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WESTISLAY TIDAL

ENERGY PARK

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technical appendices

DP ENERGY MARINE

DBE DEME Blue Energy

ENERGY PARK

volume 4 // appendix 10.1 //
summary of bird surveys technical report

West Islay Tidal Energy Park: Summary of Years 1 & 2 Bird Surveys Technical Report

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Introduction

1. This technical report summarises the two years of baseline characterisation seabird surveys undertaken between 2009 and 2011 to inform the environmental assessment of the West Islay Tidal Energy Park (WITEP) and forms Technical Appendix 10. 1 to Chapter 10 (Birds) of the WITEP Environmental Statement. It follows on from the Year 1 and Year 2 Technical Reports (hereafter referred to as the Y1 and Y2 reports, NRP 2011 and NRP 2012).

2. After the two-year survey programme was completed, the boundary of the area of interest (i.e., the proposed development area) was revised due to better spatial understanding of the tidal stream resource. It was reduced in size by two thirds (to 2.3 km^2) and repositioned approximately 2.4 km to the south-east (Figure. 1). Although the revised area of interest substantially overlaps the original search area it is no longer central located in the Survey Area 4km buffer (at its closest it is 2.7 km from the edge of the Survey Area). Furthermore, it means that the results in the Y1 and Y2 reports are no longer appropriately presented to inform the assessment of effects. The tables and text summarising seabird abundance in the Y1 and Y2 reports state abundance figures for the original search area rather than the final development site and so again are potentially misleading. Similarly, the maps presented in Y1 and Y2 reports show the original development search area, rather than the final development site and are therefore also potentially misleading.

3. Since producing the Y1 and Y2 reports the survey data have been further analysed using Distance analysis (Buckland *et al*. 2001) by Caloo Ecological Services. These analyses provide more rigorous estimates with confidence intervals of seabird abundance and density in for the survey area and sub-divisions thereof on each of the 20 survey visits. The details of the statistical analysis undertaken and the results form an Annex at the end of this report.

4. In addition to the Survey Area centred on the development search area, breeding season surveys were undertaken along two corridors linking the search area to the two closest large seabird colonies, located at Rathlin Island and Colonsay respectively. Both these sites are designated as Special Protection Areas and the purpose of these 'SPA corridor' surveys was to examine how seabird numbers varied with distance from the colonies and thereby better understand the extent of any connectivity between these colonies and the search area.

5. This report addresses a number of comments made by SNH and MSS in response to Y1 and Y2 report and at a subsequent meeting held in June 2012. In particular the Year 2 gap in autumn coverage caused by poor weather and the sampling bias towards neap tides.

The Development Search Area

6. The original Development Search Area is located approximately 8 km west of the south-west tip of the island of Islay off the west coast of Scotland. The site is centred on latitude 55.67^0 N and longitude 06.63^0 W and is 8.5 km^2 in size (Figure. 1).

7. Water depths across the survey area vary from 25 to 50m LAT. The seabed is characterised by a rock outcrop extending south-west from the Rinns of Islay and gravely sand with superficial sediment.

8. No part of the Development Search Area lies within a site designated as a Special Protection Areas (SPA) or a Site of Special Scientific Interest (SSSI). However, there are several SPAs and SSSIs in the wider region designated for their seabird populations.

9. The closest seabird breeding colony designated as an SPA is Rathlin Island (Northern Ireland). This is located approximately 50 km SE of the Development Search Area. Common guillemot, razorbill and kittiwake are species of qualifying interests at this SPA.

10. The next closest breeding seabird SPA is the North Colonsay and Western Cliffs SPA on Colonsay. This SPA is located approximately 60 km NE of the Development Search Area. Common guillemot, razorbill and kittiwake are species of qualifying interests at this SPA (Figure 1).

Scope of Studies

11. The survey work had three broad objectives:

- To determine baseline condition required for assessing the likely effects of the proposed development.
- To establish baseline conditions against which any future changes can be compared.
- To put the survey results into the context of other information on seabird population using the region.

12. Specific aims were:

- To determine the year-round distribution and abundance of birds using the Development Search Area and a 4-km wide surrounding buffer (this is referred to as the 'main survey area'),
- To determine how the summer densities of common guillemot, razorbill and kittiwake vary between the proposed Development Search Area and the two closest SPA seabird colonies, namely North Colonsay and Western Cliffs SPA and Rathlin Island SPA.

Methods

Survey Design

13. When the survey was designed in 2009 the SNH draft survey guidance for 'wet' renewable developments (Jackson and Whitfield 2011, Macleod *et al*. 2011) was not available. Furthermore there were no previous commercial tidal turbine arrays in Scotland to draw experience or lessons from.

