles below the horizontal measured abeam (at 250 ft altitude, the 49m cut-off is an angle of 60° from the horizontal, 174m is 25° and 459m represents 10° declination, angles that can be confirmed with relative ease by use of the clinometer).

Secondly, the position along the transect was recorded by noting the precise time (to the nearest second) at which the bird or flock of birds is perpendicular to the observer using watches synchronised with the GPS. The time at which each observation along the transect was made can be converted into a position by interpolating the data from the GPS and placing observations into a predetermined distance from the track-line according to the band in which the bird was recorded.

For each observation, the following information is recorded:

Species: as far as possible, all waterbird species were recorded. In cases where identification to species was not possible they should be recorded to the best level of identification, e.g. auk species, cormorant species, gull species. All cetaceans and seals were also recorded. In addition, all human activities, both mobile and static, were also recorded, e.g. boats, gas platforms, gill net markers. Species on the shore close to the high water mark were omitted since these are best monitored by other methods.

Number: the count (usually estimated for larger flocks) was recorded. Where groups of birds straddle two or more transect bands, the number in each was recorded separately.

Behaviour: the behaviour of individual birds has a considerable effect on the detectability of the individual. Since distance sampling makes the assumption that birds are recorded undisturbed at the point at which they are first detected, it is important that if the need arises, it is possible to carry out analysis on data that exclude, for example, birds flushing or flying. Consequently, four different behaviours were recognised and recorded: sitting; diving; flushing; and flying. In addition, two additional categories were used for survey in Britain and Ireland in 2001-02: sat on a buoy, and sat on a sand bank, in so far as these features are likely to affect the distribution of birds (to separate, for example, groups of feeding Cormorants from those loafing on a buoy), the latter particularly given the much greater tidal range in the Irish Sea compared with the Baltic. For marine mammals and mobile human activities, the direction of travel was recorded under behaviour.

Transect band: the distance from the plane of the bird, mammal or human activity was recorded, assigned to one of the three distance bands A, B or C (see above).

Time: time was read from the watch, attached to the window of the plane in an appropriate position to allow the observer unhindered access to read the time whenever necessary. Time was recorded to the nearest second as the observation is perpendicular to the plane. Where birds were detected either in front of or behind the plane, an allowance was made when recording the time on the dictaphone.

Additional information: where possible, the age of the bird, i.e. juvenile, immature, near adult and adult, and sex (the precise information recorded being dependent on the plumage characteristics of the individual species) was recorded, although this information was only recorded where time permitted and did not compromise the collection of priority data outlined above.

Observation conditions: sea state conditions, cloud cover and the viewing conditions were recorded at regular intervals and whenever conditions change, along with the time of the observation. Sea state conditions denoted the swell and number of whitecaps to the waves (worsening conditions are likely to affect the ability to detect birds) using a standard scoring system, cloud cover was also recorded using a standard scoring system, and viewing conditions (affected by any combination of glare, haze, rain and reflection on the water) were recorded using a subjective assessment of good, poor or bad with the transect bands affected.

Data transcription and validation

Data were transcribed from the dictaphone tapes either direct into an Excel spreadsheet or onto paper and then into the spreadsheet. The speed of dictation allowed species, number, behaviour, age and transect band to be transcribed on a first play of the tape. A second play allowed both visual validation of these data and time to be input. Data were input using alphanumeric codes (which, having meaning, reduced the likelihood of transcription error and simplify identification of errors). Date, observer initials and the observer's position in the plane were also input. Start and end times of counting, crossing of transect way points, crossing over any areas of exposed sand were input on a separate worksheet, and codified information for sea state and visibility onto another.

Data were visually inspected to ensure only valid codes have been used, and that all necessary information has been input for each observation. Times were checked by sorting the data according to time and then checking the sequence of a numerical ID field corresponding to the order in which observations were input (any anomalies in the ID field sequence, which corresponded to an incorrect time entry, were readily identified). Data were converted to numeric codes using look-up tables, thereby also providing a further means of validation that all data match valid codes.

Assigning locations to observations

The NERI system uses a combination of GIS and TurboPascal software to add a position to each record of observation data. Using the observation file and the track file, every record in the observation file can have a position calculated, with time as the link field. Records were distributed to either side of the track line, according to the observer and the transect band in question.

Position accuracy of observations

Using the methods defined above, the NERI experience has been that the majority of observations can be considered to be accurate to within 4 seconds. That is to say, an observation and all the spoken information relating to the visual encounter generally coincide to within that time period. In situations where high densities of birds have been encountered, multiple observations may have necessitated amalgamation, such that discrete observations were all recorded with a common time reference. Such grouping of observations (by virtue of extremely high bird densities) very rarely extended over a period of more than 10 seconds. Hence, overall, it should be anticipated that the positional accuracy along the axis of the transect should, in most cases, fall within less than 206 m (4 seconds travelling at a speed of 51.4m s^{-1}) of the true position, but in the case of grouped observations, this could extend to 515m accuracy. As noted above, however, such amalgamation of data was very rarely required.

Dates of Surveys

Two aerial surveys were undertaken, one on 15 March 2002 and the other on 9 April 2002. The same route was flown on both surveys, covering a transect distance of 598km (of which 93km was within the main boat survey study area).

Data analysis and presentation

As for the boat transect surveys, the first step in the analysis was to determine the distance correction factors. These were calculated in the same way as for the boat transect surveys (see above). The correction factors were applied to each raw data record, to give the distance-adjusted count. These data were used to calculate the overall bird density, and hence to estimate the populations in the whole study area (multiplying the bird density by the total area).

This was repeated for the proposed wind farm area, but using the correction factors for the whole study area (to provide a larger sample), to estimate the bird density and total numbers.

Assessment of conservation importance

An evaluation of the bird populations recorded during the September 2001 – September 2002 surveys was carried out. The principal method used to evaluate the conservation importance of the bird populations in the wind farm area and its surrounds was the standard 1% criterion (Ramsar Convention Bureau 1998). The population was considered to be internationally important if it exceeded 1% of the whole biogeographic population, nationally important if it exceeded 1% of the Irish population. Threshold levels were taken from Musgrove *et al.* (2001), Colhoun, (2000) and Gibbons *et al.* (1993).

Further categories of Regional and Local importance were used for species that did not reach national importance. The first of these was defined as more than 1% of the regional resource, whilst the latter included all species on the red or amber lists of the BirdWatch Ireland's 'Birds of Conservation Concern' (Newton *et al.*, 1999) that did not reach at least regional importance in the study area. As a comprehensive data set has been gathered, the mean counts have been used as the main basis for this evaluation (as the counts most representative of the overall use that the birds made of the site), though the peak counts have also been taken into account in this process.

Results

Bird Numbers

Boat transect surveys

The estimated bird numbers within the main Kish Bank boat survey area derived from each of the boat transect surveys are given in Table 1. These numbers have been adjusted to take into account the declining detectability of each species at increasing range, and have been scaled up from the sample area to the whole study area. Generally, bird numbers were lower through the winter months but were high from the spring through to the autumn. From at least the end of March through to the end of September the study area held particularly notable numbers of Manx shearwaters, kittiwakes, terns (mainly roseate and common), guillemots and razorbills. For the divers, terns and auks that were not identified to species, the numbers of each species were estimated from the proportions that were specifically identified during each visit.

Table 1. Estimated bird numbers in the Kish Bank main boat study area for each transect survey and peak numbers during September 2001 – September 2002.

Species	13/09/01	02/11/01	11/12/01	26/03/02	08/04/02	02/06/02	10/07/02	05/08/02	06/08/02	20/08/02	28/8/02	2/9/02	17/9/02	24/9/02	Peak population estimate
Red-throated Diver	0	1	0	2	2	0	0	0	0	0	0	0	0	0	*2*
Great Northern Diver	0	3	0	0	0	*0*	0	0	0	0	0	0	0	2	*3*
Fulmar	2	0	7	6	11	*16*	5	42	26	11	15	23	9	0	*42*
Manx Shearwater	0	0	0	1592	885	616	1384	677	3764	199	11	517	119	0	*3764*
Balearic Shearwater	0	0	0	0	0	*0*	0	0	0	0	0	2	0	0	*2*
Great Shearwater	0	0	0	0	0	*0*	0	0	0	0	0	2	0	0	*2*
Sooty Shearwater	0	0	0	0	0	0	0	0	0	0	0	3	0	0	*3*
Gannet	19	0	0	15	107	*21*	37	3	25	2	3	65	74	36	*107*
Cormorant	5	8	2	5	16	*26*	10	44	65	29	19	8	3	81	*81*
Shag	28	28	87	113	159	16	117	105	84	134	139	49	293	149	*293*
Common Scoter	0	0	0	0	0	*0*	0	0	0	0	0	31	0	0	*31*
Arctic Skua	0	0	0	0	0	*0*	0	0	3	3	5	19	2	0	*19*
Long-tailed Skua	0	0	0	0	0	0	0	0	0	0	0	2	0	0	*2*
Great Skua	0	0	0	0	0	*3*	0	2	3	0	0	0	2	0	*3*
Little Gull	0	0	5	0	0	0	0	0	0	0	0	0	0	0	*5*
Black-headed Gull	0	2	8	0	0	*0*	0	0	0	0	0	2	2	0	*8*
Common Gull	2	15	39	0	3	*0*	0	0	0	0	0	0	0	0	*39*
Herring Gull	0	3	30	16	26	*0*	0	5	6	6	0	39	2	113	*113*
Lesser Black-backed Gull	0	*2*	*0*	*5*	*2*	*0*	*0*	*0*	*2*	*0*	*2*	*5*	*0*	*0*	*5*
Great Black-backed Gull	17	13	48	21	73	*5*	3	29	14	41	15	171	8	20	*171*
Kittiwake	189	144	149	266	1052	*117*	479	530	175	221	212	4382	259	49	*4382*
Sabine's Gull	0	0	0	0	0	0	0	0	0	0	0	2	0	0	*2*
Arctic tern	0	0	0	0	0	2	26	120	109	26	22	0	144	56	*144*
Common tern	6	0	0	0	0	48	172	210	229	583	348	487	156	61	*583*
Roseate tern	0	0	0	0	0	4	0	0	16	282	41	250	12	5	*282*
Black Tern	0	0	0	0	0	*0*	0	0	0	0	0	2	0	0	*2*
Guillemot	217	209	579	5645	14218	328	714	7340	3041	5069	432	3190	7843	2801	*14218*
Razorbill	66	121	221	271	581	51	37	100	170	136	74	1506	3110	434	*3110*
Black Guillemot	8	15		2	11	*0*	2	0	8	0	0	0	0	0	*15*
Puffin	0	0	0	0	3	5	0	0	3	0	2	0	2	0	*5*

Aerial surveys

The bird populations (using data taking coverage and distance from transect into account) recorded in the whole aerial survey area and from the main Kish Bank study area during each of the two aerial surveys are shown in Table 2. Birds for which full specific identification was not possible have been included to the species group.

Table 2. Estimated bird numbers in the main Kish Bank study area and whole survey area during each of the two aerial surveys.

Species	March 15th 2002		April 9th 2002:	
	Main Kish study area	*Whole aerial survey area*	*Main Kish study area*	*Whole aerial survey area*
Diver sp	5	30	0	21
Great crested grebe	0	0	0	8
Fulmar	51	536	6	183
Manx shearwater	0	123	0	810
Gannet	17	351	34	209
Cormorant	3	70	0	29
Shag	90	230	62	482
Common scoter	0	208	0	3
Red-breasted merganser	0	8	0	0
Kittiwake	370	1,250	615	2,041
Other gull sp	37	308	468	1,332
Tern sp	0	0	0	3
Auk sp	2,810	6,008	407	1,333

Boat fixed point surveys

The rates of bird movements across the Kish Bank determined from the boat fixed point surveys is summarised in Table 3. The data have been presented as the mean number of flight movements per hour for each visit, adjusted to take into account declining detectability at increasing range. Flight activity generally reflected the abundance of each species, with Manx shearwaters, cormorants and shags, kittiwakes, terns (mainly roseate and common) and auks (mostly guillemots and razorbills) the most frequently observed species.

Table 3. Mean number of bird flight movements per hour observed during each fixed point survey. Blank cells indicate species not recorded on that date.

Species	03/11/01	25/03/02	23/04/02	03/05/02	16/08/02	03/09/02	16/09/02
Great Northern Diver	0.2						
Unidentified diver sp	0.2	0.2					
Fulmar		1.4	0.8	0.4	2.4	1.4	2.4
Manx Shearwater		9.0	30.4	19.6	3.0	24.6	1.2
Gannet	0.8	1.8	2.6	0.2	1.6	2	4.6
Cormorant	1.2	0.6	1.4	1.2	1.6	1.2	0.4
Shag	3.4	0.4	1.8	1.6	3.4	1.8	1.2
Whimbrel				0.2			
Arctic Skua					0.2	0.4	
Black-headed Gull	4.0		0.4	0.2		0.6	

Common Gull	1.8	0.2		0.2		0.2	
Herring Gull	3.8	2.0	0.2		0.2	0.2	0.8
Lesser Black-backed Gull		0.2					
Great Black-backed Gull	1.4	1.6	1.2	0.2	1	1.2	1.4
Kittiwake	14.2	6.2	8.0	8.4	4.6	39.6	5.0
Arctic Tern			0.4	1.8	5.6		
Common Tern			0.8	0.4	16.2	19.8	0.6
Roseate Tern					11.0	4.6	
Black Tern						0.4	
Unidentified tern sp			0.4		24.6	6	0.4
Guillemot	3.6	8.6	6.2	10.6			
Razorbill	4.6	2.8	1.0				
Black Guillemot	0.4						
Puffin			0.4			0.2	
Unidentified auk sp	4.2		0.8	0.4			

Summary of Bird Populations Sep 2001 – September 2002.

An assessment of the conservation importance of each species within the main study area during the September 2001-September 2002 period is summarised in Table 4. One species (roseate tern) exceeded the threshold for international importance. Six species (Manx shearwater, shag, kittiwake, common tern, guillemot and razorbill) exceeded the threshold for national importance, and a further three (gannet, cormorant and arctic skua) occurred in regionally important numbers. Ten additional species were classed as locally important (see Table 4).

Table 4. Assessment of the conservation importance of each species within the main study area during the September 2001-September 2002

Species	Peak count	Conservation importance
Red-throated Diver	*2*	Local
Great Northern Diver	*3*	
Fulmar	*42*	
Manx Shearwater	*3764*	National
Balearic Shearwater	*2*	
Sooty Shearwater	*3*	Local
Great Shearwater	*2*	Local
Gannet	*107*	Regional
Cormorant	*81*	Regional
Shag	*293*	National
Common Scoter	*31*	Local
Arctic Skua	*19*	Regional
Long-tailed Skua	*2*	
Great Skua	*3*	
Little Gull	*5*	Local
Black-headed Gull	*8*	Local
Sabine's Gull	*1*	
Common Gull	*39*	Local
Lesser Black-backed Gull	*5*	
Herring Gull	*113*	
Great Black-backed Gull	*171*	
Kittiwake	*4382*	National
Common Tern	*583*	National

Arctic Tern	*64*	Local
Roseate Tern	*282*	International
Black Tern	*2*	
Guillemot	*14218*	National
Razorbill	*3110*	National
Black Guillemot	*15*	Local
Puffin	*5*	Local

Bird Distribution

The data on the bird distributions recorded during the boat transect surveys have been summarised in two ways for all of the key species (all species occurring in internationally, nationally or regionally important numbers, with sufficient records for this to be meaningful, and any other abundant species – taken as peak count >100). The data adjusted for distance corrections have been plotted (red dots), showing the locations of the birds recorded along each of the boat transect lines. In addition the bird records from the fixed point surveys have also been included (green dots). Secondly the distance-corrected data have been used to determine the bird densities in each 2x2km grid square within the study area. For both of these the data from the boat transect surveys have been pooled (with the plotted densities reflecting the average bird density for each grid square). Finally the over-flying rates for each species at each of the 10 fixed observation points have been mapped for each key species.

Manx Shearwater

The distribution of Manx shearwater sightings within the main Kish Bank study area, determined from the boat surveys during September 2001 – September 2002, is shown in Figure 3. This species was abundant over most of the study area but particularly around the northern and middle part of the Kish Bank and in the deeper waters in the eastern part of the study area. This distribution is further shown in Figure 4, where the Manx shearwater densities for each 2x2km square within the study area have been mapped. The observed flight rates (Figure 5) were also highest over the northern part of the bank, but occurred all along its length. Thus overall this species was widely distributed through the study area, particularly over the Kish Bank itself and in the waters to the east, with only the southern tip of the bank less-heavily used.

Figure 3. Distribution of Manx Shearwater sightings within the main Kish Bank study area during the Sept 2001 -Sept 2002 boat surveys (transect and fixed point data).

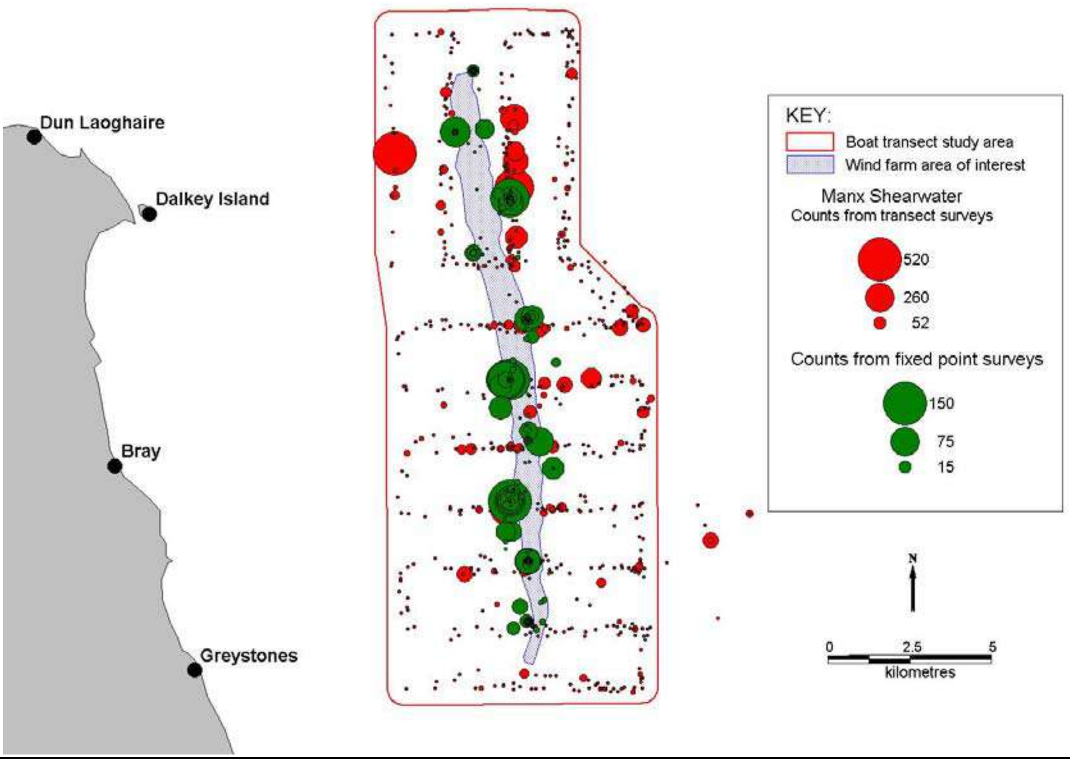


Figure 4. Manx shearwater densities within the main Kish Bank study area during the Sept 2001 -Sept 2002 boat surveys.

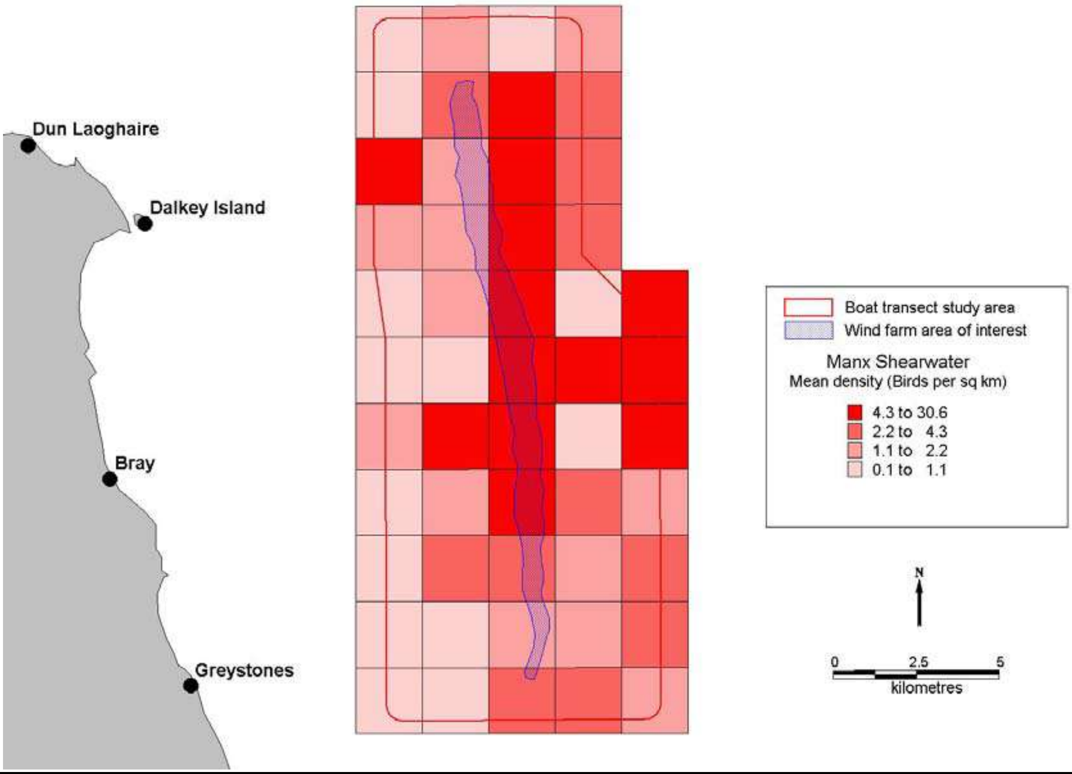
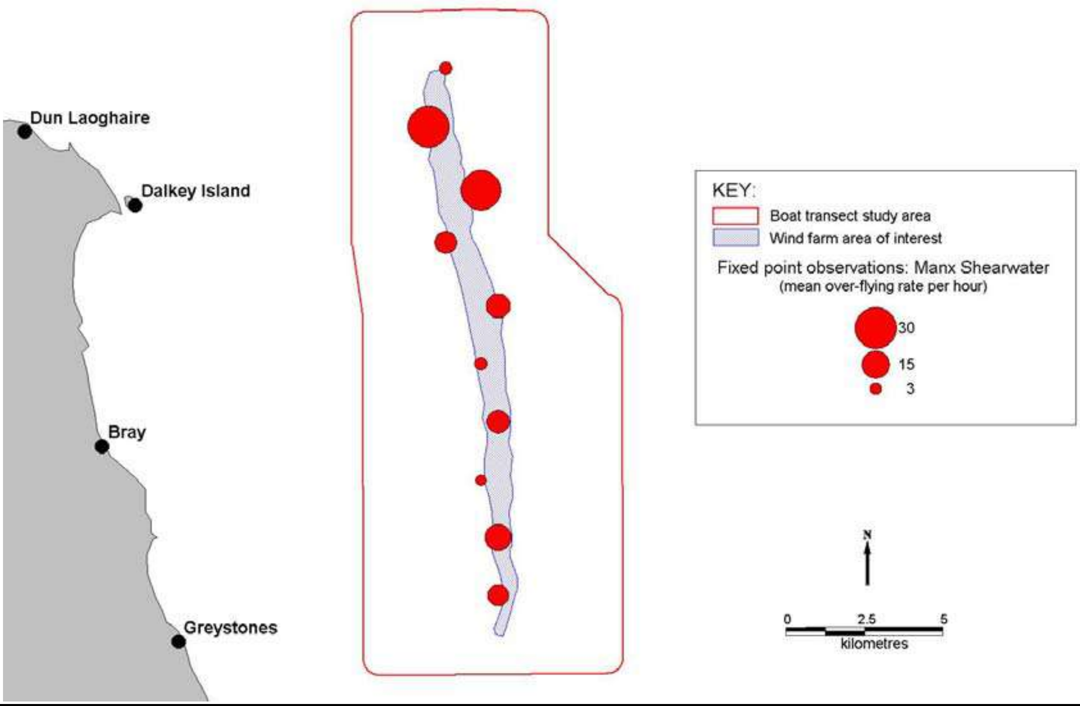


Figure 5. Manx shearwater flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Gannet

The distribution of gannet sightings is shown in Figure 6, and the gannet density in each 2x2km square in Figure 7. This species was widely scattered through the study area, with no particular concentrations. The observed flight rates (Figure 8) were also quite uniform along the length of the Bank. Thus overall this species was widely distributed through the study area, but at quite low density.

Figure 6. Distribution of gannet sightings within the main Kish Bank study area during the Sept 2001 -Sept 2002 boat surveys (transect and fixed point data).

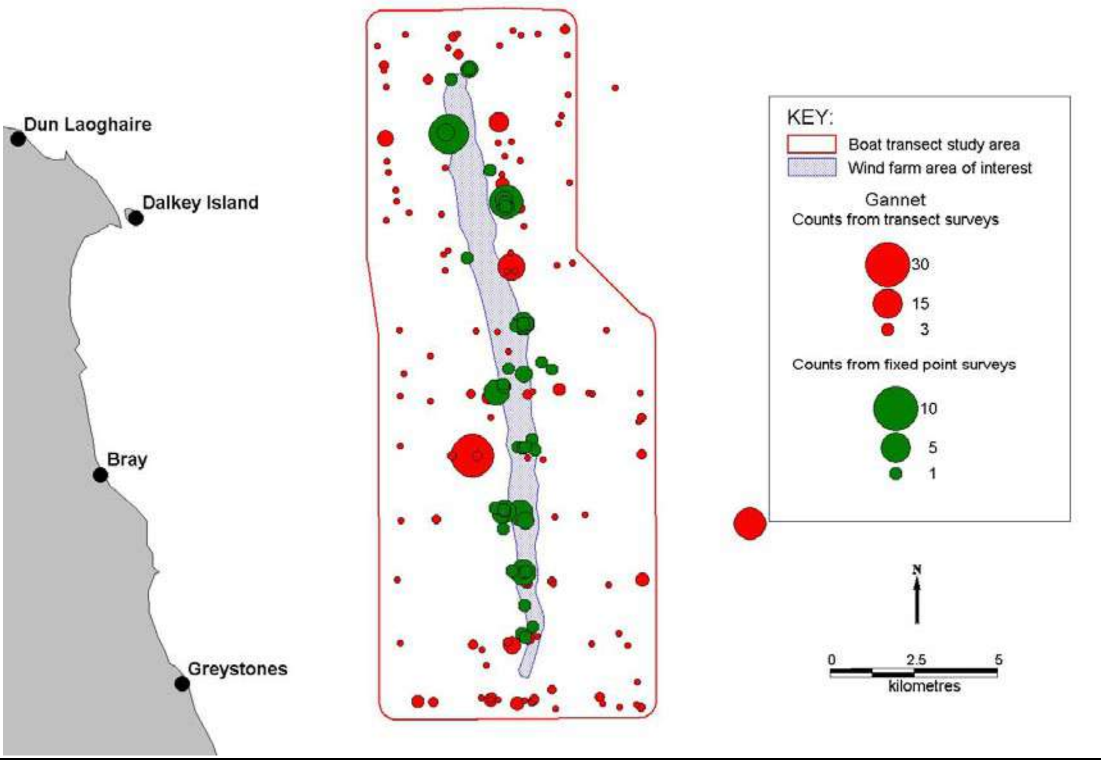


Figure 7. Gannet densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

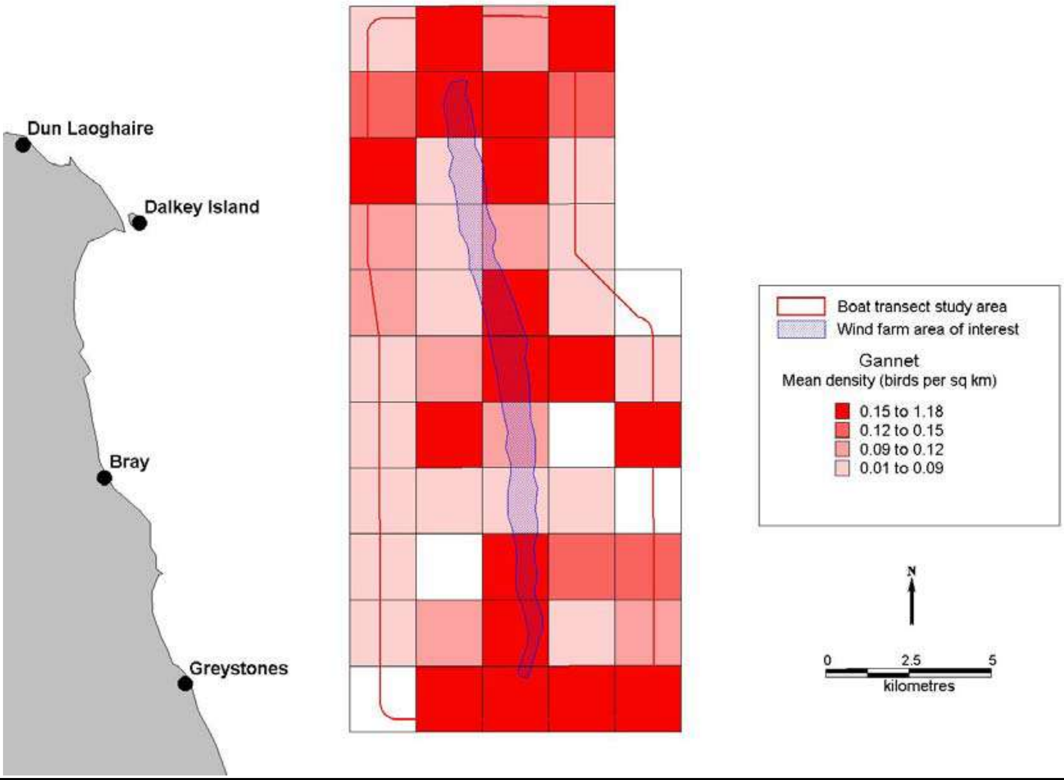
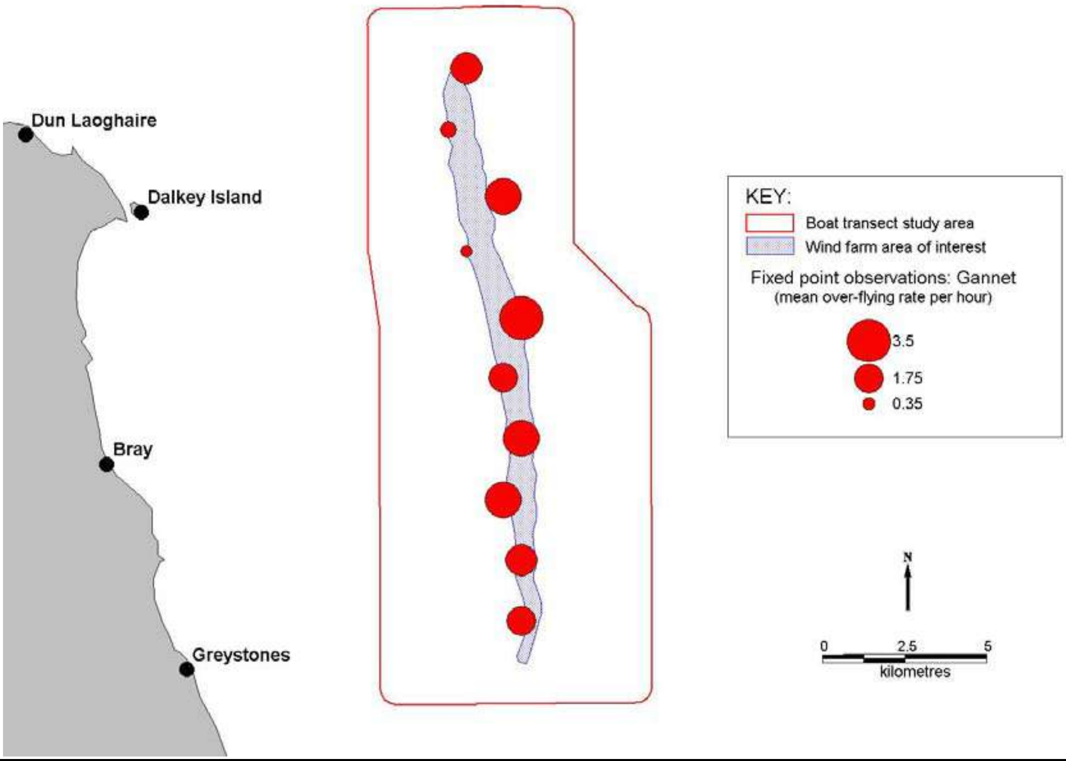


Figure 8. Gannet flight rates observed from the Kish Bank fixed points, Sept 2001 - Sept 2002.



Cormorant

The distribution of cormorant sightings is shown in Figure 9, and the cormorant density in each 2x2km square in Figure 10. This species had quite a scattered distribution within the study area, but was most numerous at the north end of the Kish Bank (particularly around the Kish lighthouse, which it used as a roost site). The observed flight rates (Figure 11) were quite uniform along the length of the Bank.

Figure 9. Distribution of cormorant sightings within the main Kish Bank study area during the Sept 2001 -Sept 2002 boat surveys.

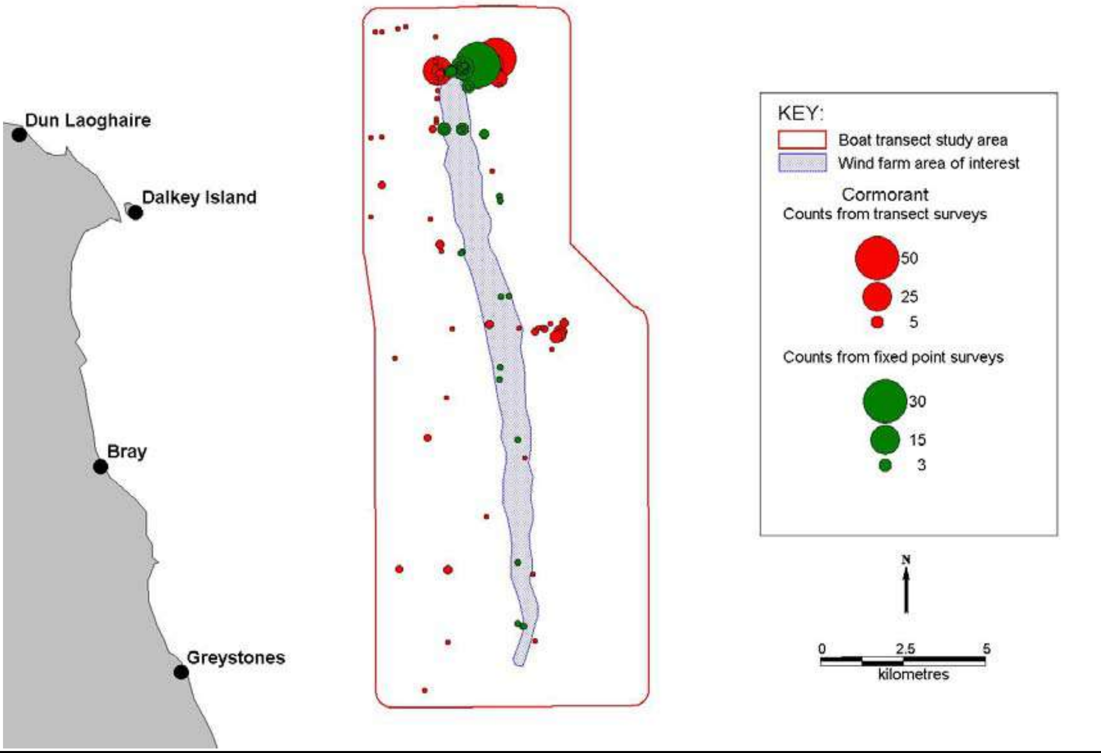


Figure 10. Cormorant densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

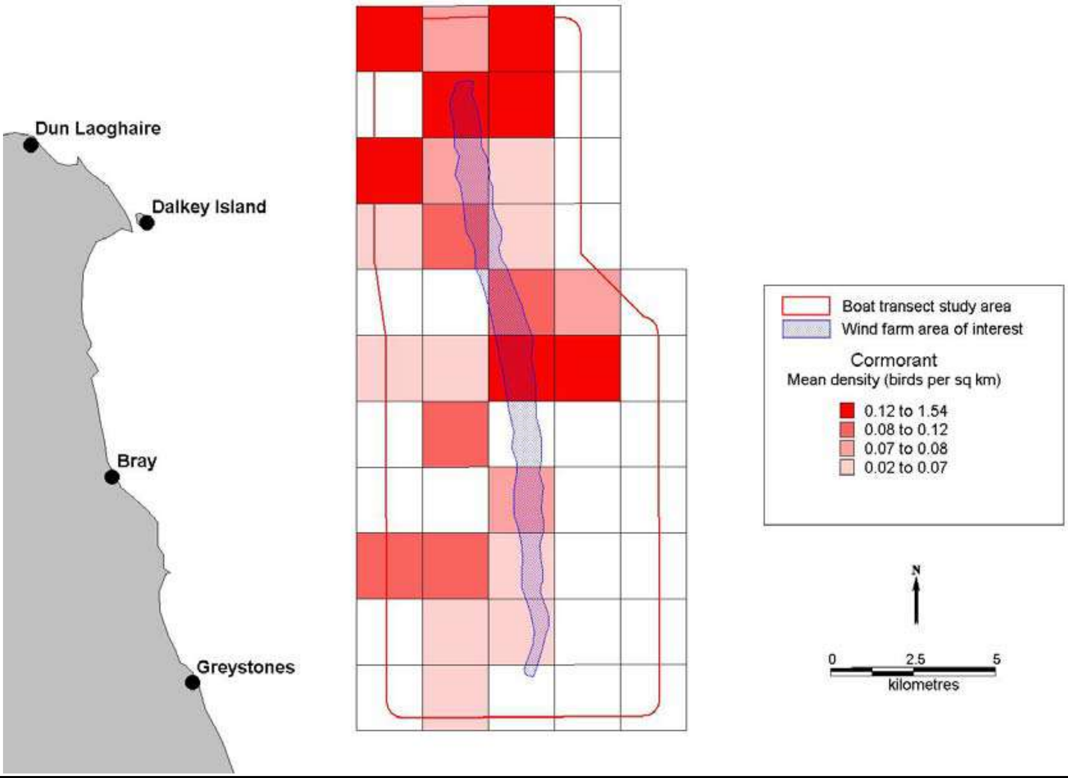
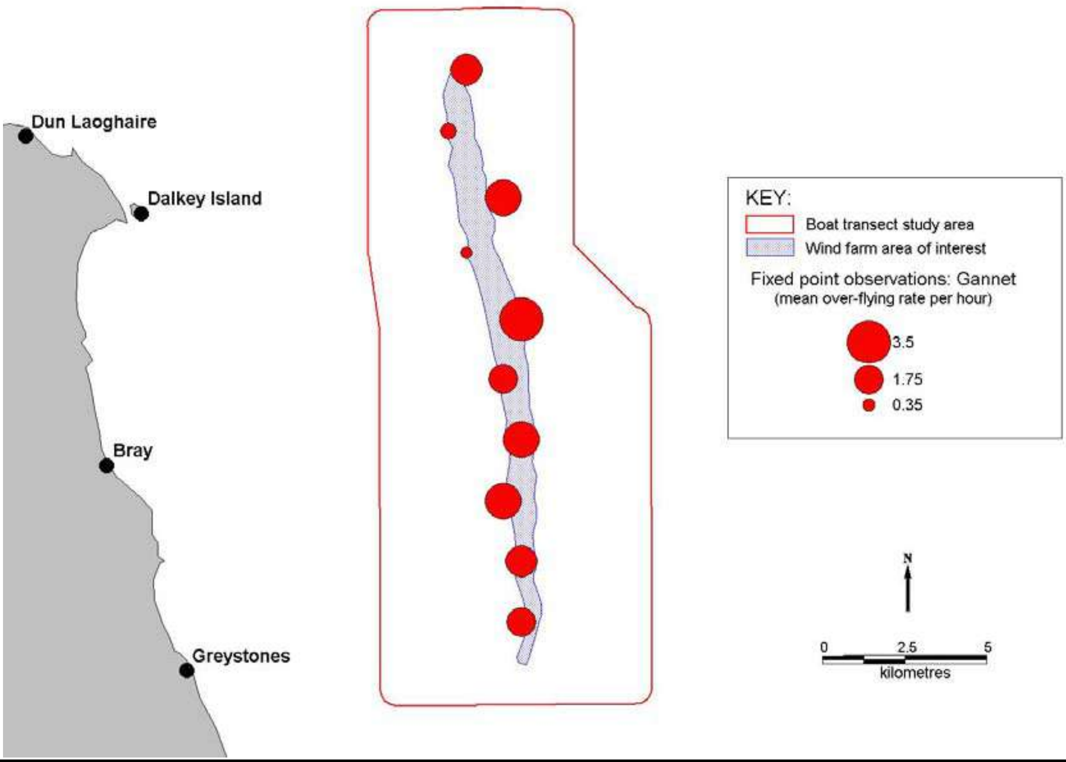


Figure 11. Cormorant flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Shag

The distribution of shag sightings is shown in Figure 12, and the shag density in each 2x2km square in Figure 13. This species was concentrated along the shallower waters of the Kish Bank. Like the cormorant, it was particularly concentrated at the north end around the Kish lighthouse. The observed flight rates (Figure 14) were also highest at the north end of the Bank.

Figure 12. Distribution of shag sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

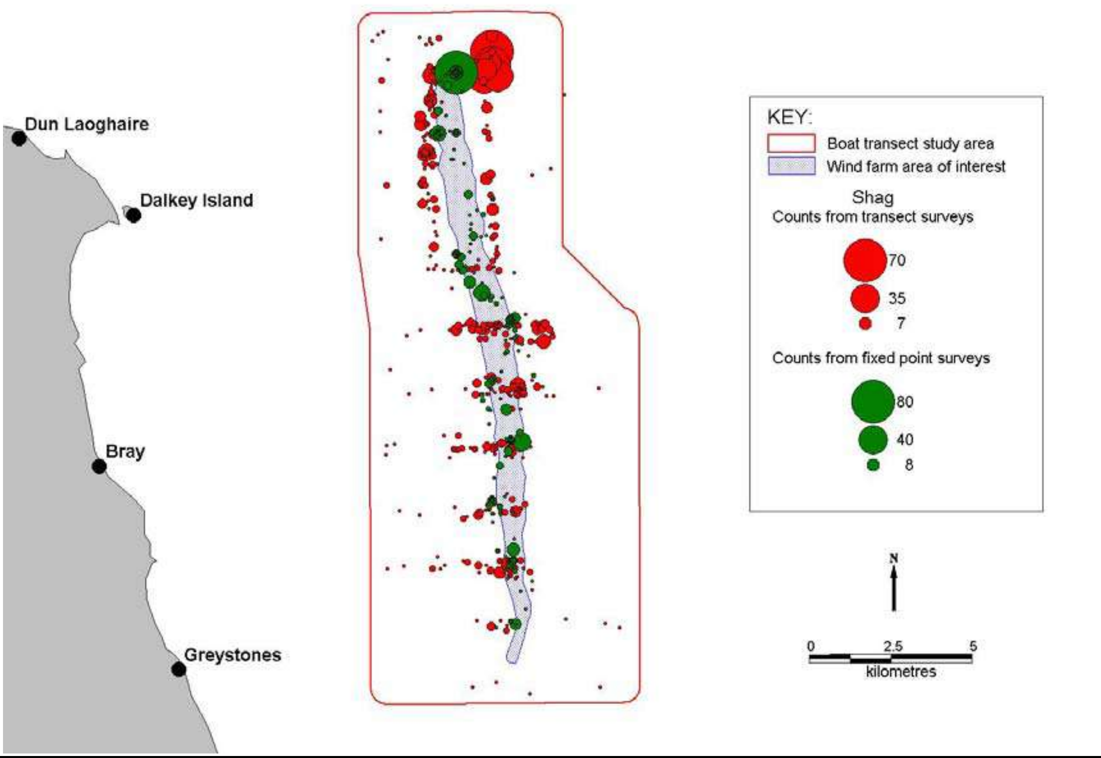


Figure 13. Shag densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

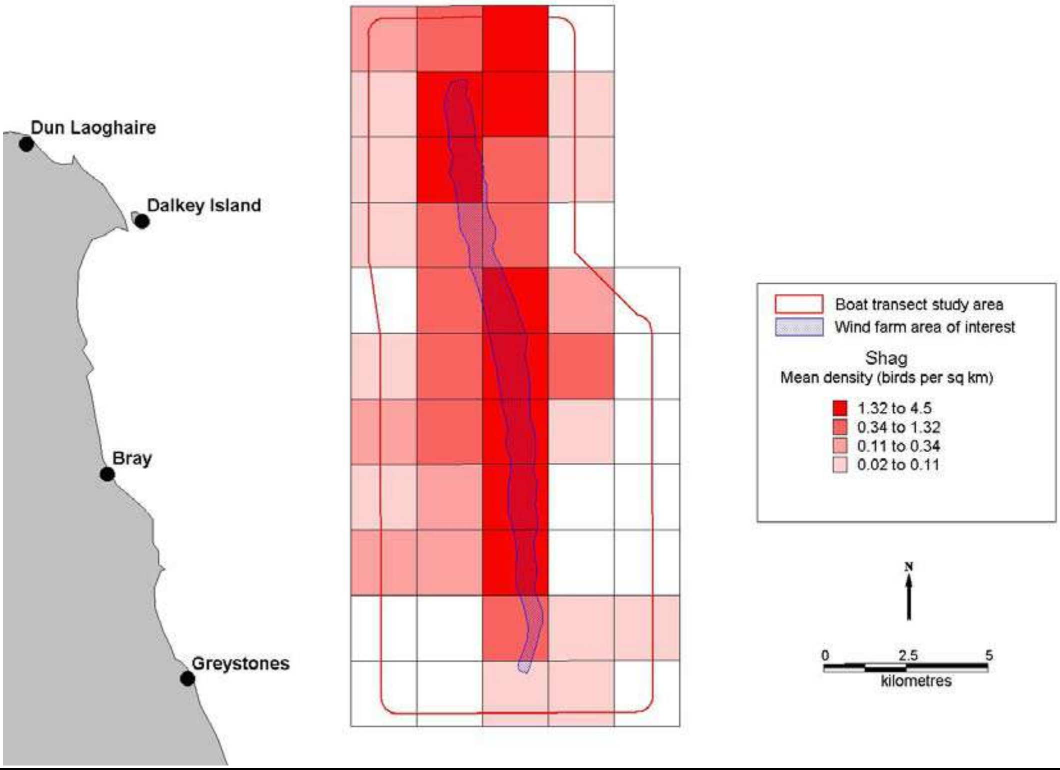
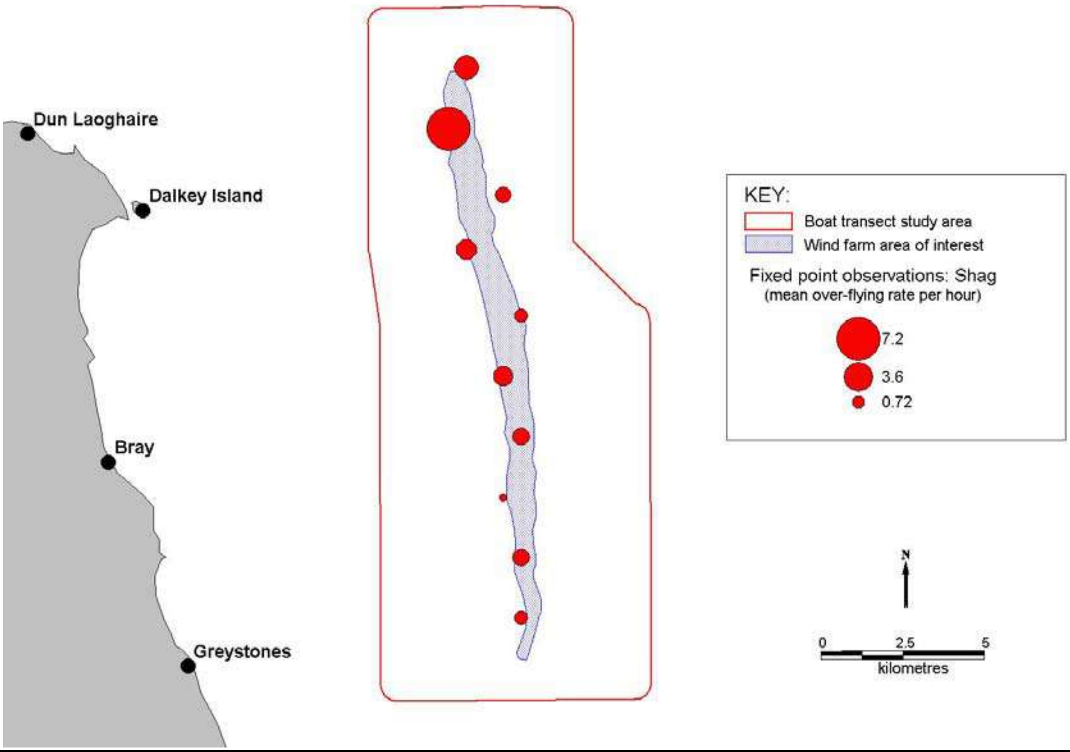


Figure 14. Shag flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Herring Gull

The distribution of Herring gull sightings is shown in Figure 15, and the Herring gull density in each 2x2km square in Figure 16. This species was found throughout the study area, but with greatest numbers at the north end of the Kish Bank. The observed flight rates (Figure 17) were also highest at the north end of the Bank.