14. The COWRIE survey guidance for offshore windfarms was taken as a starting point (Camphuysen *et al.* 2004). This guidance advises that the European Seabird at Sea (ESAS) method is the most appropriate for offshore sites.

15. The main survey area comprised the Development Search Area (covering 8.5 km^2) plus a 4-km wide surrounding buffer area (covering 98 km^2). A 4-km wide buffer is typically used for offshore windfarm surveys and was endorsed by SNH at the scoping stage (Figure 1).

16. Seven parallel transects spaced 2 km apart and orientated WSW – ENE, approximately perpendicular to the major environmental gradients of tidal current and bathymetry, formed the layout of the survey (Figure 1). The choice of spacing and orientation was in line with the guidance for offshore windfarms (Camphuysen 2004). Orientating transects perpendicularly to the direction of tide currents had the further advantages of minimising the potential problems of over or under recording birds due to the relative movement of the sea surface to the vessel during strong tidal conditions.

17. The two outside transects were extended to be the same length as their neighbours (Figure 1) to aid density interpolation and to allow for the possibility of analysing survey data with formal Distance Sampling methods (Buckland 2001) should this be appropriate in future. For example, this type of analysis would improve the power to detect changes over time from a period of monitoring spanning several years.

18. The seven transects totalled 64.6 km.

19. In the summer months additional survey work was carried out along two corridors stretching from the main survey area to the North Colonsay and Western Cliffs and Rathlin Island SPAs respectively. The design of this element of the survey programme in covered below in the section on ‘SPA corridor surveys’ (Figure 1).

Survey Method

20. The European Seabirds At Sea (ESAS) survey method was used for all survey work (Camphuysen 2004).

21. Surveys were conducted approximately monthly throughout the year. The site experiences strong tidal currents (up to approximately 8 knots) and this potentially causes serious practical difficulties to conducting surveys at a constant speed. Strong tidal currents can also tend to increase sea state conditions especially when it is wind against tide. To minimise these difficulties, survey work was avoided during periods of strong spring tides.

22. Detection rates of birds on the sea are reduced in high sea states. In compliance with ESAS guidelines (Webb & Durinck 1992, Camphuysen *et al*. 2004), survey work was not conducted in persistent conditions above sea state 4. The sea state and swell conditions at the time of survey work of each transect are summarised in Appendix 1.

23. The survey vessel was used simultaneously by a team of surveyors conducting ESAS surveys (primarily aimed at recording seabirds) and a team surveying only marine mammals and sharks. Both sets of surveyors operated from the same observation platform (Data on marine mammals and sharks are reported in (Technical Appendices 7.1 and 7.2).

24. Three different survey vessels were used over the course of the two year period; The MV Aora, the MV Seahorse and the MV Elizabeth G (illustrated in Photo 1). All three vessels complied with the recommendations for COWRIE offshore surveys in terms of their size, stability, survey speed and size and height of the observation deck. The MV Aora was used for all but two of the surveys.

Photo 1. The three vessels used for the surveys. MV Aora (top, 22 m), MV Elizabeth G (middle, 22.8 m), MV Seahorse (bottom, 26 m).

25. The survey vessel normally maintained a constant speed of 10 knots, the recommended speed for bird survey work (Camphuysen et al 2004). This meant that the snapshot interval used to assess if flying birds were in transect (within a rectangle 300m x 300m stretching out and forwards from the vessels) was 1 minute. At times the survey vessel went slower (as low as 8 knots) in which case the snapshot interval was adjusted accordingly.

26. The seven transects and the cable route typically took slightly under five hours to survey in their entirety. Surveyors had a break of approximately 10-15 minutes between each transect.

27. Surveyors recorded all birds seen within 300m of the transect line (to one side of the survey vessel). The species, number, plumage, activity, flight direction, distance-band from the boat (0-50m; 50-100m; 100–200m; 200-300m), and whether flying birds were in transect were recorded.

28. The position of the survey vessel was automatically recorded by GPS every 30 seconds.

29. The survey conditions prevailing at the time survey work were recorded in terms of sea state, swell height, wind force and direction, precipitation and sun glare.

30. Surveys were conducted approximately monthly throughout the year. The site experiences strong tidal currents (up to approximately 8 knots) and this potentially causes serious practical difficulties to conducting surveys at a constant speed. Strong tidal currents can also tend to increase sea state conditions especially when it is wind against tide. To minimise these difficulties all survey work was conducted in the neap tide cycles, when tidal currents are weaker.