Figure 15. Distribution of herring gull sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

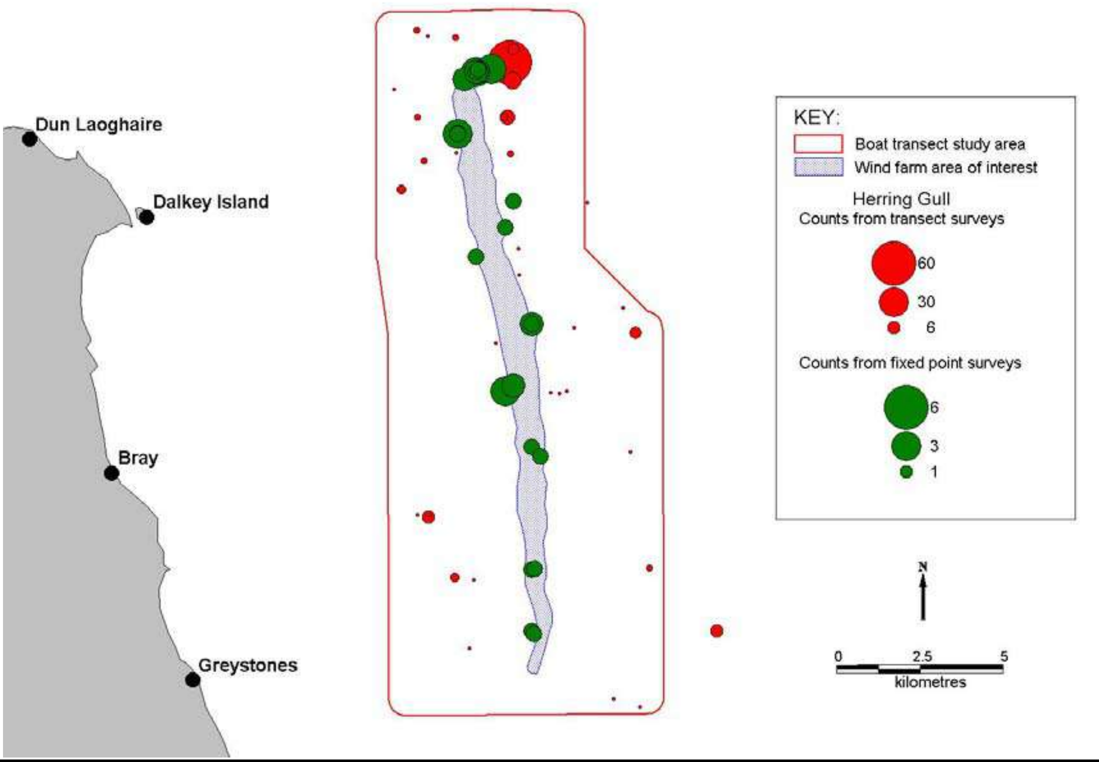


Figure 16. Herring gull densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

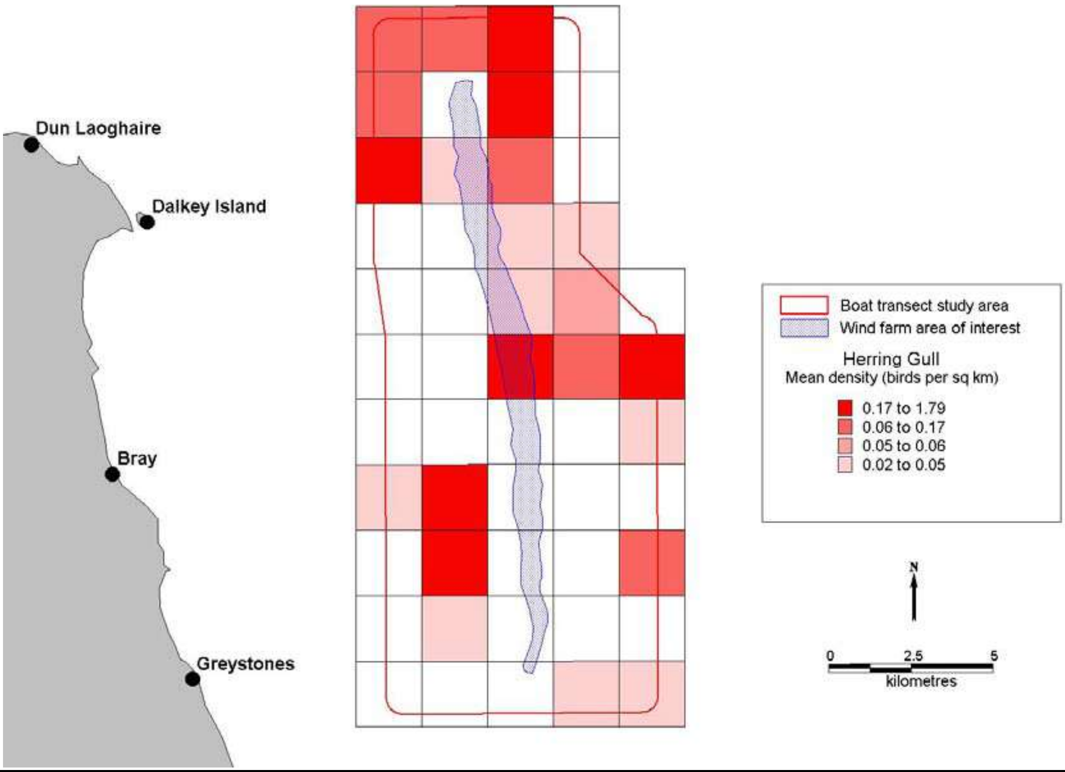
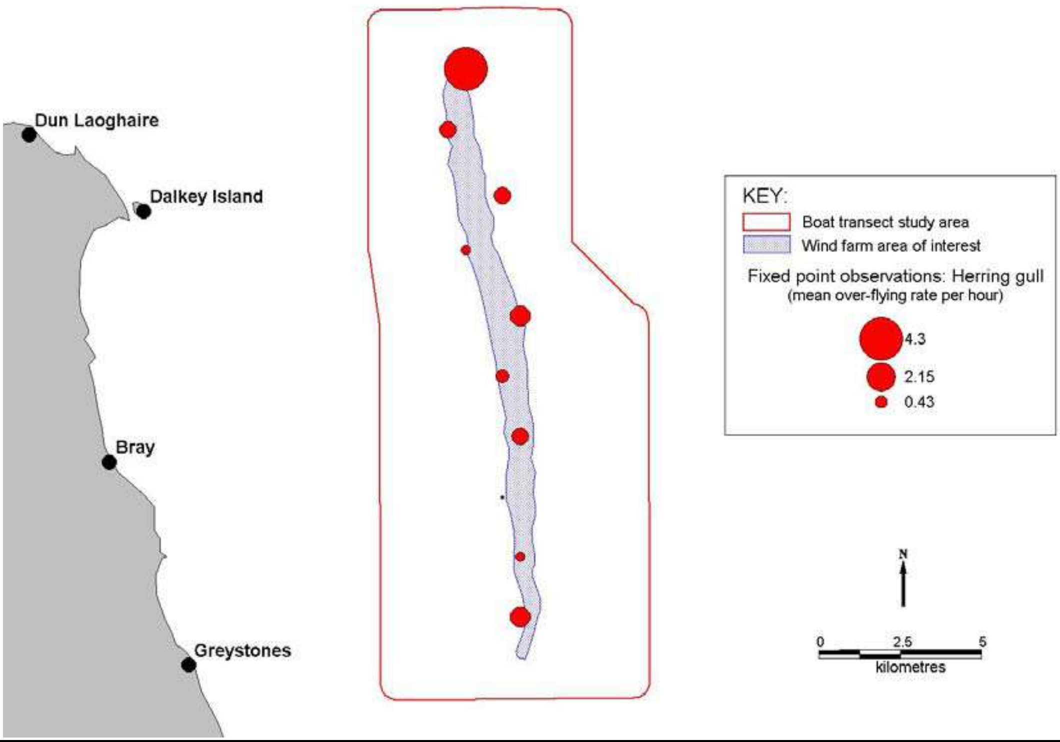


Figure 17. Herring gull flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Great black-backed gull

The distribution of great black-backed gull sightings is shown in Figure 18, and the shag density in each 2x2km square in Figure 19. This species had a similar distribution to that of the herring gull, widespread but with highest numbers at the north end of the Kish Bank. The observed flight rates (Figure 20) were also higher at the north end of the Bank.

Figure 18. Distribution of great black-backed gull sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

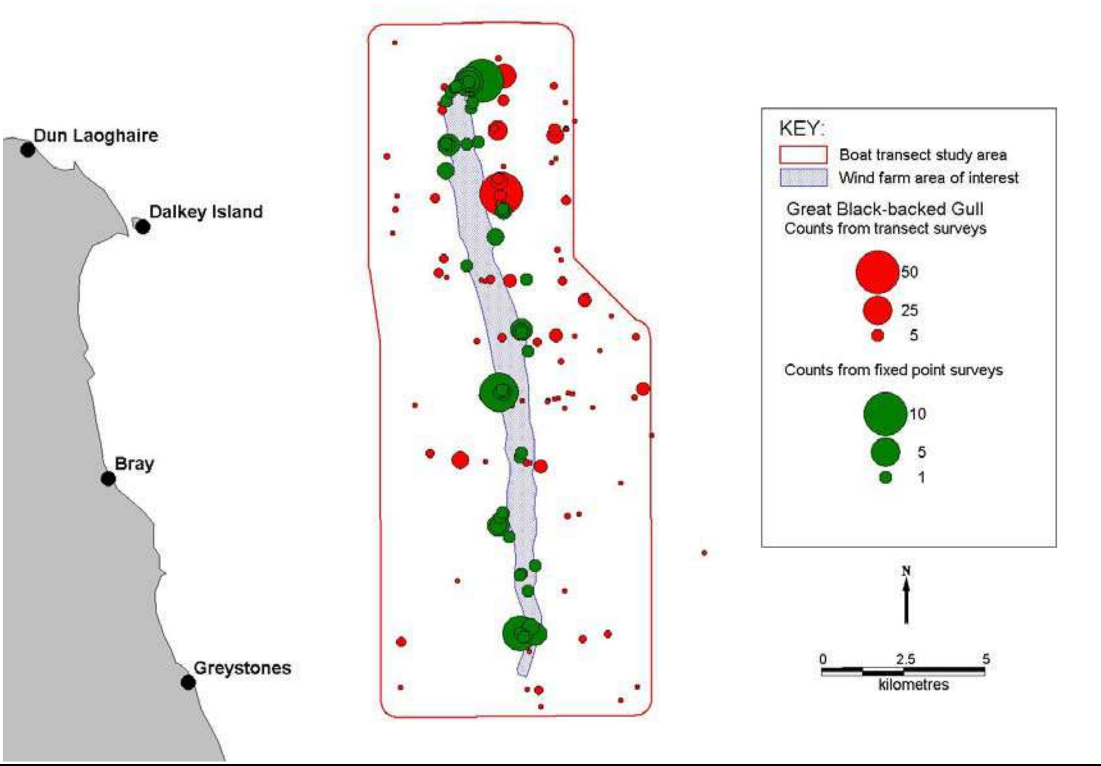


Figure 19. Great black-backed gull densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

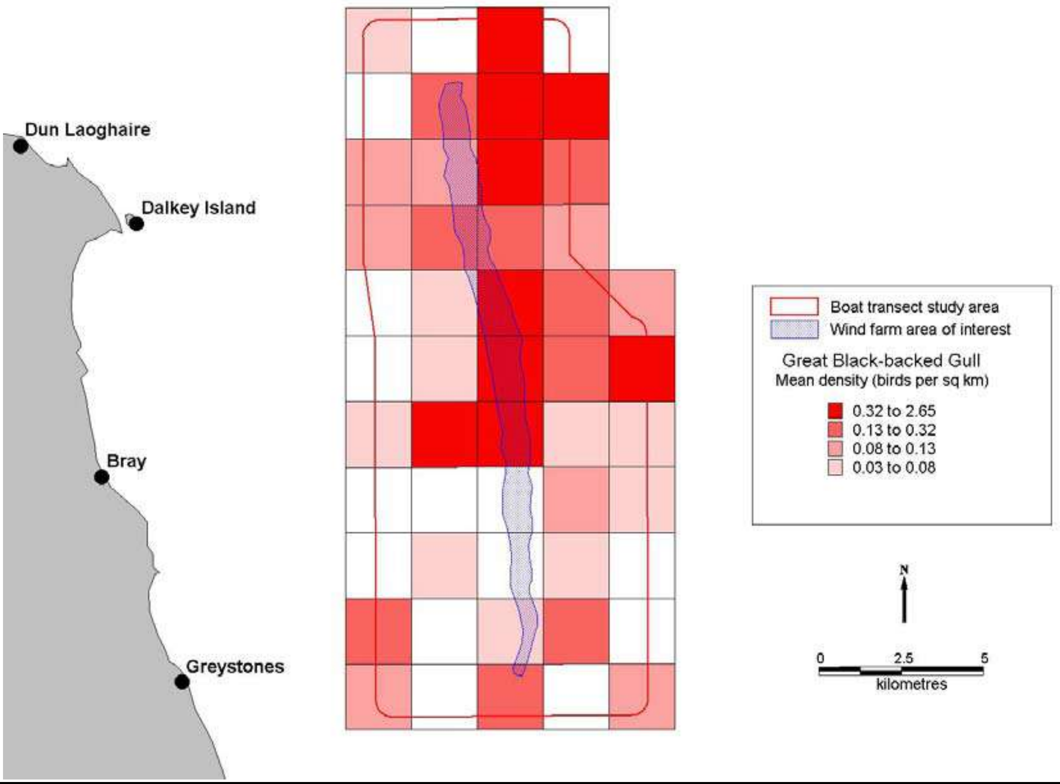
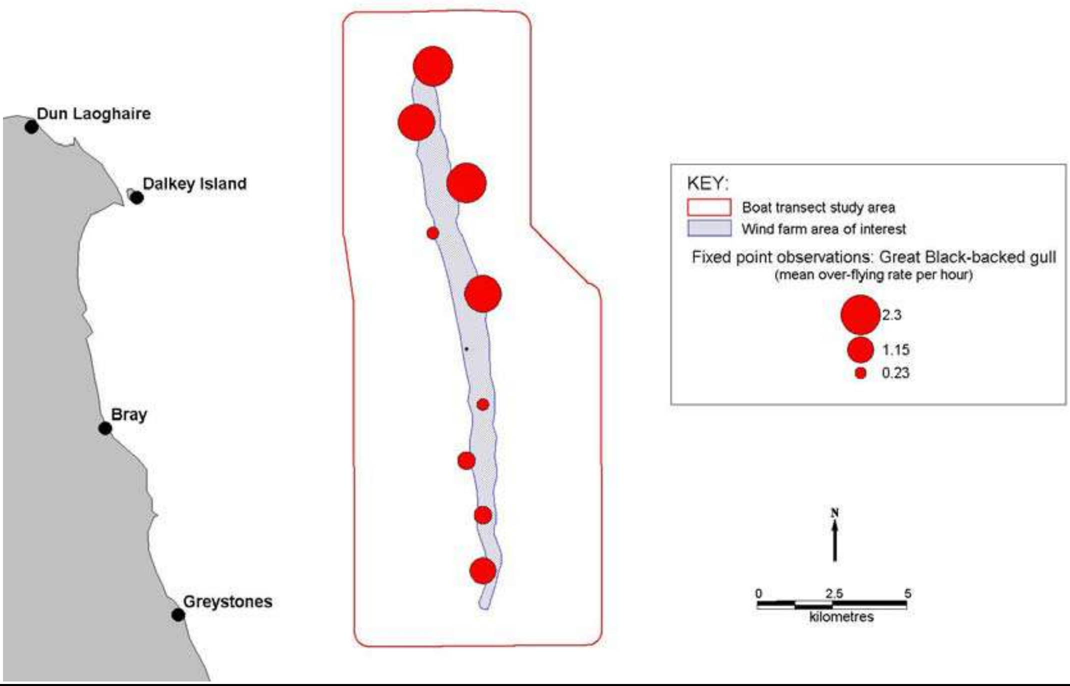


Figure 20. Great black-backed gull flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Kittiwake

The distribution of kittiwake sightings is shown in Figure 21, and the kittiwake density in each 2x2km square in Figure 22. This species was widespread throughout the study area, but most abundant in the northern and middle parts of the Kish Bank. The observed flight rates (Figure 23) were highest at the southern end of the Bank though high numbers were also observed from the northern-most observation point.

Figure 21. Distribution of kittiwake sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

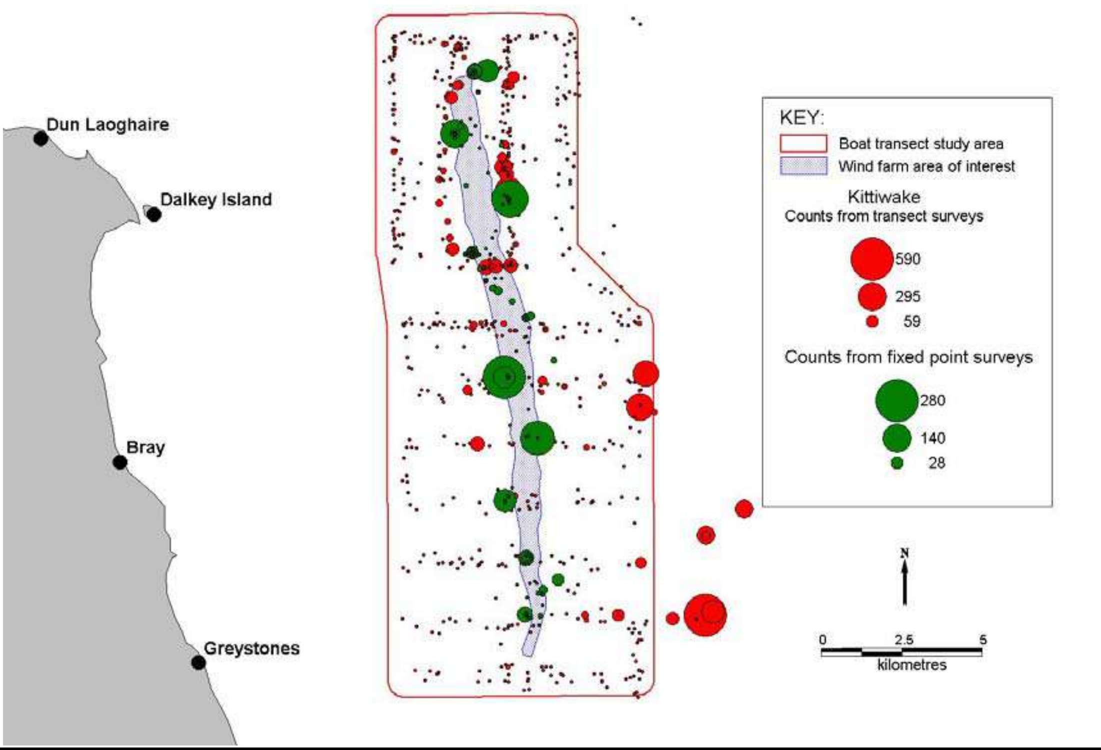


Figure 22. Kittiwake densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

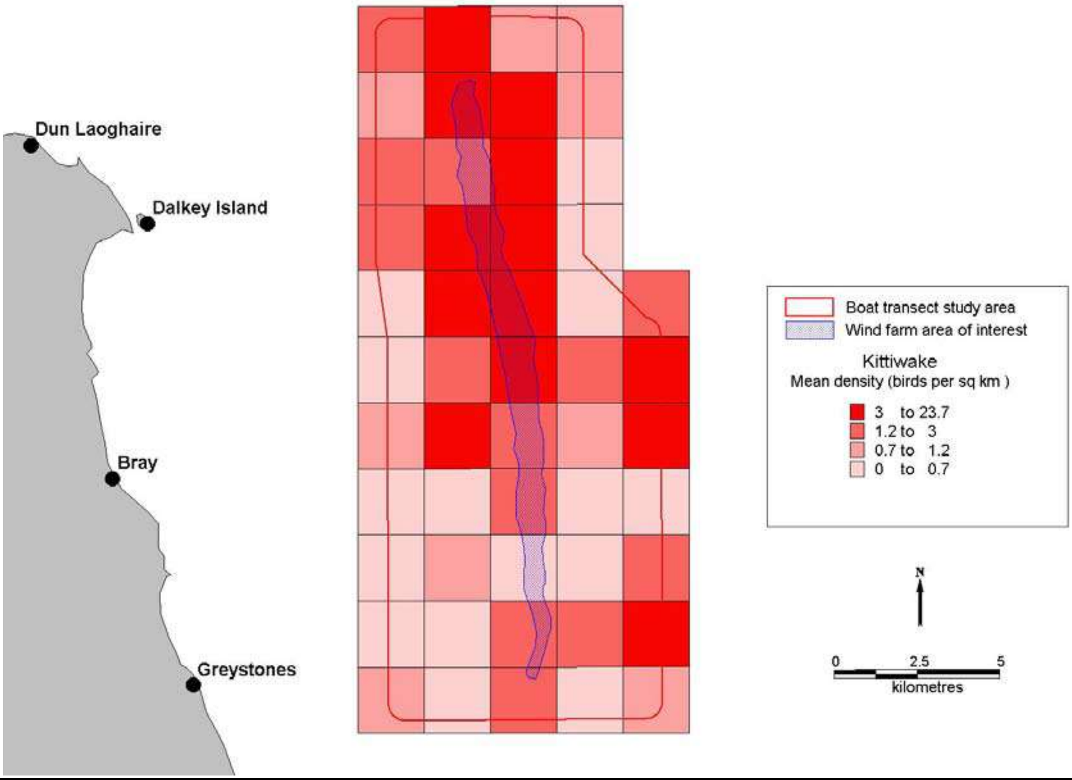
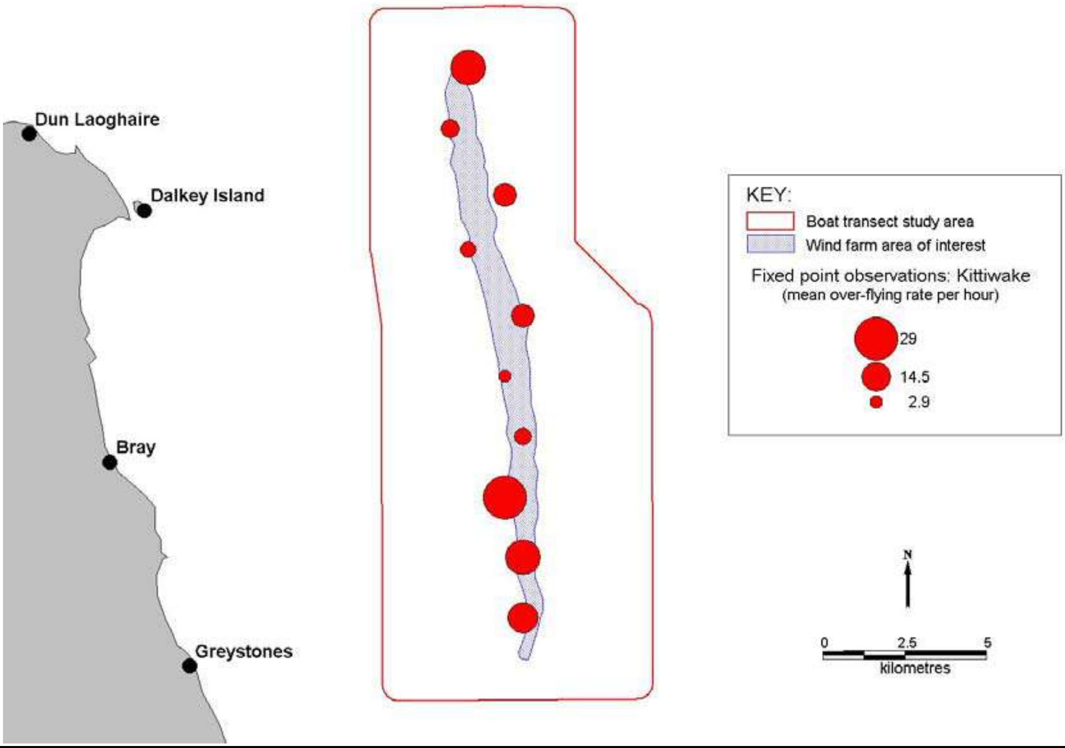


Figure 23. Kittiwake flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Arctic tern

The distribution of arctic tern sightings is shown in Figure 24, and the arctic tern density in each 2x2km square in Figure 25. This species was widespread along the whole length of the Kish Bank and in the deeper waters to the west, with no particular concentrations. The observed flight rates (Figure 26) also followed a similar distribution.

Figure 24. Distribution of arctic tern sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

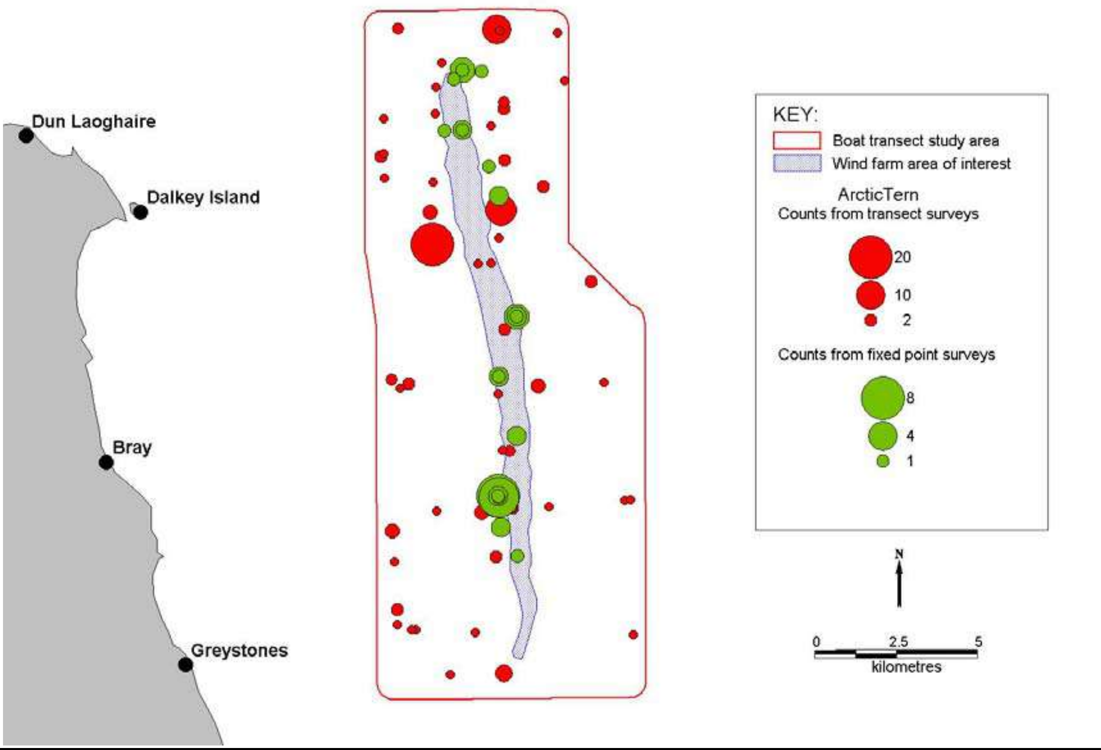


Figure 25. Arctic tern densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

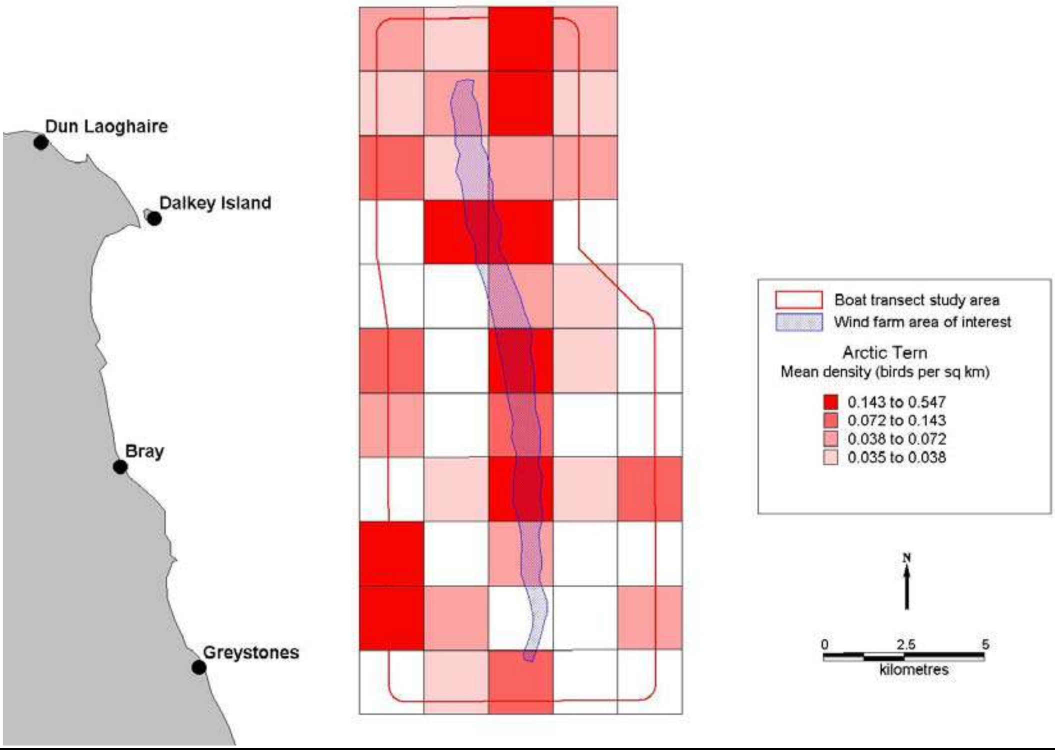
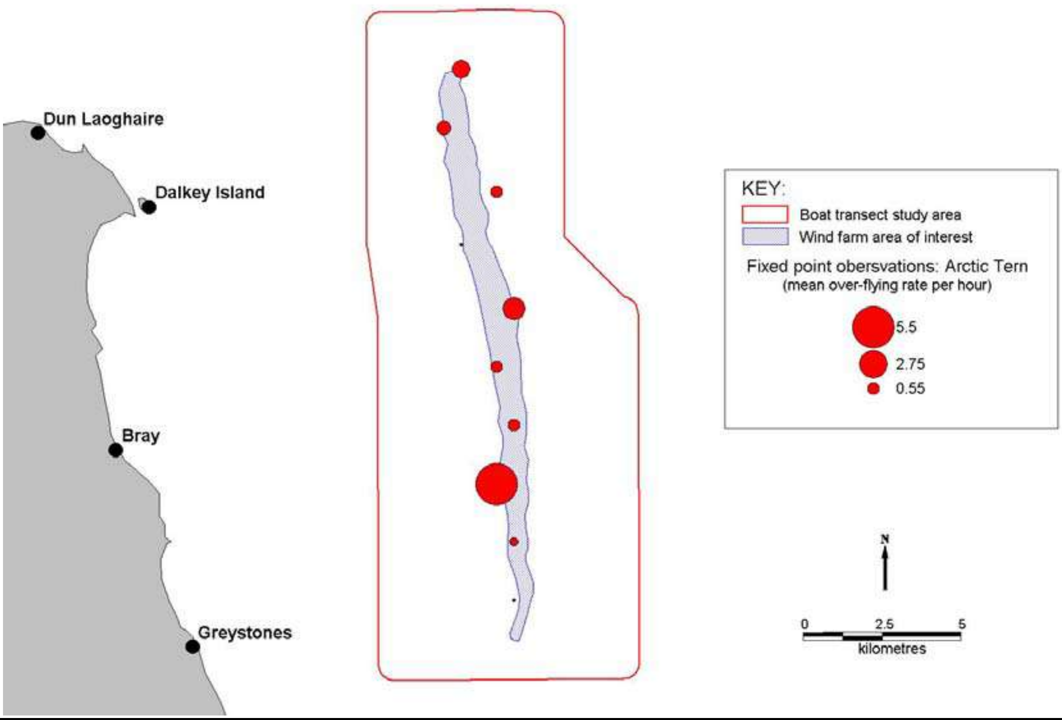


Figure 26. Arctic tern flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Common tern

The distribution of common tern sightings is shown in Figure 27, and the common tern density in each 2x2km square in Figure 28. This species was found throughout the study area, but was generally more abundant along the length of the Kish Bank and in the deeper waters to the west of this (particularly at the north end). The observed flight rates (Figure 29) were also higher at the northern end of the Bank.

Figure 27. Distribution of common tern sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

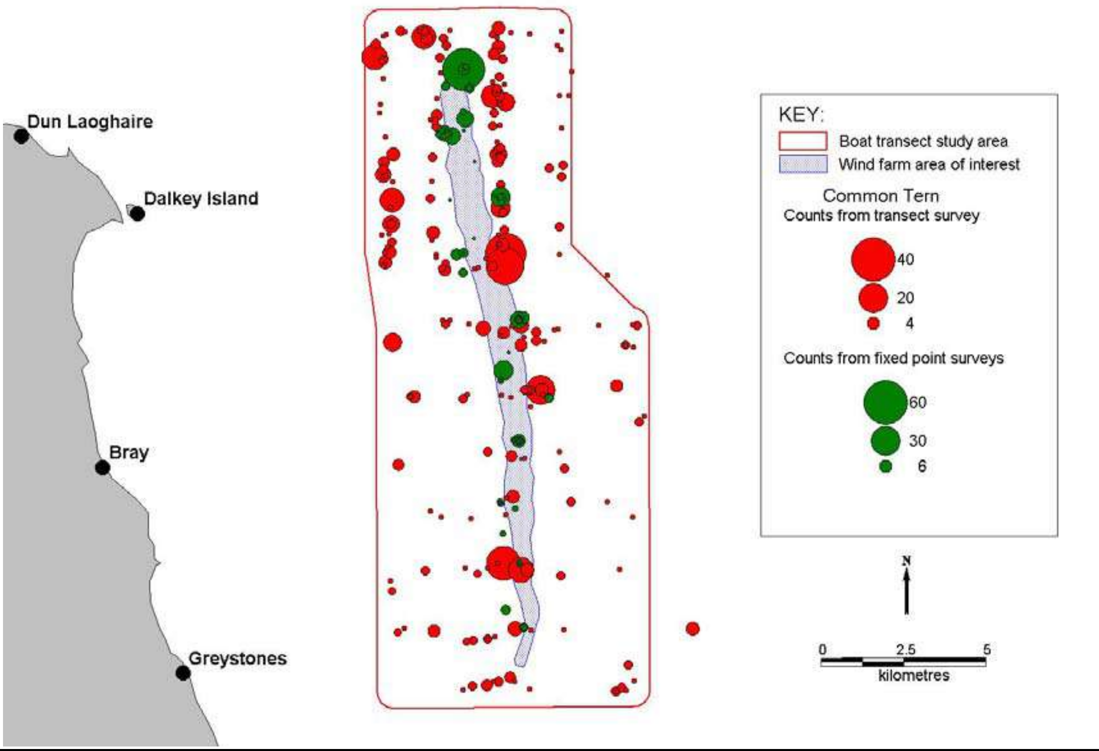


Figure 28. Common tern densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

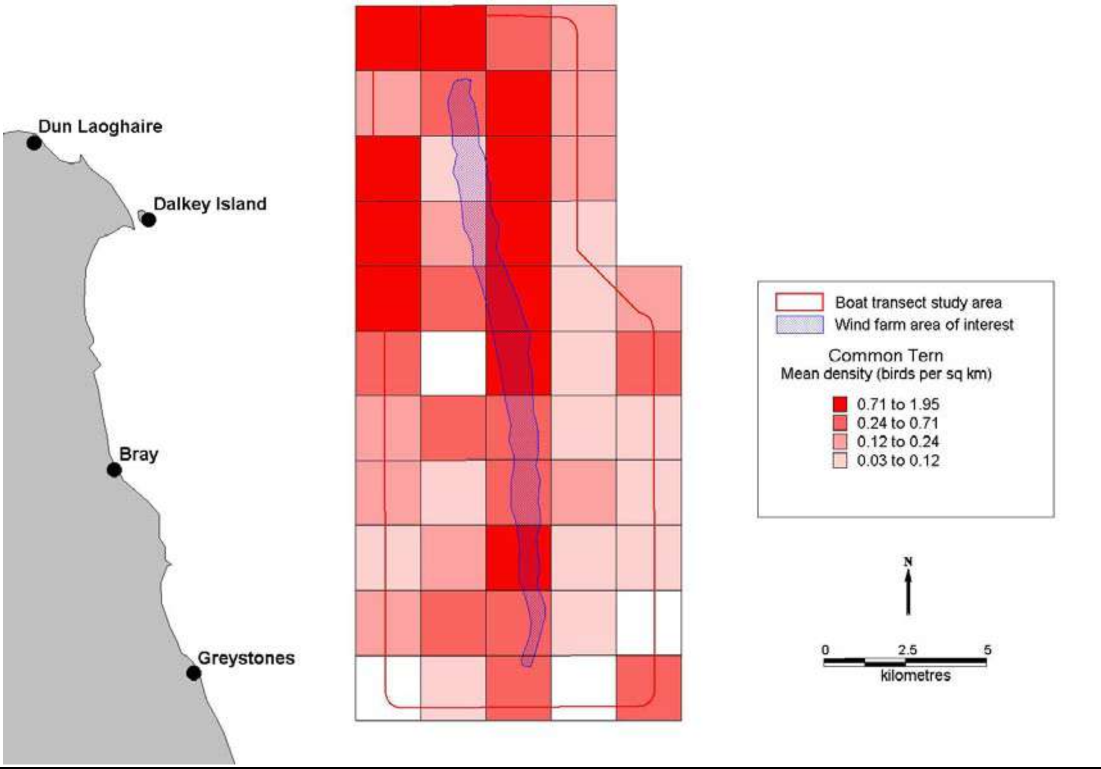
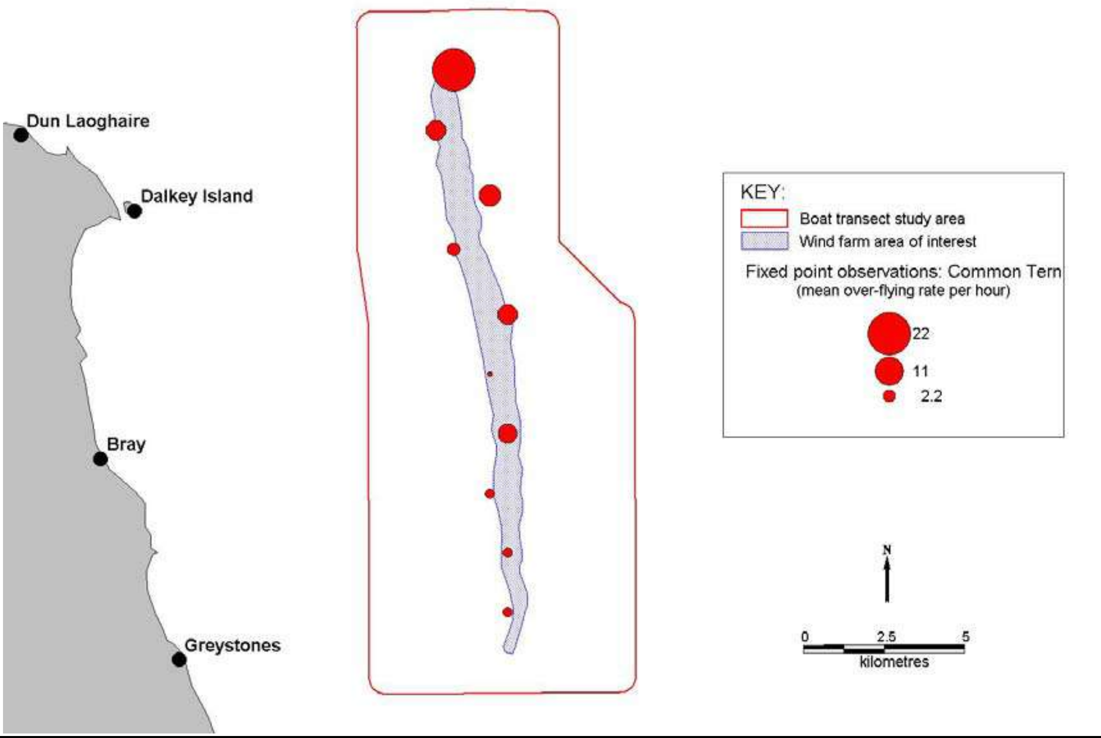


Figure 29. Common tern flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Roseate tern

The distribution of roseate tern sightings is shown in Figure 30, and the roseate tern density in each 2x2km square in Figure 31. This species was concentrated in the northern third of the Kish Bank, mostly along its eastern side. Largest numbers were seen around the Kish lighthouse, which it used as a roost site. Much smaller numbers were recorded in the southern part of the study area. The observed flight rates (Figure 32) followed a very similar distribution.

Figure 30. Distribution of roseate tern sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

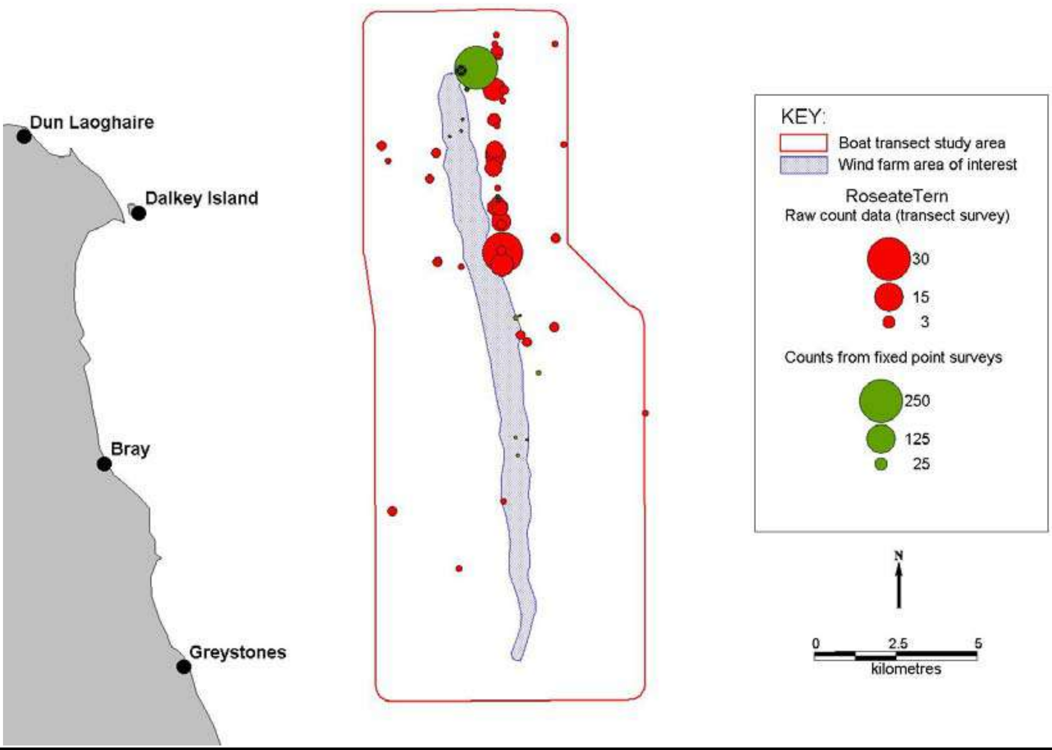


Figure 31. Roseate tern densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

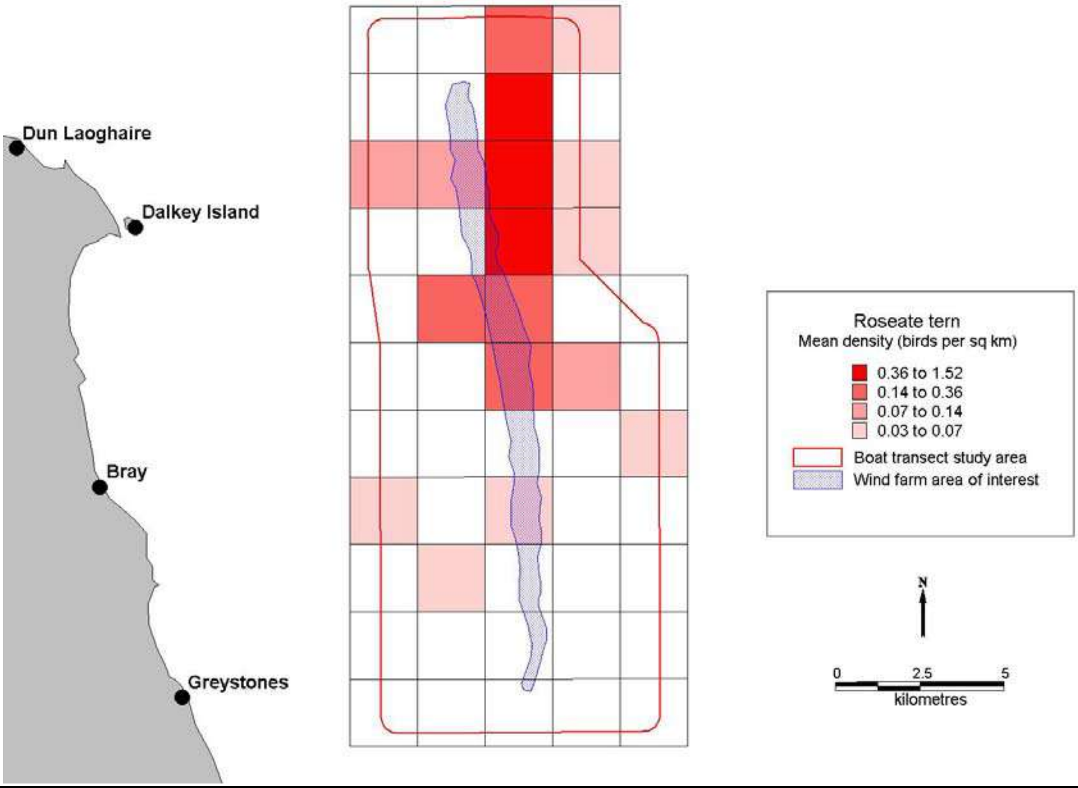
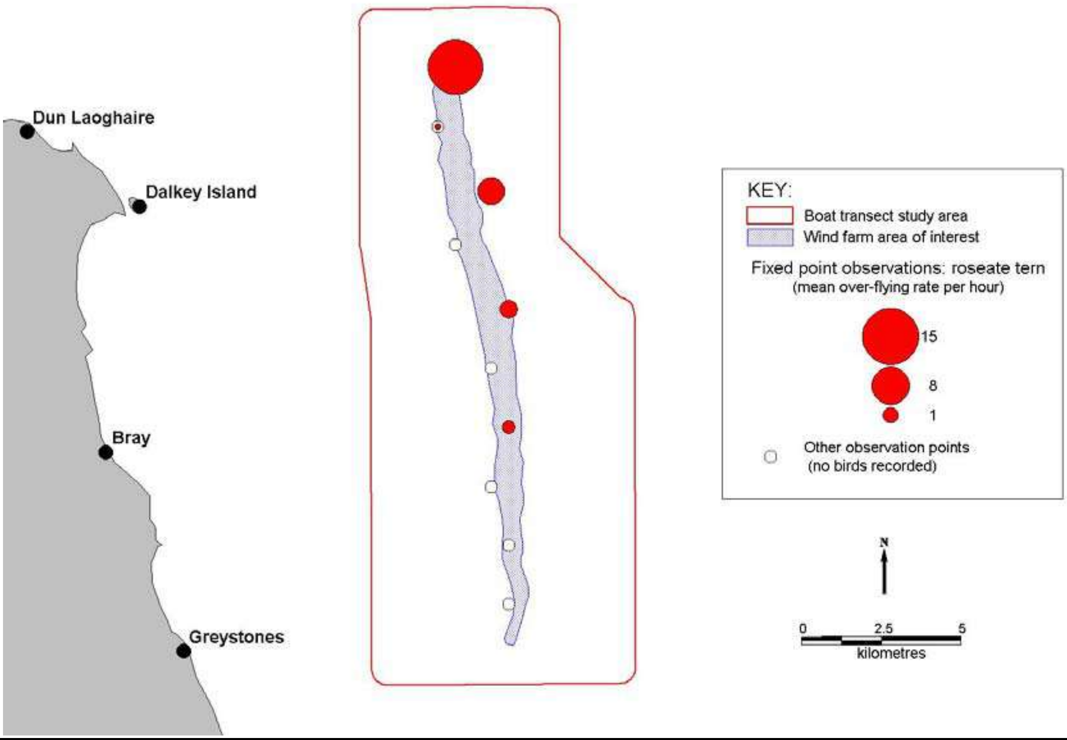


Figure 32. Roseate tern flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Unidentified tern species

Common, arctic and roseate terns all have a similar appearance and can be difficult to separate at distance. The distribution of all the tern sightings that it was not possible to identify to species is shown in Figure 33, and the unidentified tern density in each 2x2km square in Figure 34. These distributions and densities follow, as would be expected, a combination of the results of each of the three tern species, as do the observed flight rates (Figure 35), with most tern activity in the northern part of the Kish Bank but at least some activity extending along its whole length.

Figure 33. Distribution of unidentified tern sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

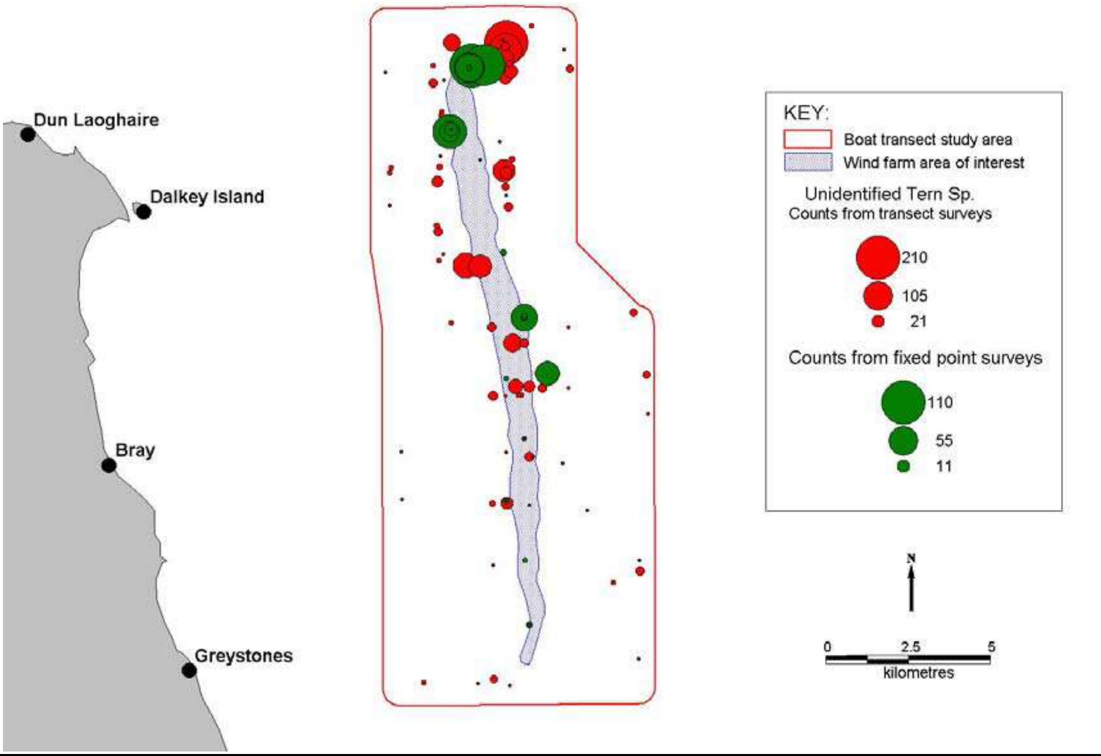


Figure 34. Unidentified tern densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

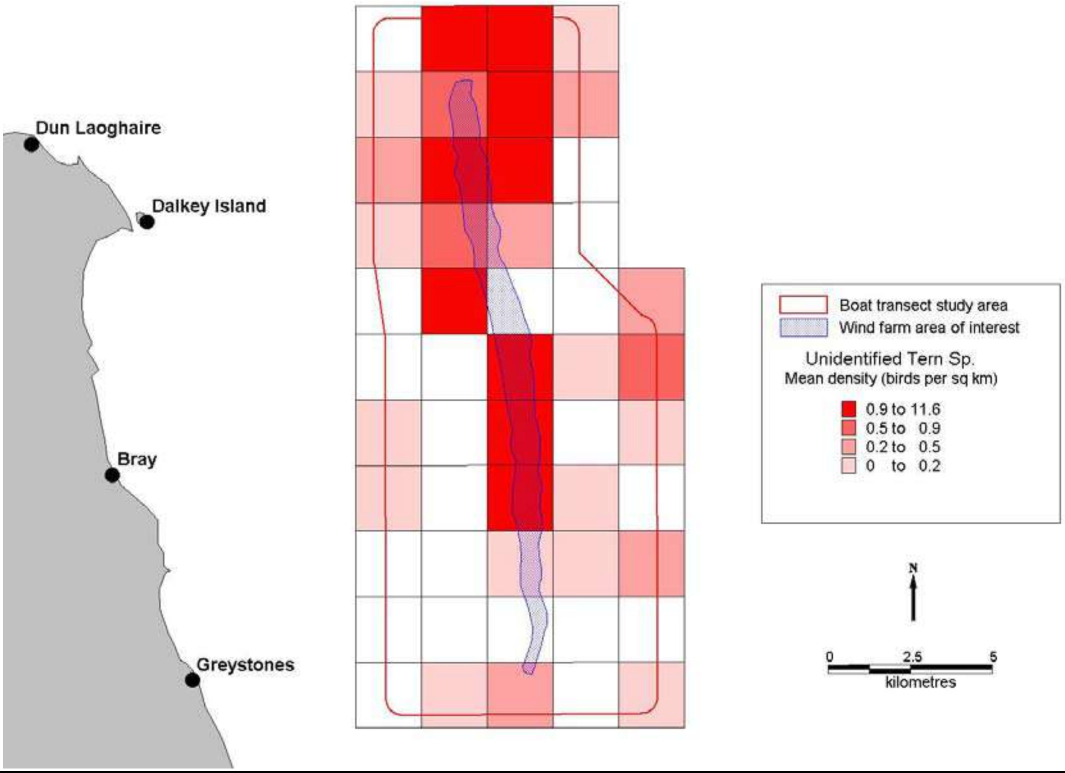
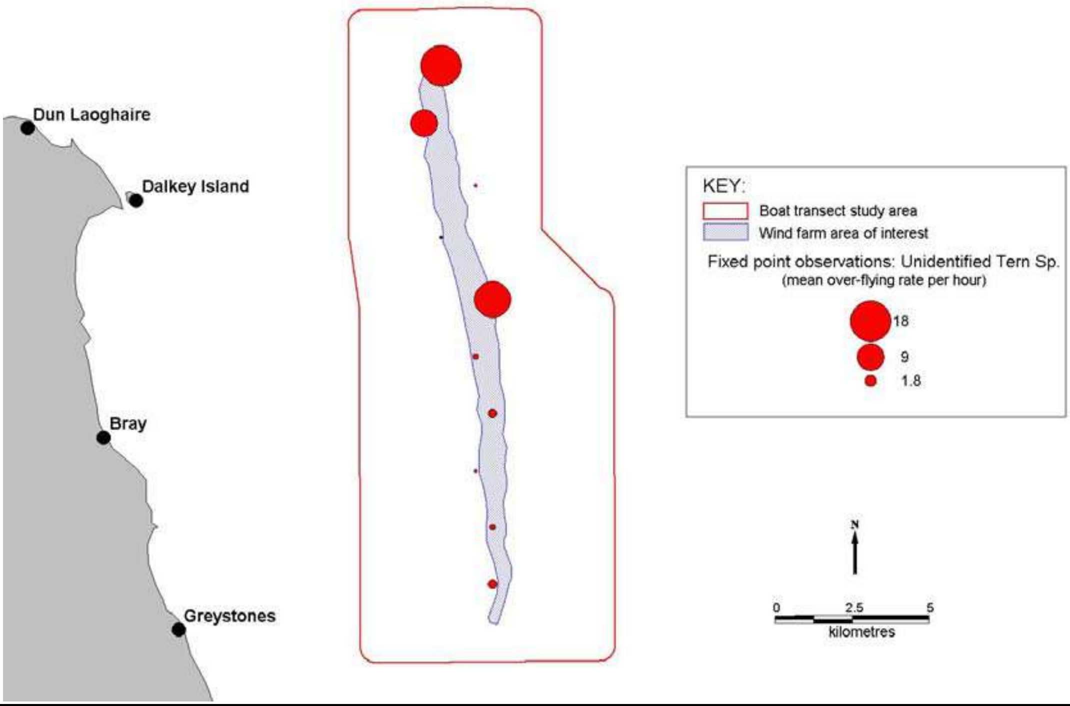


Figure 35. Unidentified tern flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Guillemot

The distribution of guillemot sightings is shown in Figure 36, and the guillemot density in each 2x2km square in Figure 37. This species was abundant along the northern two-thirds of the Kish Bank, and in the deeper waters to the east and the west. The observed flight rates (Figure 38) were quite uniform along the whole Bank.

Figure 36. Distribution of guillemot sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

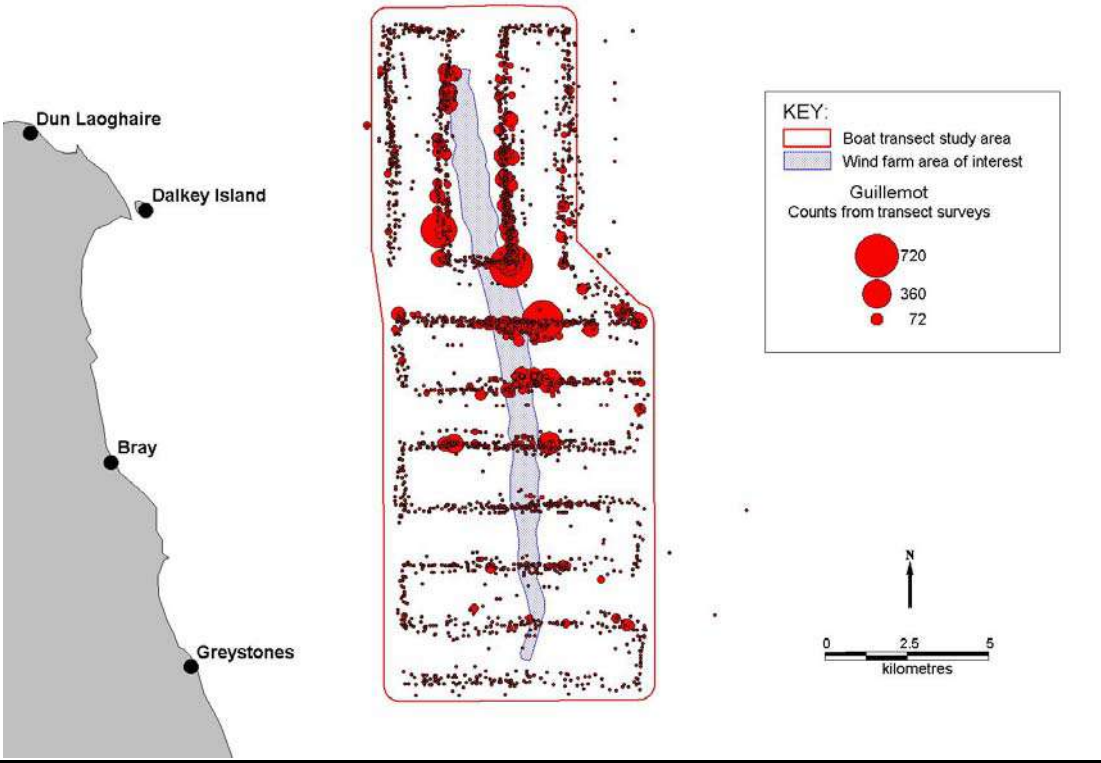


Figure 37. Guillemot densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

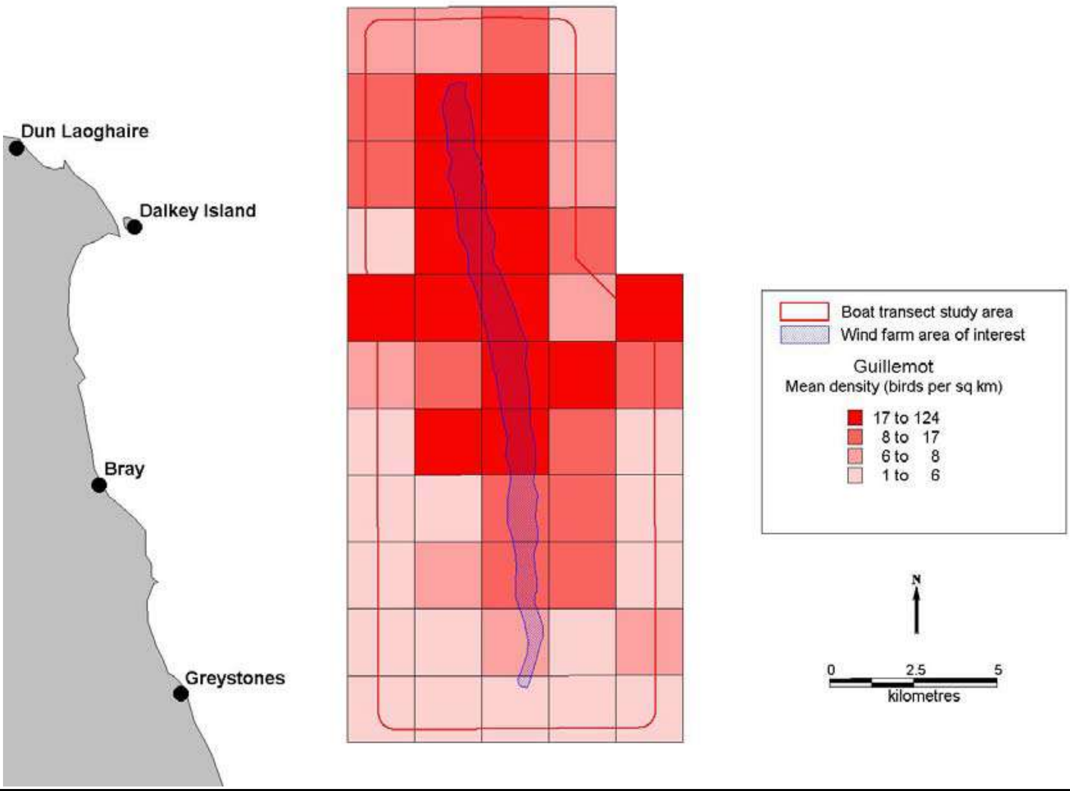
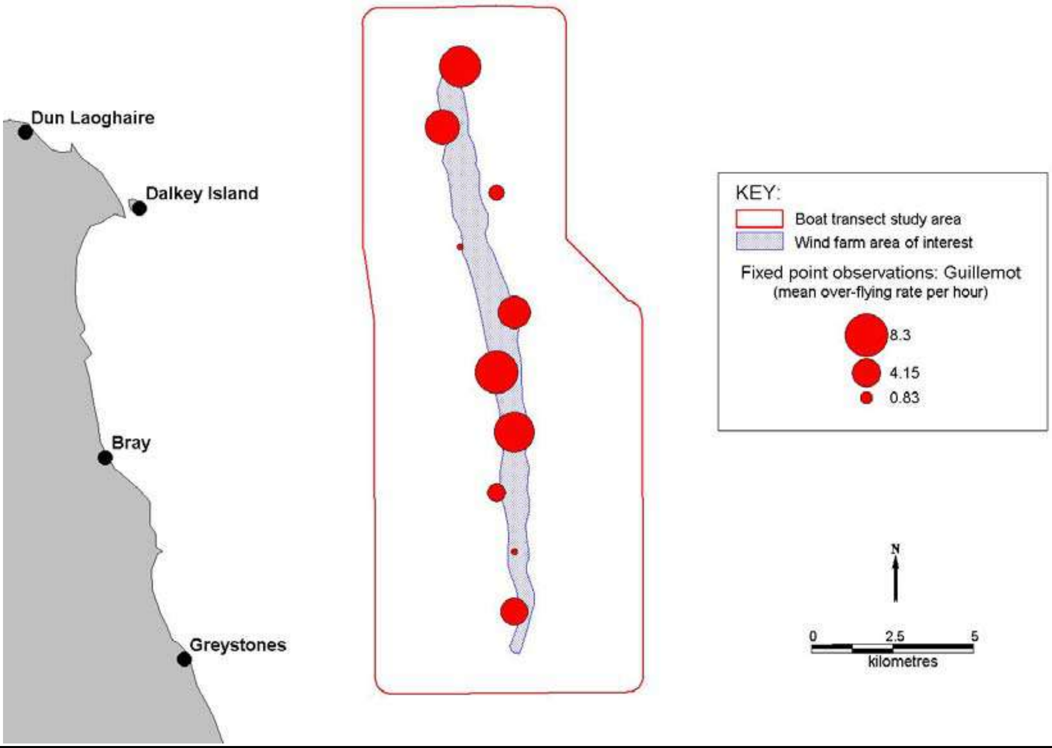


Figure 38. Guillemot flight rates observed from the Kish Bank fixed points, Sept 2001 -Sept 2002.



Razorbill

The distribution of razorbill sightings is shown in Figure 39, and the razorbill density in each 2x2km square in Figure 40. This species was abundant throughout the study area but particularly in the southern and eastern parts. The observed flight rates (Figure 41) did not show any major differences along the whole Bank.

Figure 39. Distribution of razorbill sightings within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

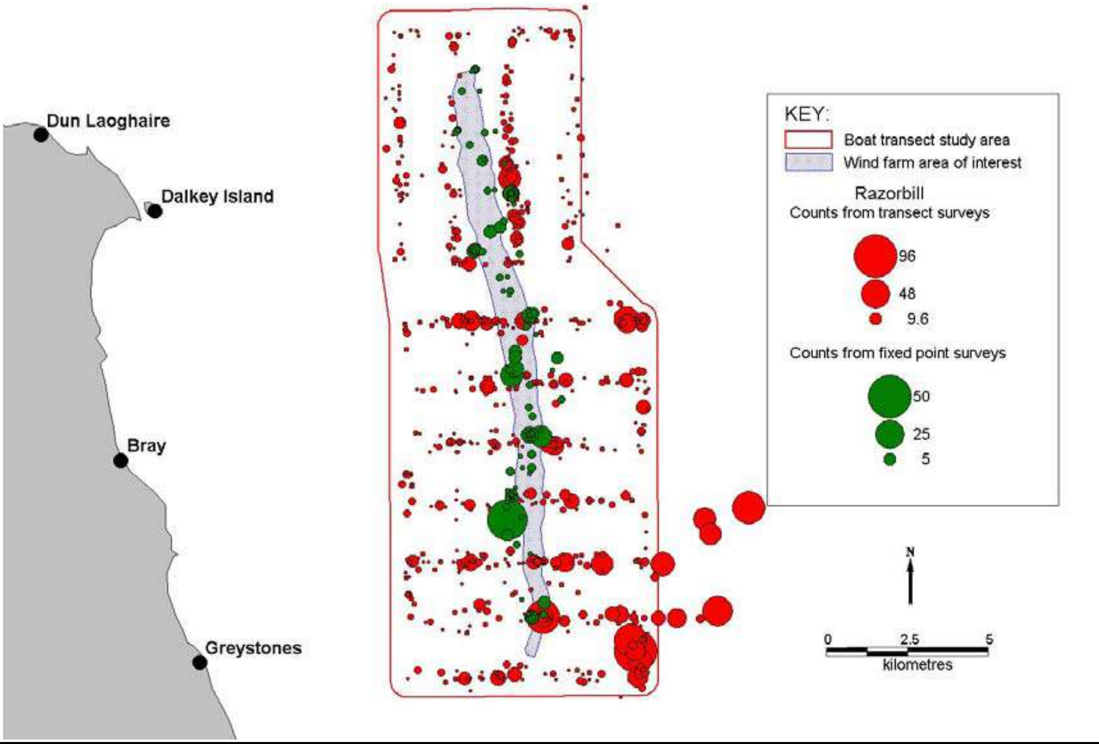


Figure 40. Razorbill densities within the main Kish Bank study area during the Sept 2001 - Sept 2002 boat surveys.

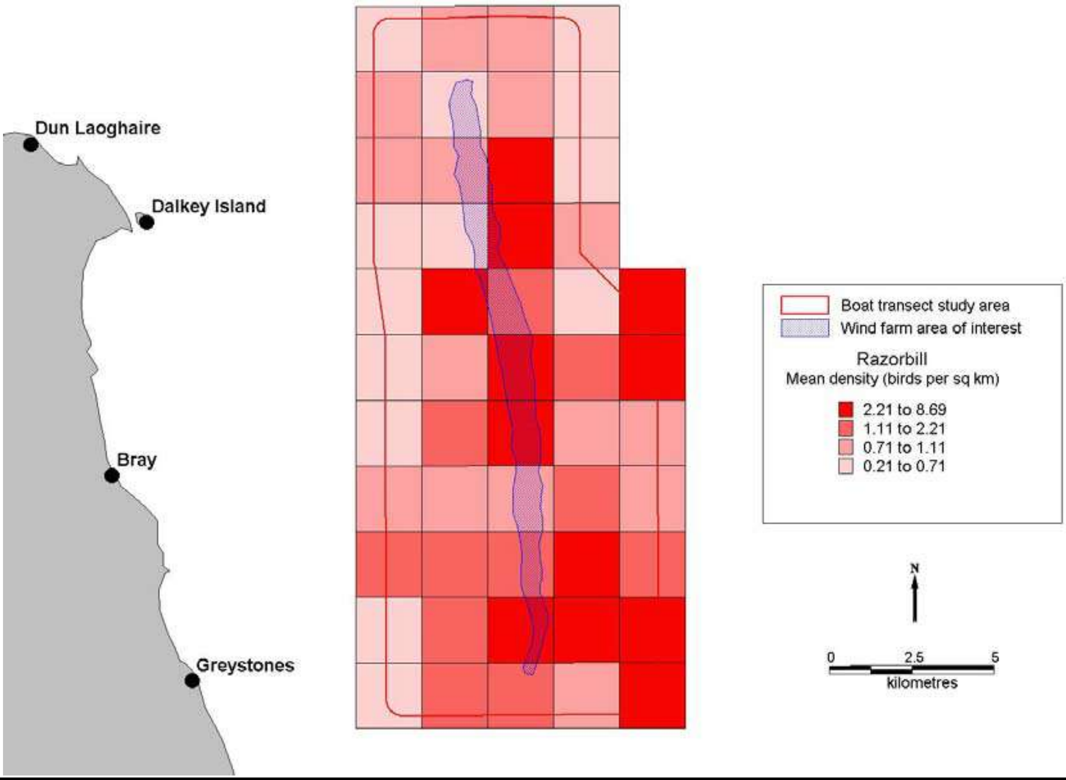
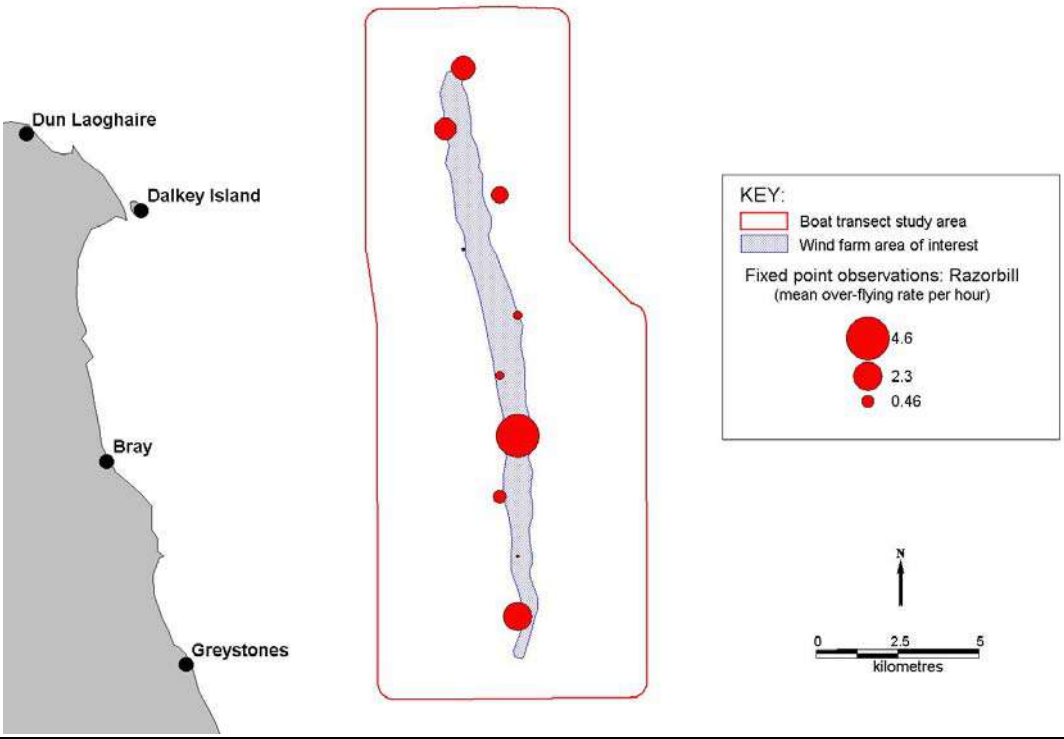


Figure 41. Razorbill flight rates observed from the Kish Bank fixed points, Sept 2001 - Sept 2002.

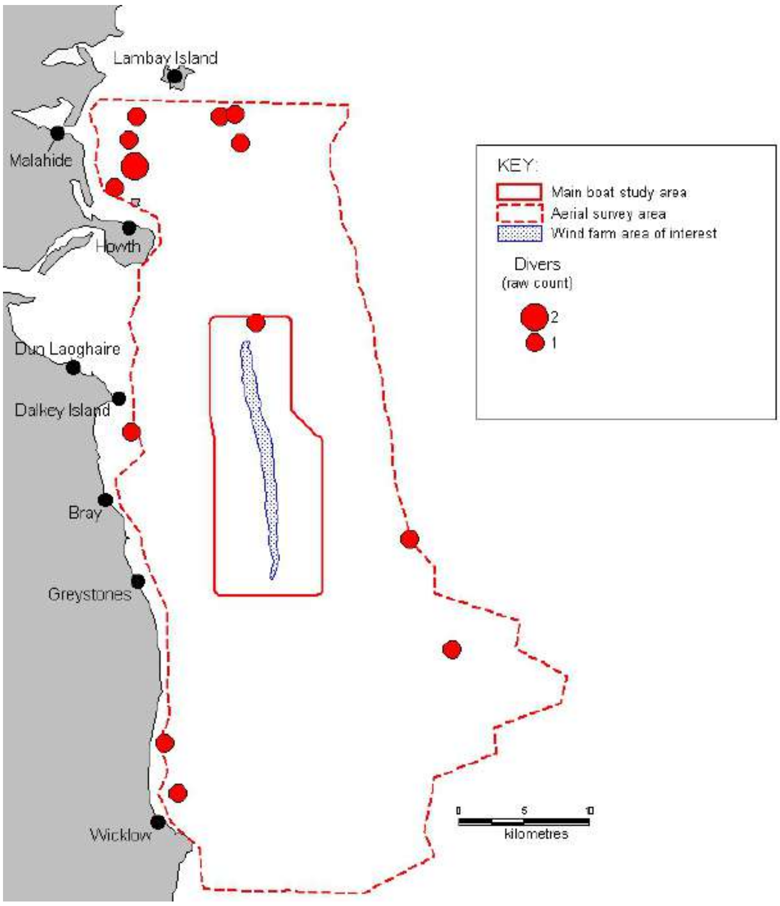


Aerial survey data

The data on the bird distributions recorded during the aerial surveys have been summarised in two ways (as for the boat transect surveys). Firstly the raw data (unadjusted for distance corrections) have been plotted, showing the locations of the birds recorded along each of the aerial transect lines flown. Maps have not been produced for great crested grebe, cormorant or red-breasted merganser as there were so few records of these species. Secondly the distance-corrected data have been used to determine the bird densities in each 2x2km grid square within the study area (where there were sufficient records for this to be meaningful). For both of these the data from the two aerial surveys have been pooled (with the plotted densities reflecting the average bird density for each grid square).

The distribution of the diver records is shown in Figure 42, only one of which was within the main Kish Bank study area. From the records from the boat surveys these are likely to have been either red-throated or great northern divers. There were insufficient diver records to plot meaningful grid densities.

Figure 42. Distribution of diver sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of fulmar sightings is shown in Figure 43. Few were seen within the Kish Bank study area, with most records coming from the southern part of the aerial survey area. This is further illustrated by the fulmar densities shown in Figure 44.

Figure 43. Distribution of fulmar sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

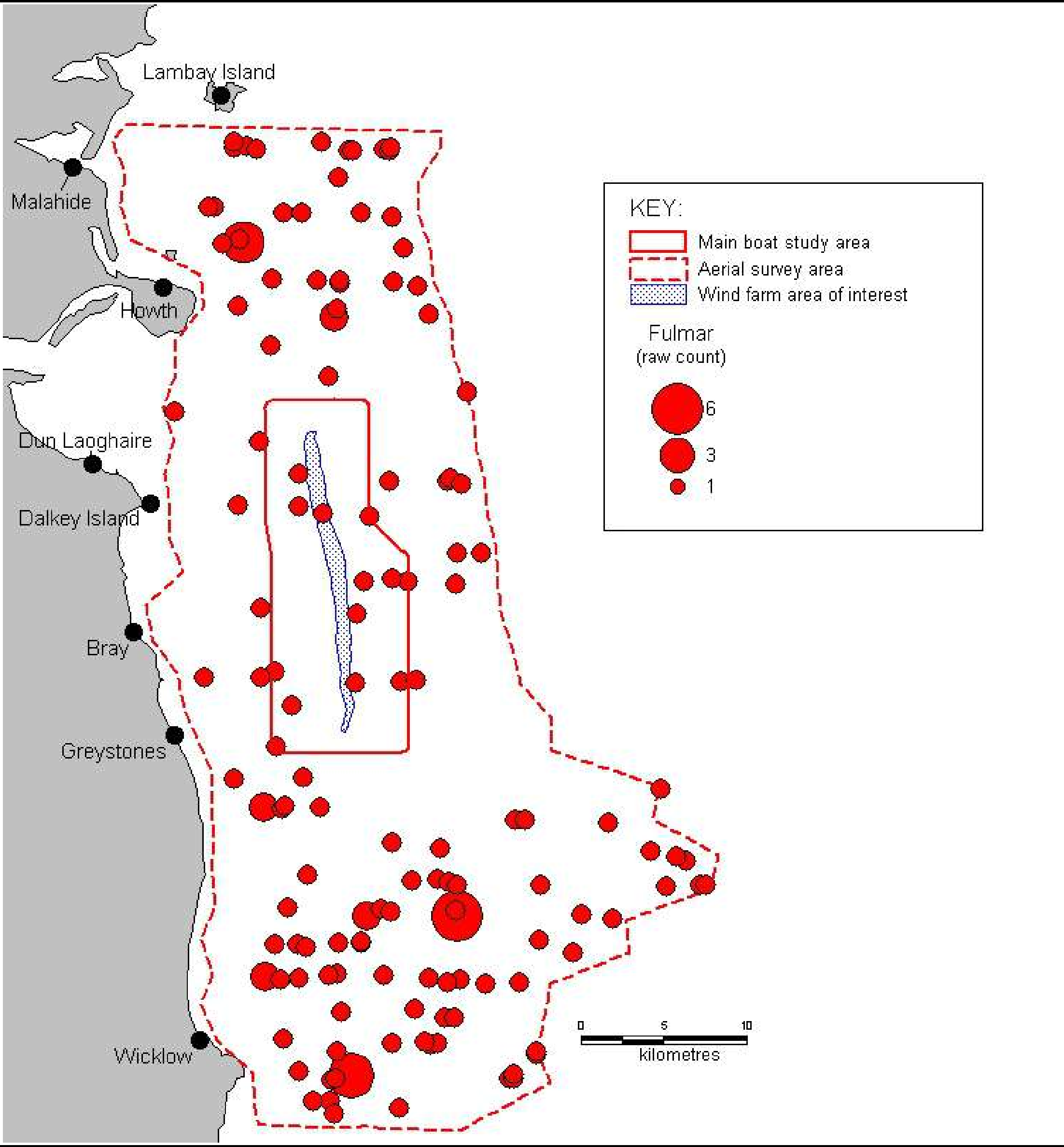
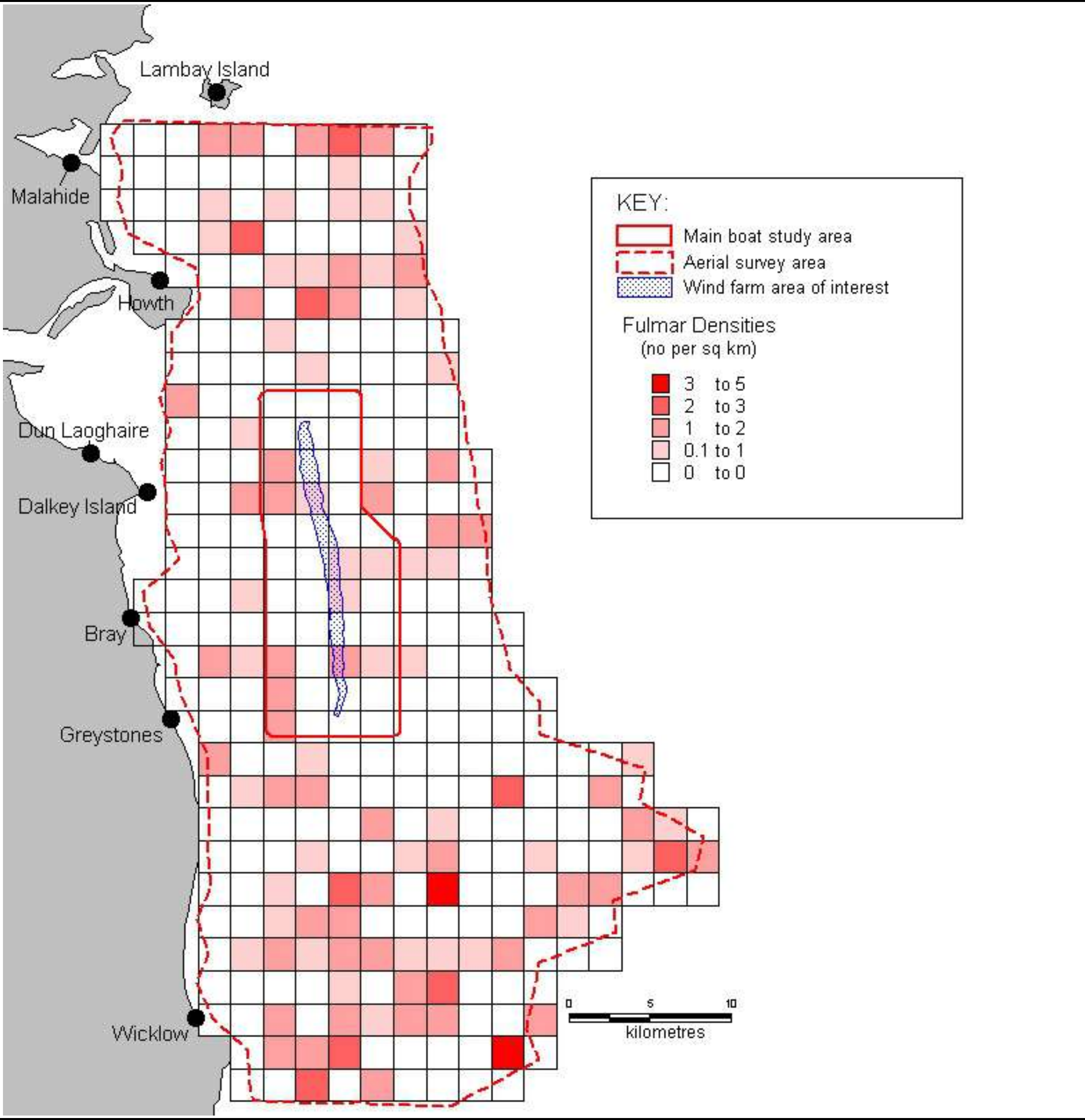


Figure 44. Fulmar densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of Manx shearwater sightings is shown in Figure 45. Most were seen to the east of the Kish Bank, though the Bank itself also held quite high numbers. Figure 46 shows the Manx shearwater grid densities.

Figure 45. Distribution of Manx shearwater sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

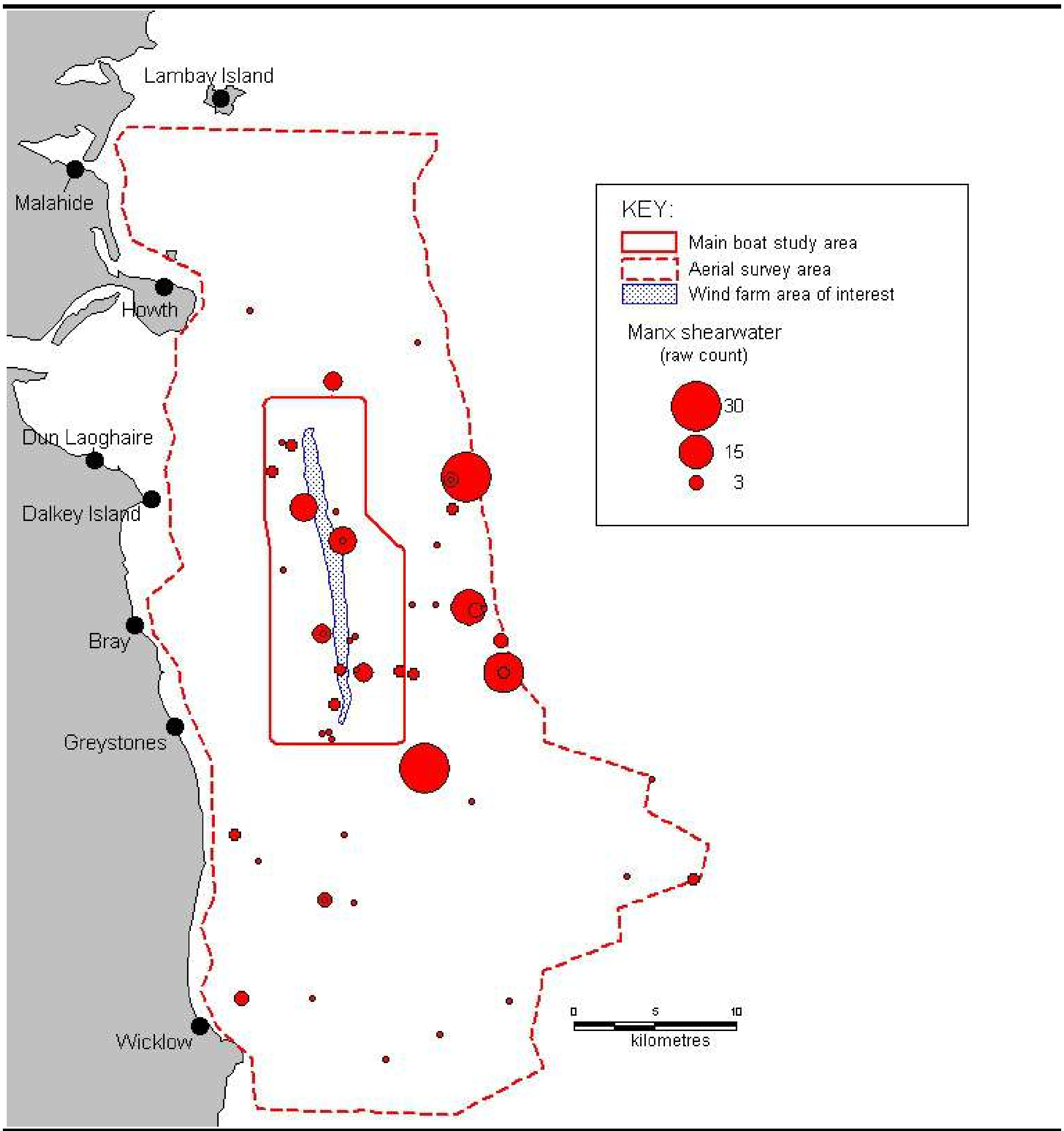
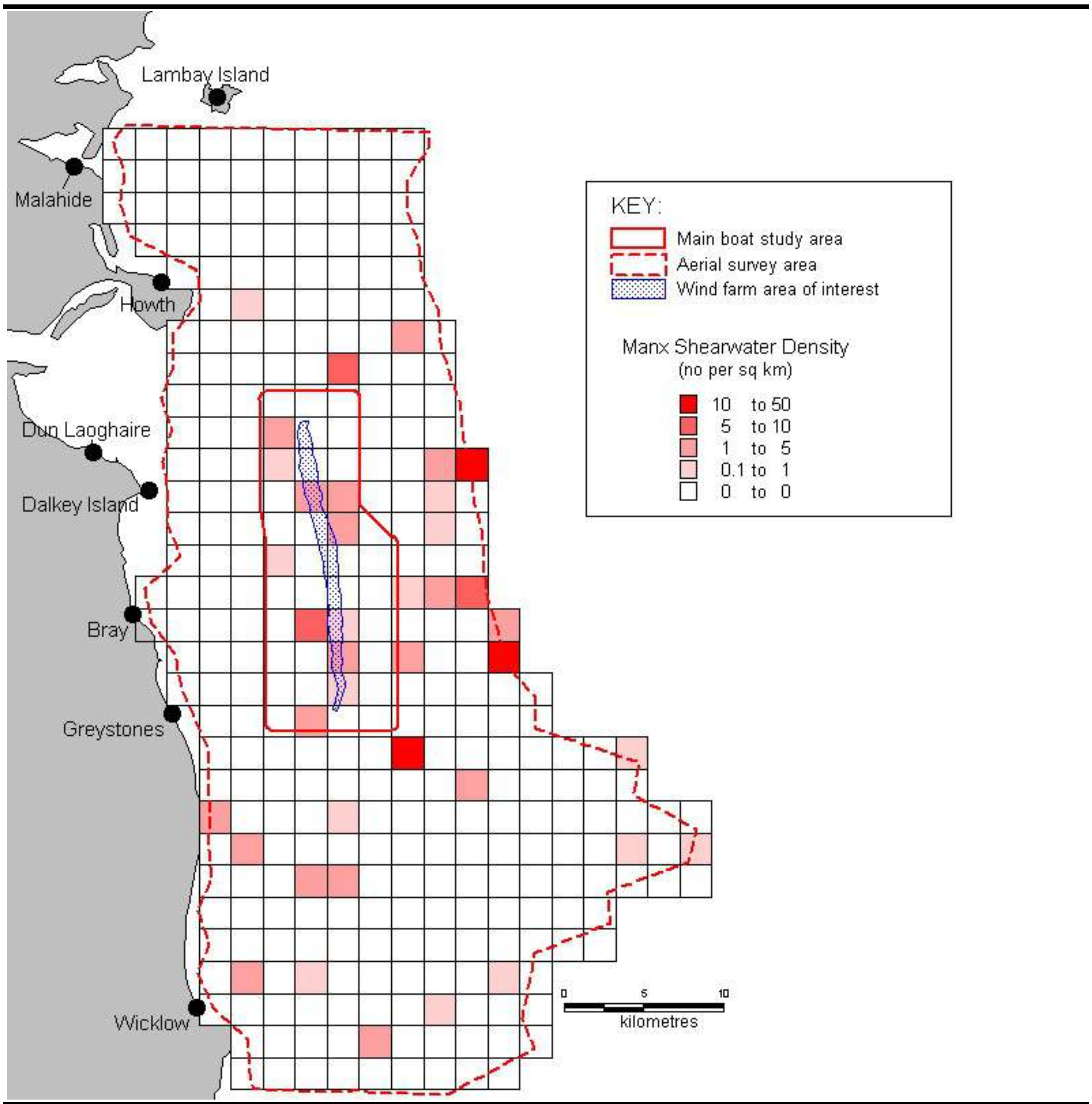


Figure 46. Manx shearwater densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of gannet sightings is shown in Figure 47 and the densities in Figure 48. Records were generally scattered across most of the aerial survey area, with the greatest concentration on the northern edge of this area.

Figure 47. Distribution of gannet sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

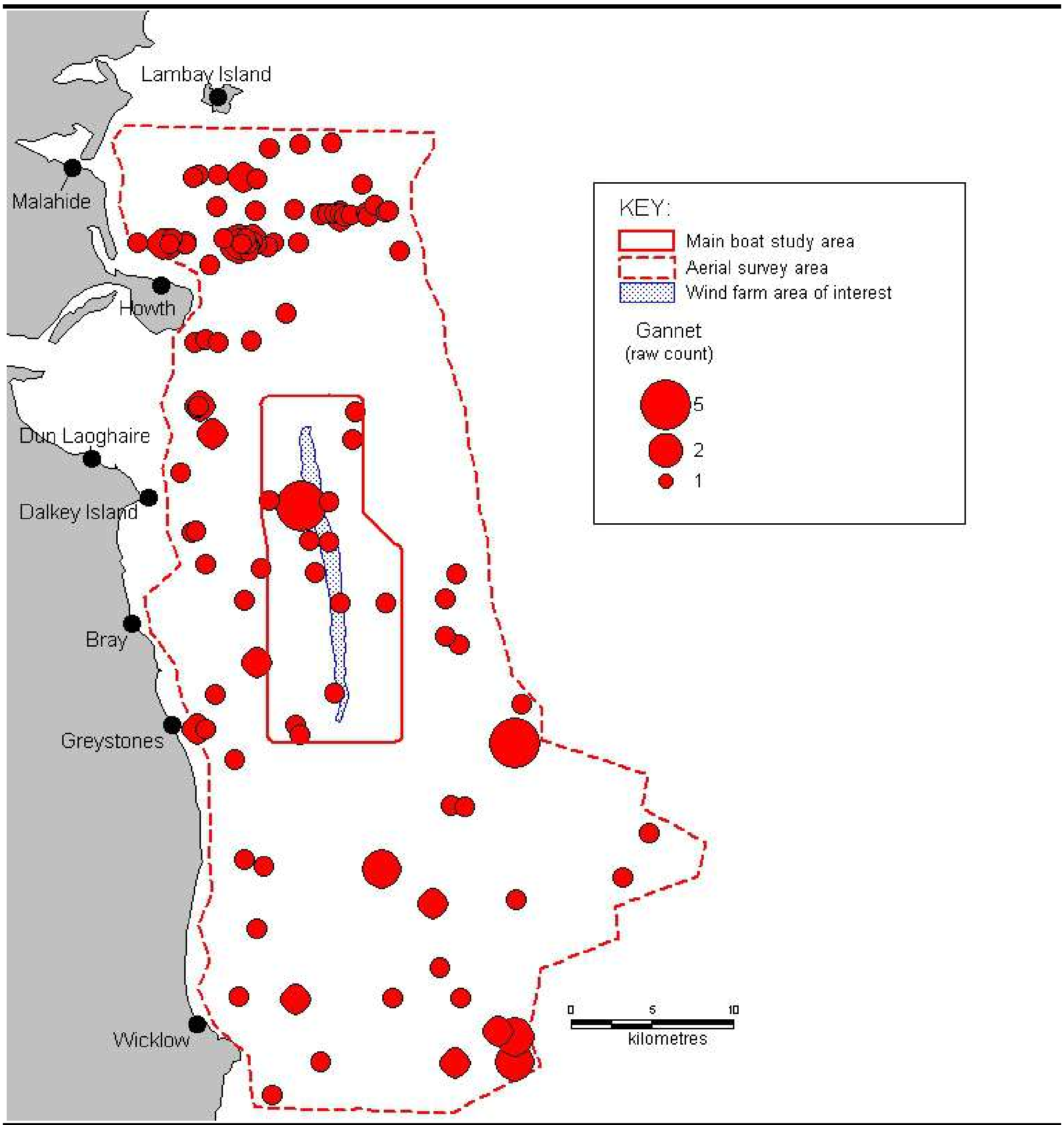
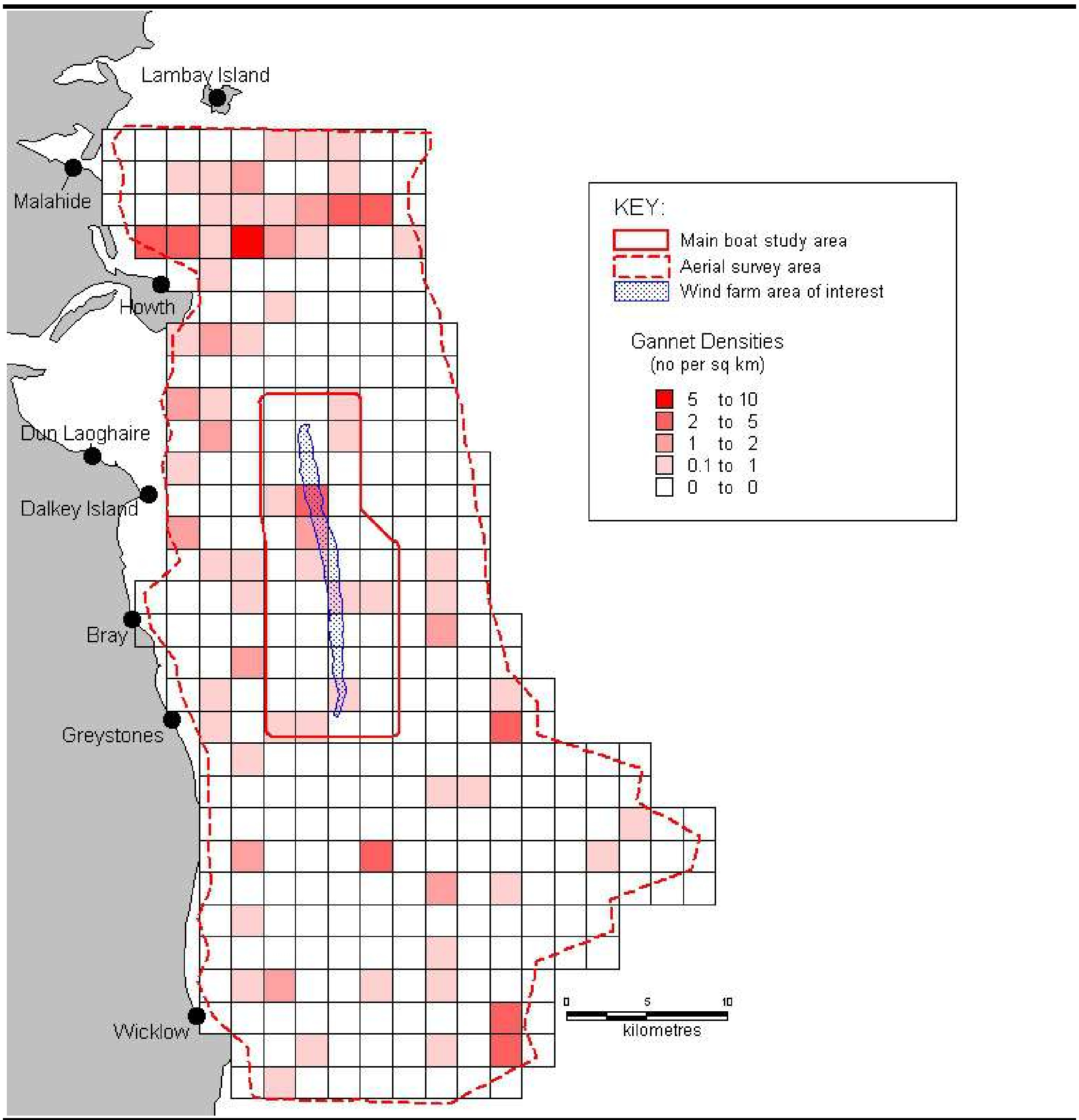
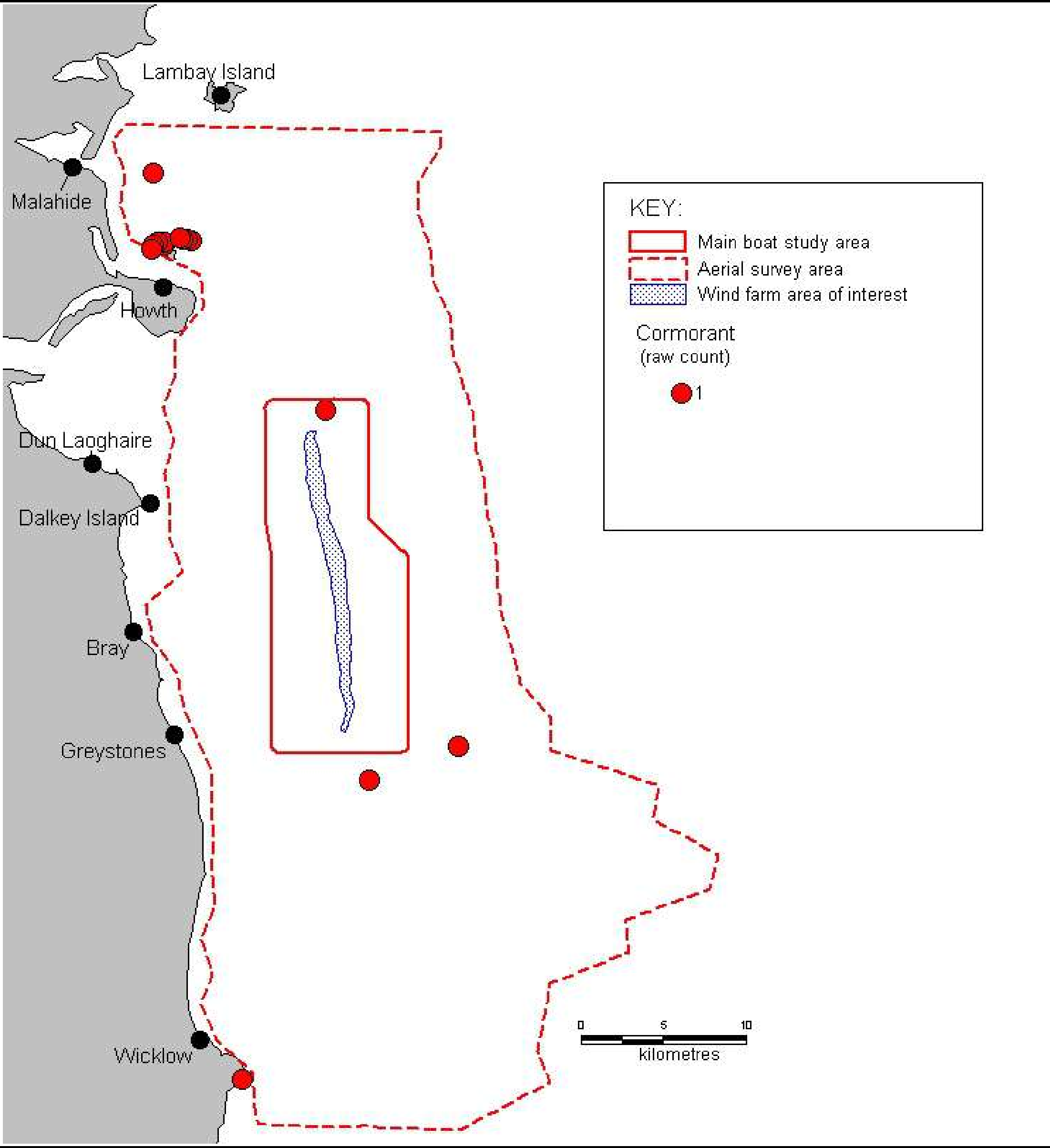


Figure 48. Gannet densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of cormorant sightings is shown in Figure 49. Only 1 was recorded within the Kish Bank study area, with most records around Ireland's Eye to the north of Howth. There were insufficient sightings to plot a meaningful density grid.

Figure 49. Distribution of cormorant sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of shag sightings is shown in Figure 50, and the grid density in Figure 51. There were two major concentrations, one at the north end of the Kish Bank, and one further north from there (up to the northern edge of the aerial survey area).

Figure 50. Distribution of shag sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

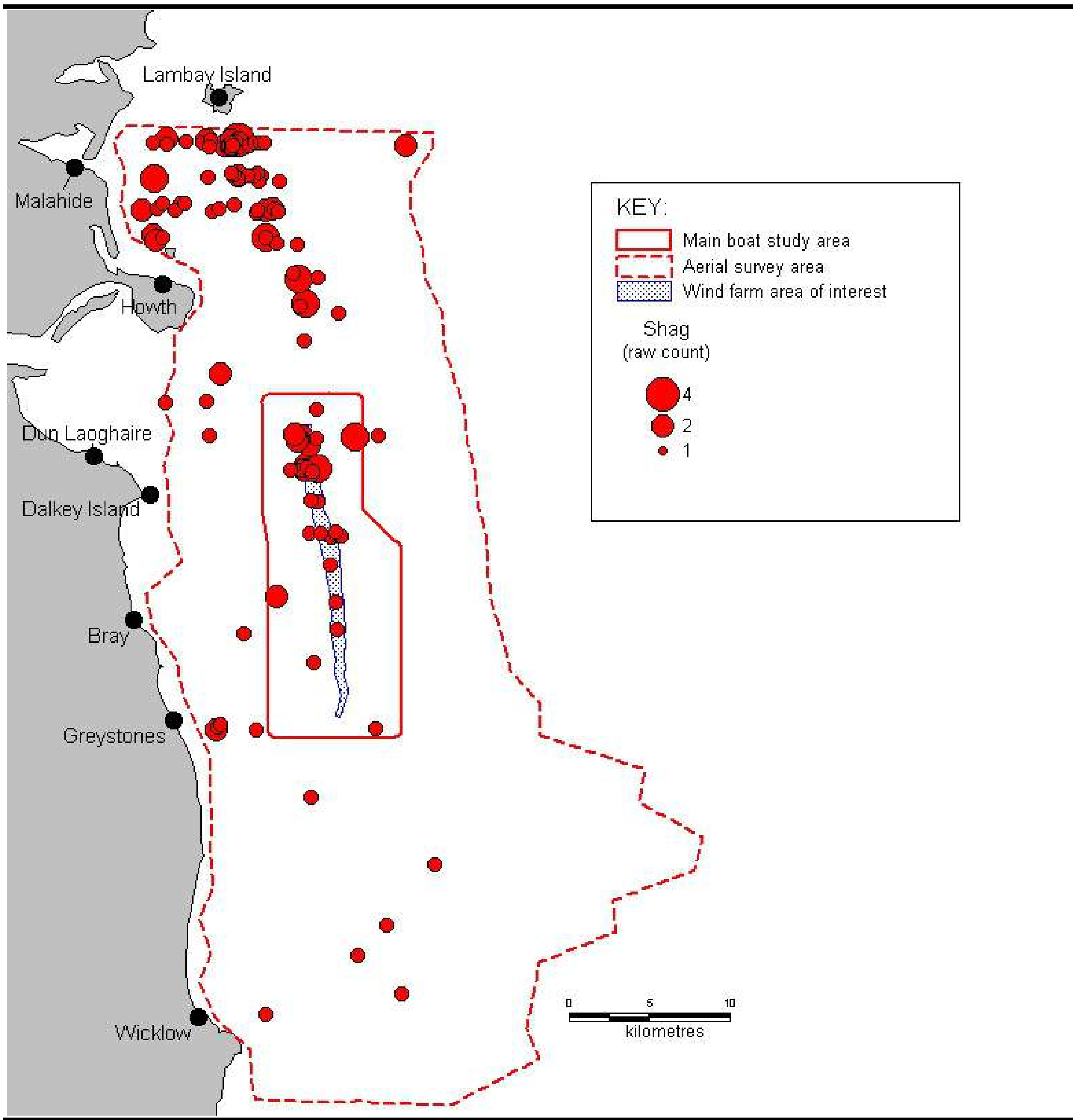
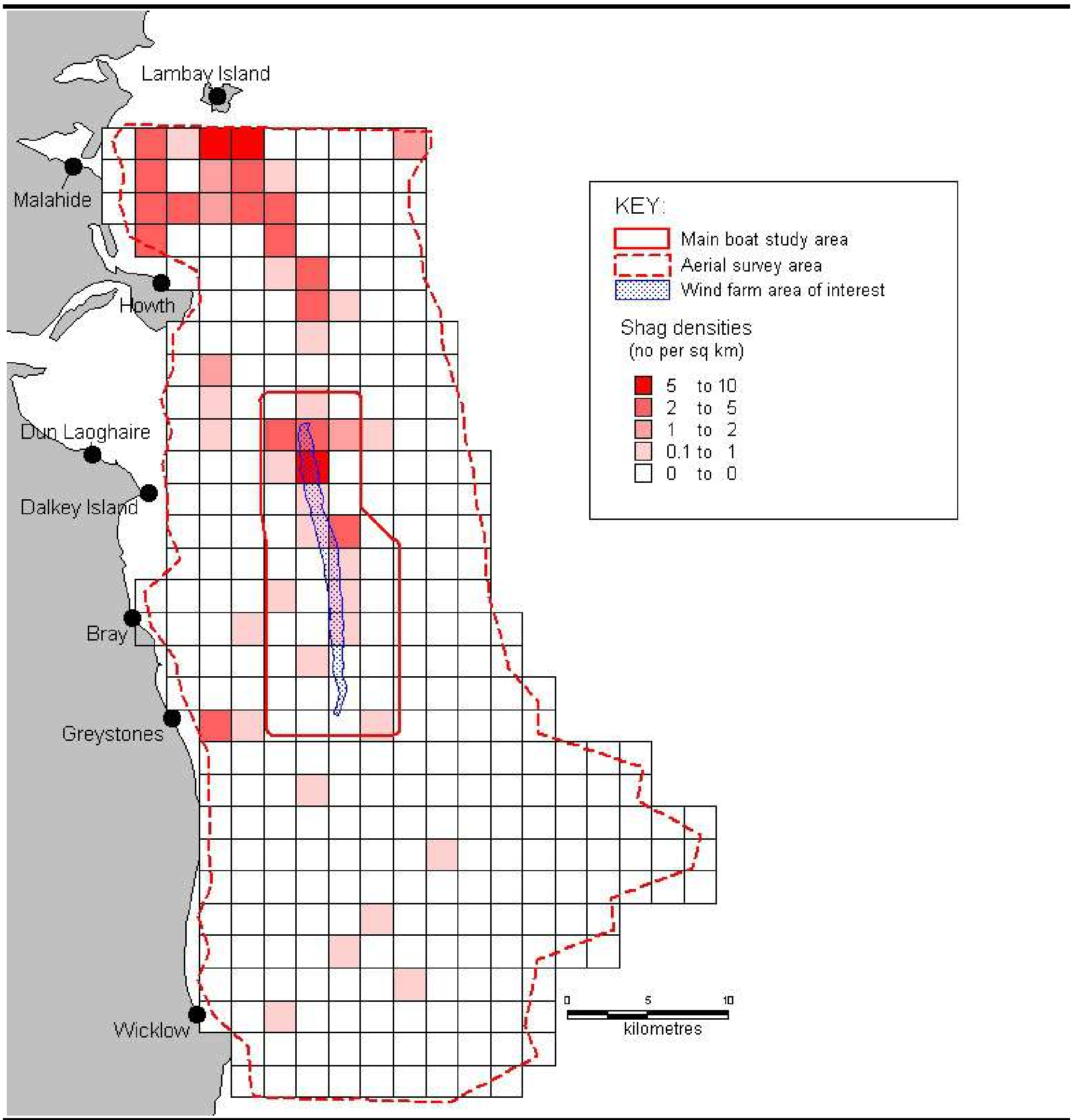
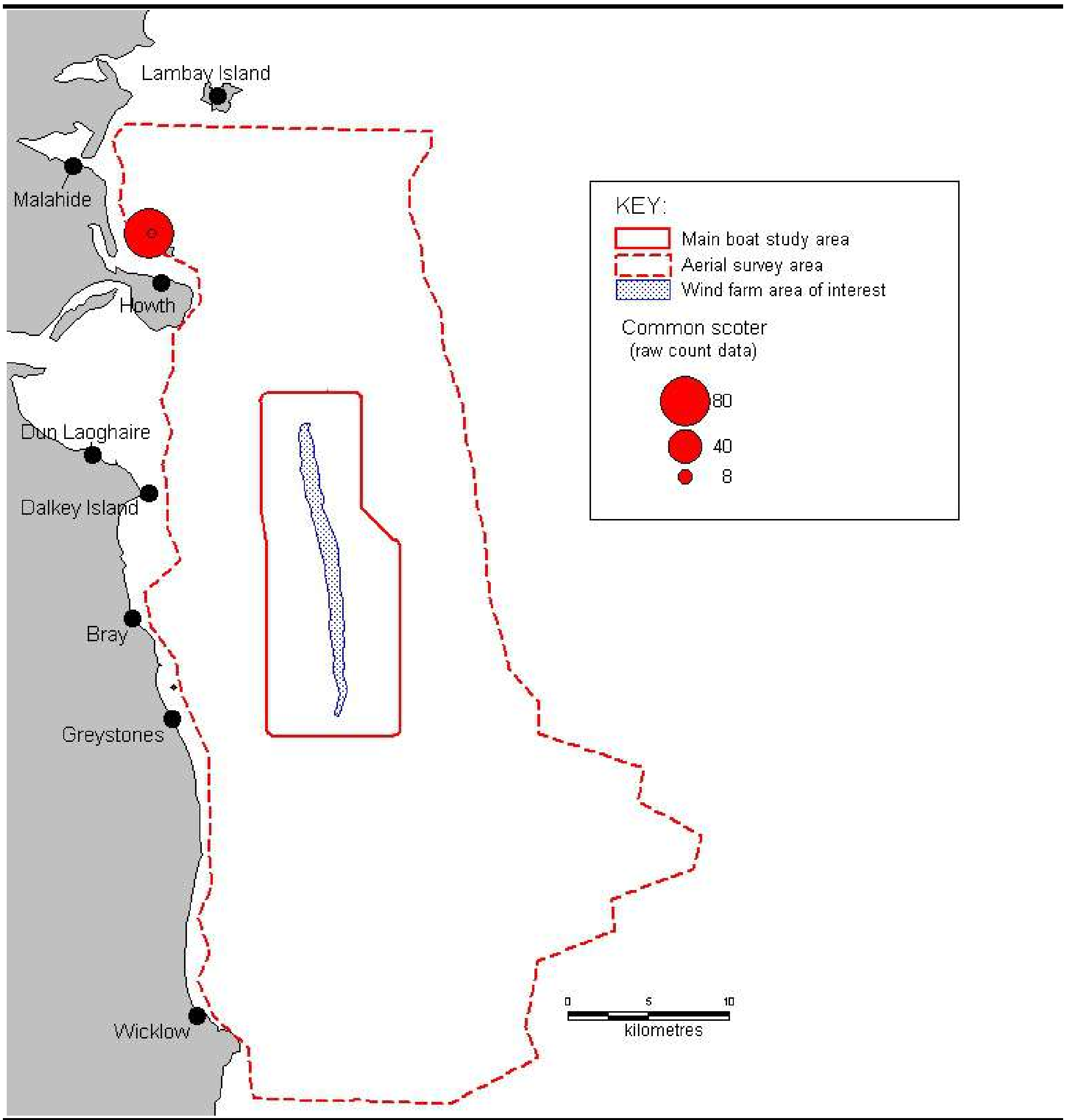


Figure 51. Distribution of shag sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of common scoter sightings is shown in Figure 52. This species was found in only low numbers within the whole of the aerial survey area. The only flock of any size was seen close inshore off Ireland's Eye in the north-west corner of the survey area. There were insufficient records to plot a meaningful density grid.

Figure 52. Distribution of common scoter sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of kittiwake sightings is shown in Figure 53. This species was found across most of the study area, though the numbers in the northern part of the aerial survey area (and particularly around the Kish Bank and just to the north) were comparatively high. The density of kittiwakes in each 2x2km grid square is shown in Figure 54, again highlighting the lower densities in the southern part of the aerial survey area.

Figure 53. Distribution of kittiwake sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

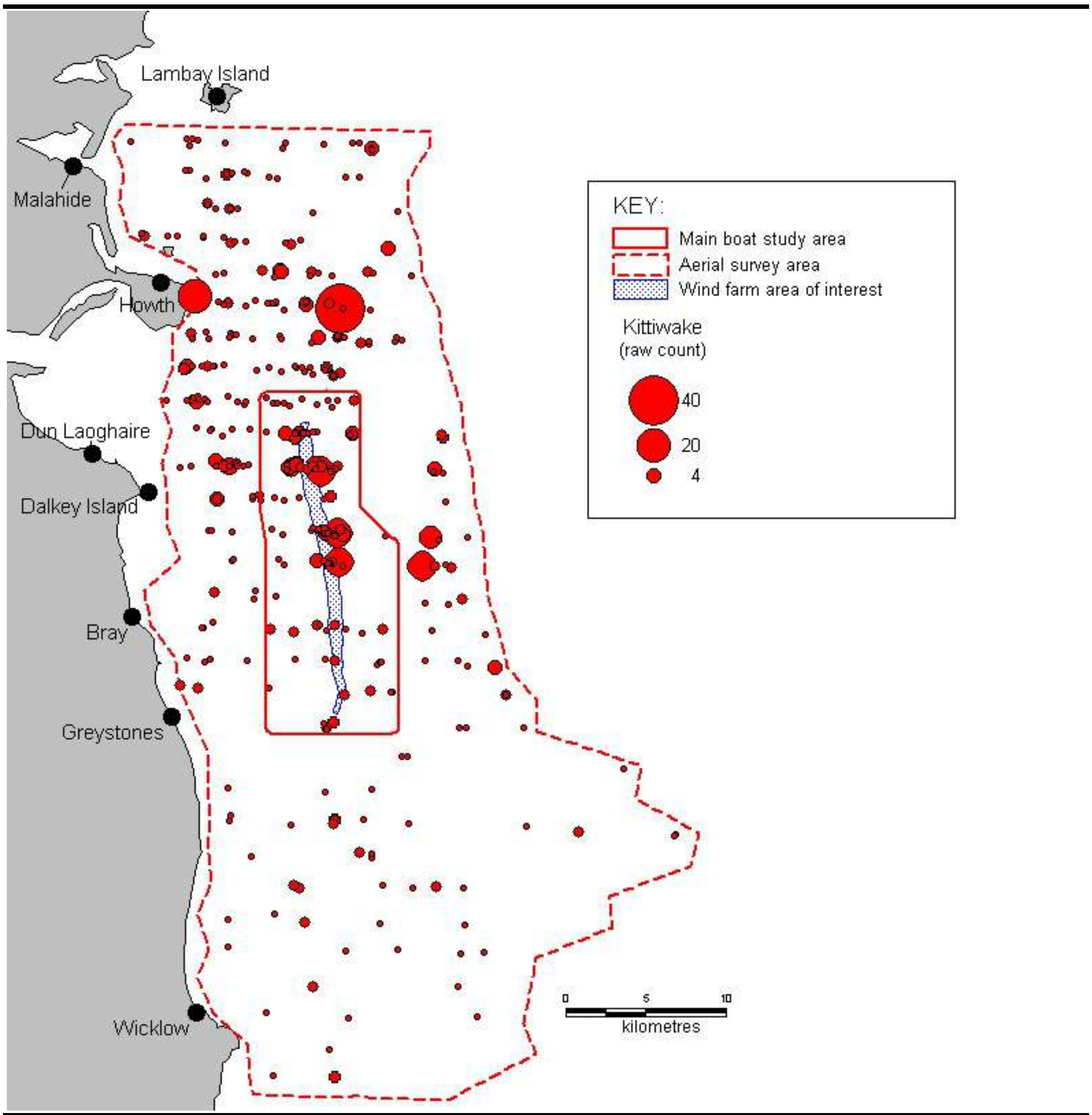
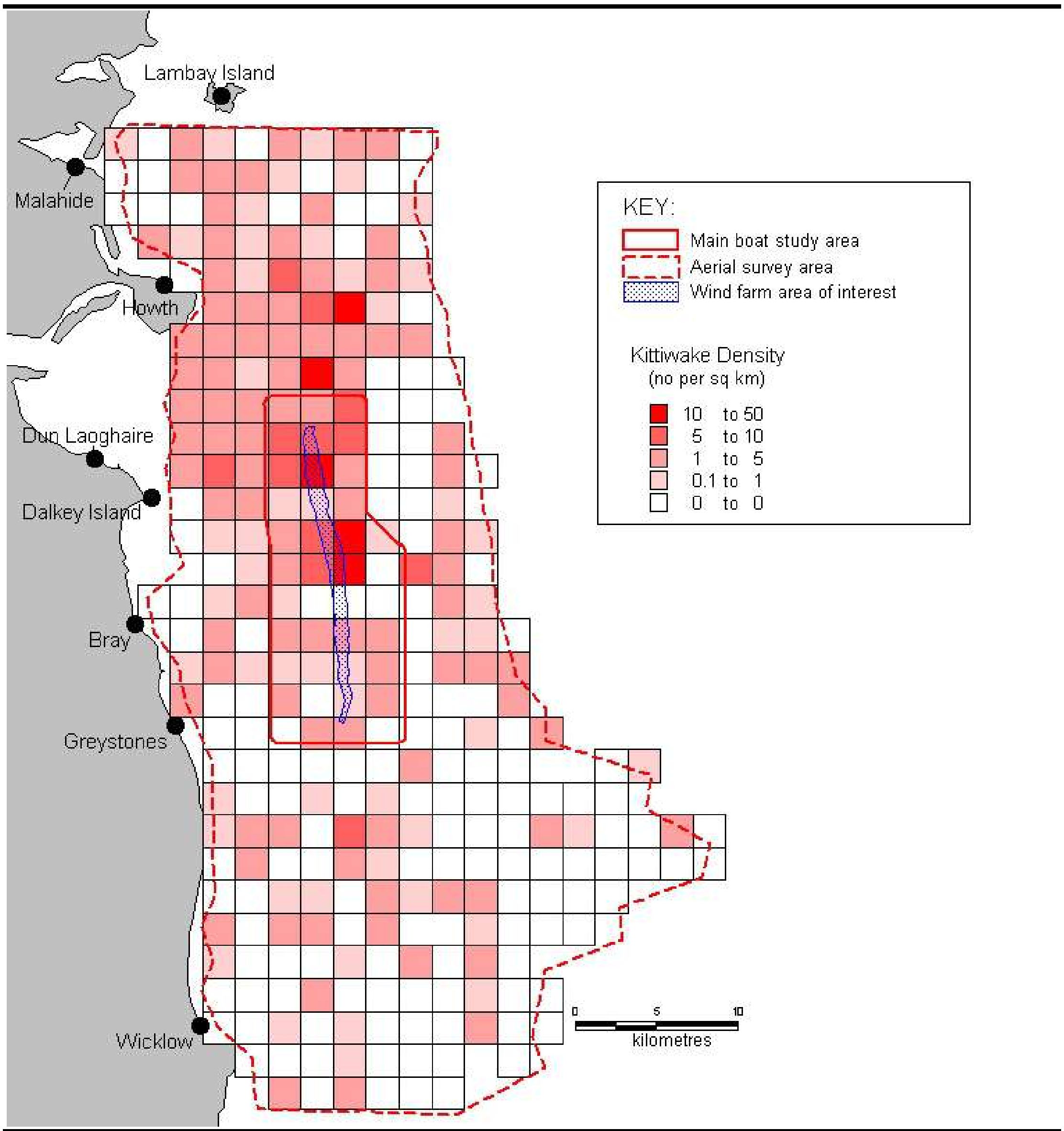


Figure 54. Kittiwake densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of other gull species (i.e. species other than kittiwake) sightings is shown in Figure 55. These birds were found across most of the study area, though with higher numbers within around the northern part of the Kish Bank. The density of other gull species in each 2x2km grid square is shown in Figure 56.

Figure 55. Distribution of other gull species sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

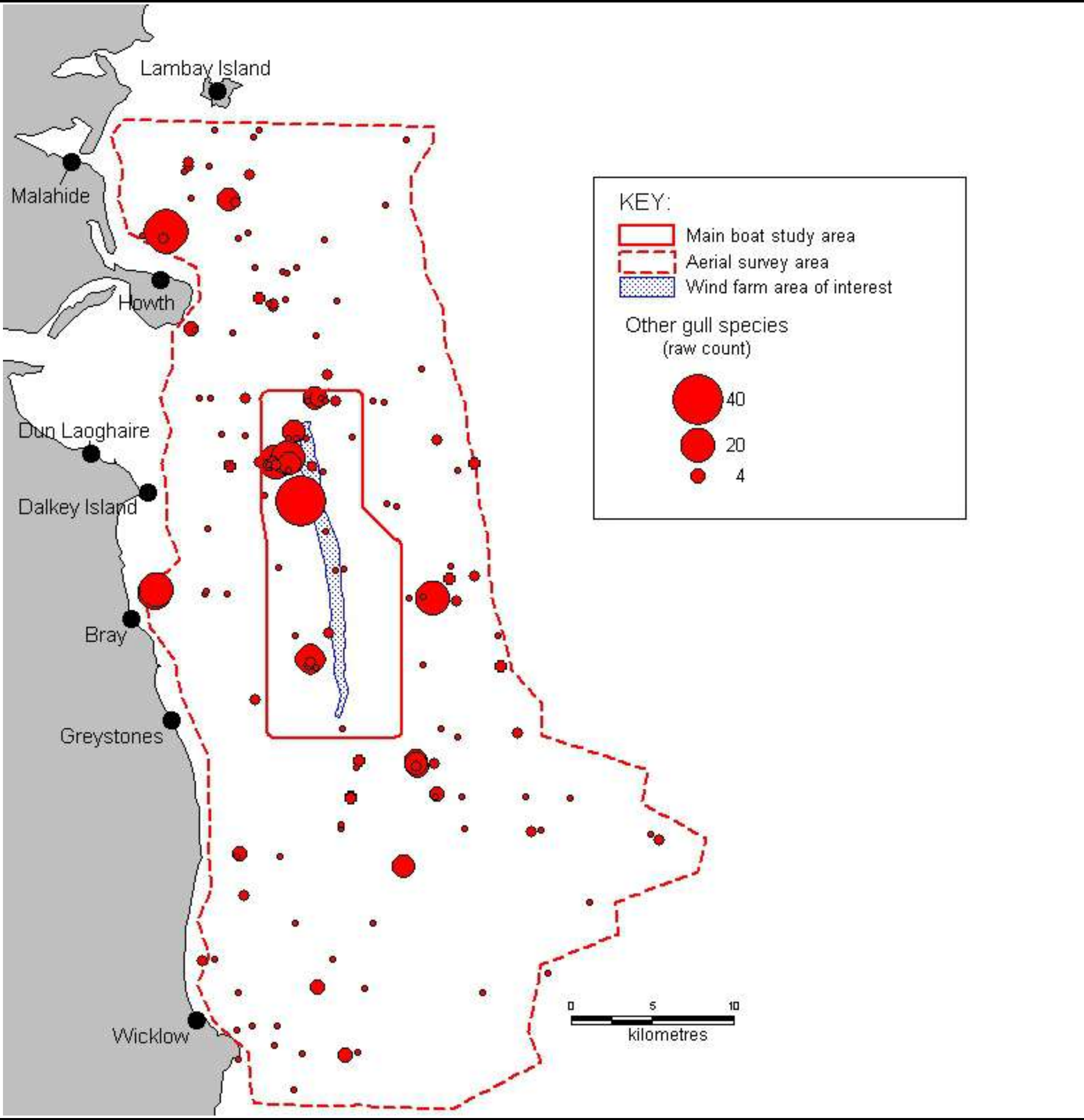
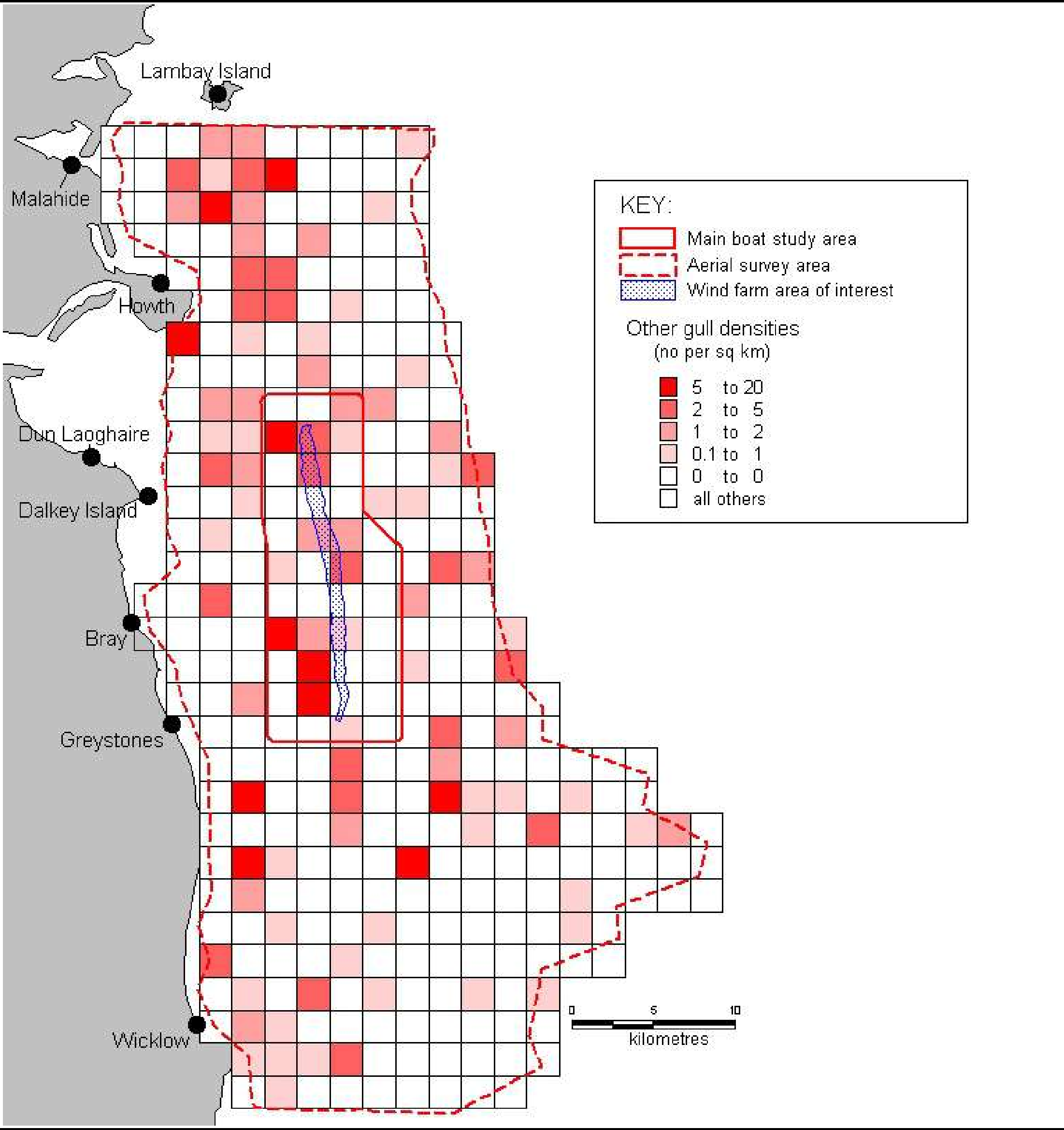


Figure 56. Other gull species densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



The distribution of auk sightings is shown in Figure 57. These birds were found across most of the study area. The density of auks in each 2x2km grid square is shown in Figure 58. Numbers were generally lower towards the southern edge of the aerial survey area but high elsewhere.

Figure 57. Distribution of auk sightings within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.

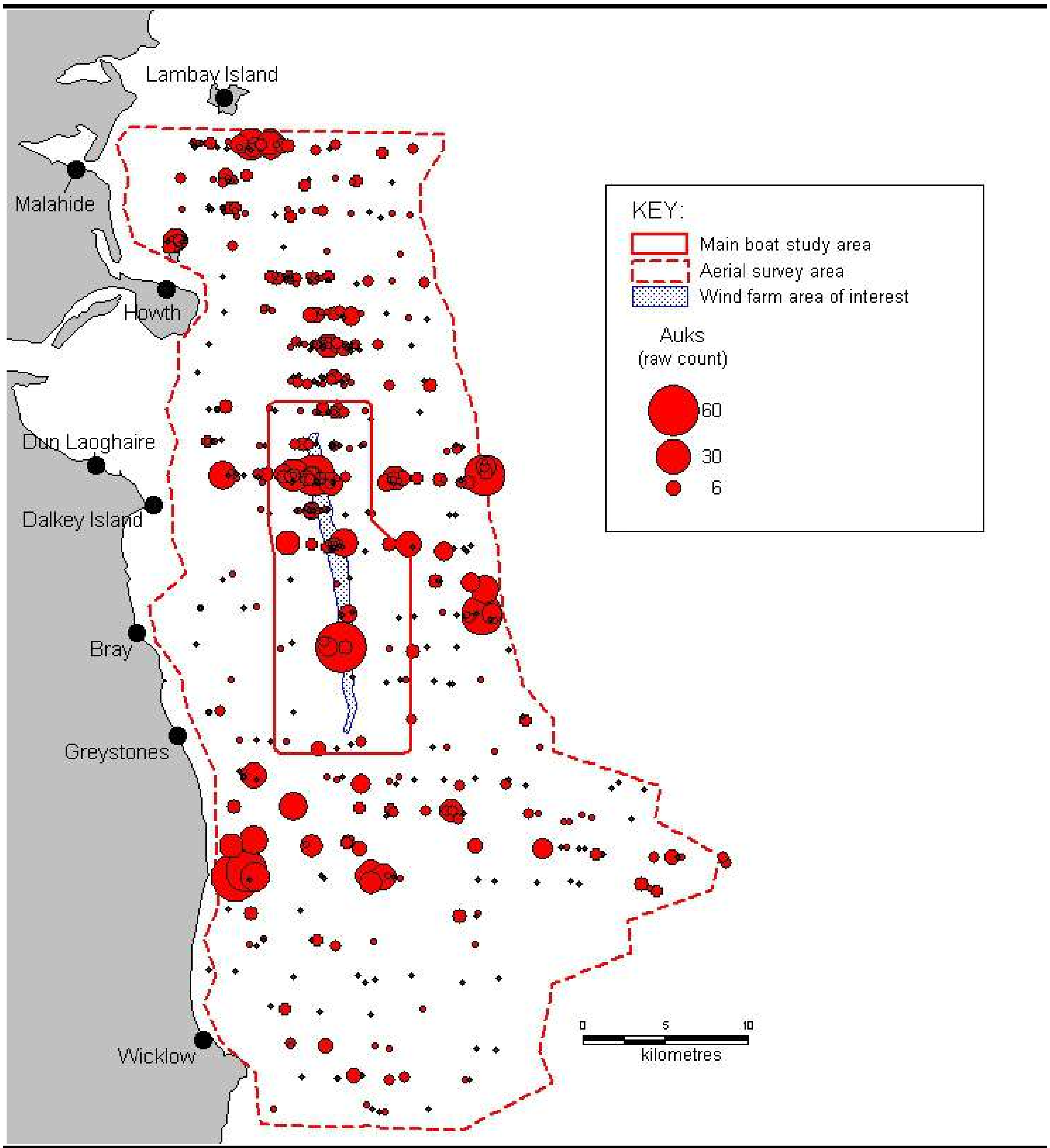
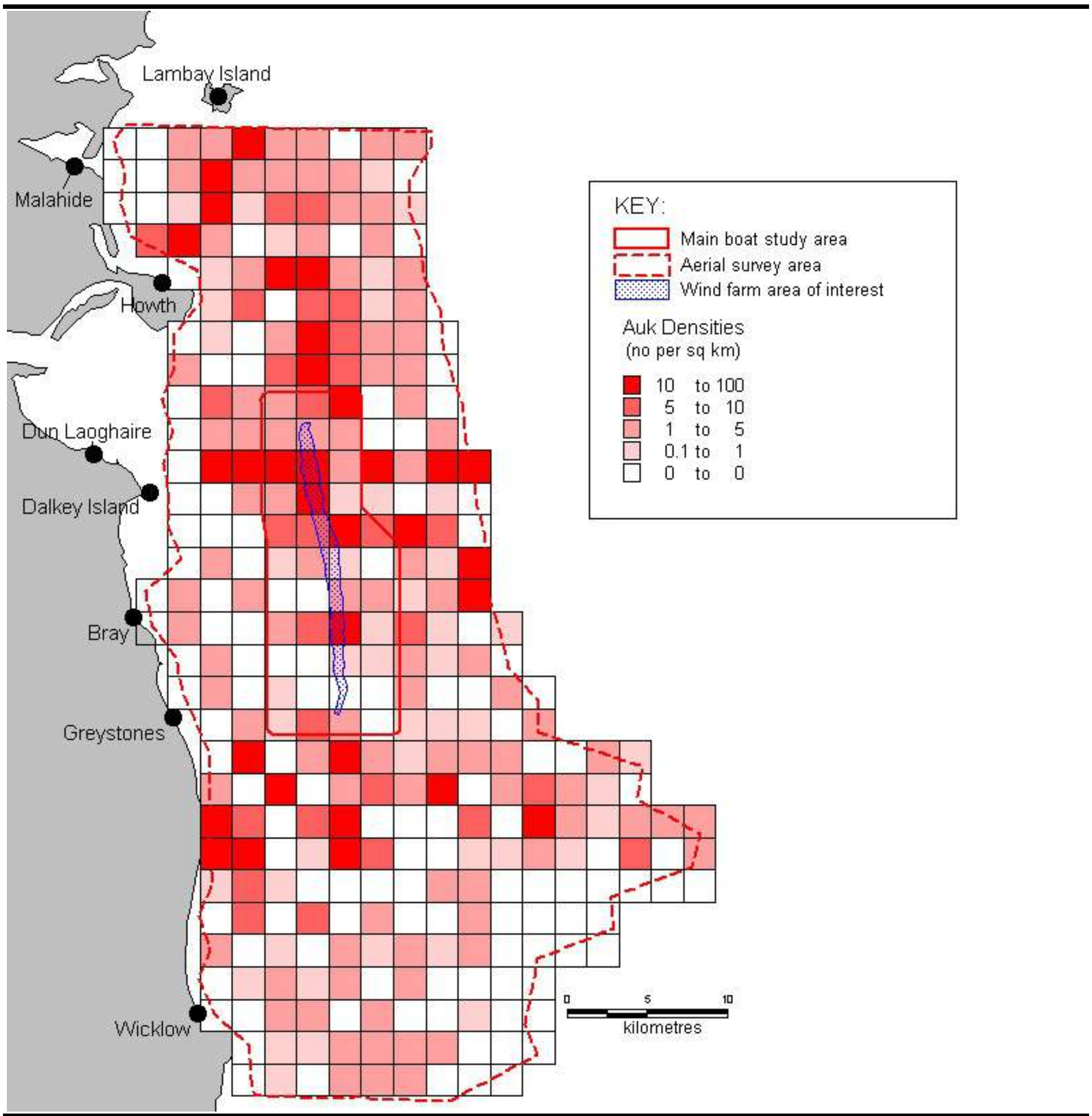


Figure 58. Auk densities within the aerial survey area and the main Kish Bank study area during the March and April 2002 aerial surveys.



Marine Mammals

The marine mammal populations (using data which have been adjusted to take coverage and distance from transect into account) recorded in the aerial survey area as a whole and within the main Kish Bank study area during each of the two aerial surveys are shown in Table 5. Generally the observed numbers of all of these species/species groups was low, with no important concentration noted during the aerial surveys.

Table 5. Estimated marine mammal numbers in the main Kish Bank study area and the whole aerial survey area during each of the two aerial surveys.

Species	March 15th 2002		April 9th 2002:	
	Main study area	*Whole aerial survey area*	*Main study area*	*Whole aerial survey area*
Dolphin sp.	4	17	7	24
Harbour porpoise	2	57	2	49
Seal sp.	4	14	0	11
Small cetacean sp.	0	5	0	5

Discussion and Conclusions

The survey results showed that the main Kish Bank study area held a range of important bird populations, including (based on the peak counts recorded) internationally important numbers of roseate terns, nationally important numbers of Manx shearwaters, shags, kittiwakes, common terns, guillemots and razorbills, and regionally important numbers of gannets, cormorants, and arctic skuas.

The seasonal pattern of occurrence of most of these species was marked, with generally many more birds present in the spring, summer and autumn surveys than in the winter. None of the thresholds of national importance, for example, were exceeded during the winter. These results would indicate that the study area is of international importance for post-breeding roseate terns in the autumn (Aug-Sep), of national importance through the spring, summer and autumn for Manx shearwaters, shags, kittiwakes, common terns, guillemots and razorbills but of rather less importance in winter (Nov-Feb).

The aerial surveys detected a similar range of species to the boat surveys, though in rather lower abundance. Densities of species in the study area for which aerial survey is particularly suited (especially common scoter) were generally low. The results suggest however that the boat surveys have not missed any important bird populations. The most likely explanation for the discrepancy between the boat and the aerial surveys is that the assumption that all the birds are seen within the closest distance band in the aerial survey may not hold true for some species, hence the resultant under-estimation of the total numbers present. The aerial surveys were very useful in providing a wider context for the main study area, and showed particularly than the areas to the north of the Kish Bank hold concentrations of most species of importance in comparable densities to those found on the Kish Bank itself.

The distributions of most of the seabird species were not uniform within the main Kish Bank study area (nor within the wider aerial survey area). The only species recorded in internationally important numbers, roseate tern, was largely restricted to the northern half of the Bank, with few records to the south of this. Most of the nationally important species had a wider distribution, though in most of these numbers were lower in the southern part of the Bank.

In the preliminary desk study carried out before field data were obtained a range of possible ornithological issues with a wind farm development in this area were identified. The most important of these was the possible impact on roseate terns. Surveys carried out previously by BirdWatch Ireland had suggested that important numbers of this species may use the area, and the field studies in 2001/02 showed this to be the case, with internationally important numbers of this species recorded.

The preliminary report considered the potential impacts and concluded that the risk of birds colliding with the wind turbines was likely to be small. However it was noted that the roseate tern is endangered in Europe, and the evidence on the population dynamics of this species suggests that even a small level of additional mortality could be significant (Cabot 1996, Nisbet and Spendelow 1999). With important numbers using the possible wind farm area and the lack of current knowledge about tern-wind farm interactions, it would not be currently possible to demonstrate that such an impact would not occur.

The other potential impact highlighted in the preliminary report was the possible displacement of foraging seabirds from the Kish Bank by the presence of the wind farm. This was identified as a potentially significant impact for rather more species of national importance. As stated in that report, shallower sea areas such as the Kish Bank are relatively scarce in this region, the Kish itself constitutes quite a large proportion of the available resource. Therefore any effective loss of habitat would be more likely to result in significant ecological consequences, such as reduced breeding success and increased mortality. Alternative feeding areas with similar characteristics may well be limited. Similarly for birds outside the breeding season, loss of feeding resources could be significant. Again, if a disturbance effect occurs, its ecological consequence would be dependent on the availability of alternative feeding areas. If such alternative areas were not available and then birds were unable to reach adequate body condition before migration, this could result, for example, in increased mortality rates.

The main problem still lies in the lack of information about how these species would be affected by the presence of a wind farm (Percival 2001a). However, given the importance of the area, a precautionary approach would need to be taken. This is particularly the case when the conservation status of the populations using the Kish Bank is considered. The Bank itself has sufficient conservation value to qualify for SPA status, solely on the grounds of the roseate tern numbers that use it. This is not, however, the only SPA issue, as many of the seabird populations using the Kish are very likely to be from designated SPAs nearby. This includes all of the following:

- Rockabill Island - breeding roseate and common tern.
- Skerries Islands - breeding shag and cormorant
- Lambay Island - breeding Manx shearwater, shag, guillemot, razorbill, fulmar, cormorant, kittiwake.
- Ireland's Eye - breeding gannet, cormorant, kittiwake, guillemot and razorbill.
- North Bull Island Dollymount - breeding common tern, passage roseate and other terns.
- Howth Head - breeding kittiwake and razorbill.
- Sandymount Strand / Tolka Estuary - breeding common tern, passage roseate and other terns.
- Wicklow Head - breeding kittiwake, razorbill, guillemot, fulmar and shag.

If birds feeding on the Kish and breeding/on passage at any of these other SPAs were affected, it is possible that the overall SPA populations of these species could be reduced.

With the current lack of knowledge about how seabirds are affected by wind farm developments it can be concluded at this stage that as far as the most sensitive bird issue on the site is concerned, roseate tern, it would be inappropriate to construct a wind farm within its main area of use (i.e. in the northern half of the Bank). It would not be possible to be sure that significant impacts would not occur, and hence the only current solution would be to locate the wind farm outside the area used by this species.

In terms of the nationally important species, there are potentially significant issues with regard to the impacts on the Kish populations themselves and also in terms of possible impacts on neighbouring SPAs for a range of species, particularly including Manx shearwater, shag, kittiwakes, common terns, guillemots and razorbills. A wind farm located at the southern end of the Kish Bank would be less likely to impact on most of these species, though not all of them. Razorbills, for example, were more abundant in this area. Thus the risk of significant impact would be reduced, but consultations with Duchas and BirdWatch Ireland would need to be undertaken to clarify their position as to whether this would be reduced to an acceptable level.

If it were acceptable to construct a wind farm at the southern end of the Kish Bank, this may provide an opportunity to obtain the data required on the actual effects of wind farms on seabirds, through a detailed monitoring programme. If these found impacts to be acceptable, then this may facilitate future development further north along the Bank.

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