31. With the exception of one winter survey in Year 1 when only one surveyor was available, two ESAS bird surveyors were used on each visit. On all but two surveys all surveyors were experienced and accredited ESAS surveyors. One the two surveys when the survey team included a non-accredited surveyor, their contribution was restricted to scribing.

SPA Corridor Surveys

32. Additional survey data was collected to help to establish the importance of the survey area to common guillemots, razorbills and kittiwakes breeding at the North Colonsay and Rathlin Island SPAs. These are situated approximately 60 km NE and 50 km SE from the Development Search Area, respectively and as a consequence the Development Search Area is potentially within the foraging range of these species when they are breeding at these two SPA's.

33. Additional data to inform this subject was gathered by undertaking surveys along two corridors stretching from the main survey area (the edge of the 4km buffer) directly towards each of the SPAs (Figure 1). In both cases the corridor comprised two transect lines 2 km apart. The corridor directed towards North Colonsay followed a kinked route to avoid shallow water off north-west Islay; these transects were kept approximately parallel to the coast of Islay and Colonsay (Figure 1).

34. The SPA corridors were surveyed using exactly the same methods as the main survey area and the cable route.

Statistical Analyses

35. As explained in detail in Annex 1 (Caloo Ecological Services statistics report), four methods were used to estimate bird densities. Distance analyses was undertaken to give a population

density estimate with confidence limits for the entire survey area (Method 1). These density estimates can be used to infer the likely average numbers in sub-divisions of the survey area if it is assumed that birds are distributed randomly. However, for some species there is evidence (e.g., from the mapped distribution of records and encounter rates) that this assumption is not true, in which case density estimates specific to a sub-division of interest are preferable. Nigel Harding has also undertaken Distance analyses using a subsample of the overall survey data to estimate densities in three subareas (Methods 2, 3 and 4) and for some species the density values derived from these may be more appropriate for estimating the numbers of birds likely to be affected in the anticipated impact footprint. Irrespective of the method used to estimate bird density, the estimated number in the anticipated impact footprint is calculated by multiplying density by area. The four methods used are explained in full in Appendix 1 and are as summarised follows:

- **Method 1**, all records from all transects, i.e. the Distance design-based estimate for the whole survey area;
- **Method 2**, records from the portion of all transects overlapping a band defined by the width (maximum WSW – ENE dimension) of the development area (see Figure 2 in Annex 1);
- **Method 3**, records from the portion of all transects overlapping a band defined by the width (maximum WSW – ENE dimension) of the development area buffered to 1 km (see Figure 3 in Annex 1);
- **Method 4**, records only from the portions of the transect overlapping the development area buffered to 1 km (i.e., approximately the central parts of transects T4, T5 and T6 only) (see Figure 3 in Annex 1).

36. A fifth method using only data from the portions of the transects overlapping the DA was also considered but the number of records available in this very restricted area were too few to undertake a meaningful analysis.

37. Guillemots and razorbill are similar in their appearance and some individuals could not be identified to species level during surveys, for example some birds seen in poor light in the outer parts of the survey strip. In all survey visits the vast majority of individuals of these two species were positively identified. The results for these two species were examined in a number of ways (see Annex 1). For the purposes of estimating mean abundance for environmental assessment the density estimates based on apportioning unidentified birds in accordance to the ratio of positively identified individuals on that survey visit were used (these are labelled '*guProp*' and '*rxProp*' in the Excel worksheets). This was considered to be the best way of dealing with this issue as it makes best use of the available data without introducing obvious biases.

38. These statistical results have been commented on my MS and SNH and they have advised that for assessment purposes the estimated abundance of a species in the anticipated impact footprint should be derived from the density figures calculated from the entire survey area (letter 12 March 2013). This method (Method 1) uses all the available data and has the advantage of producing estimates with the smallest confidence intervals.

39. An aim of this report is to determine from the baseline survey data the importance of the area potentially affected by the development (i.e., the anticipated impact footprint) to each seabird species. This was calculated from the average number of a species present in a particular season and comparing this to the size of the regional population. In the case of seabirds, the appropriate anticipated impact footprint for assessing potential impacts is taken as being

either development area (DA) alone or the development area buffered to 1km (DA+1km). The Importance is examined for the breeding season (the period when adults are attending colonies, for most species taken as April to August) and the autumn and winter period (for most species taken as September to March). For guillemot and razorbill a post-breeding period (August and September) is also considered.

40. The results of the Distance analyses are presented in full in Annex 1. The mean densities and estimated mean abundance for the breeding season and autumn/winter period are shown in Tables 4 to 6.

Unidentified guillemots and razorbills

41. Guillemots and razorbill are similar in their appearance and some individuals could not be identified to species level during surveys, for example birds seen in poor light in the outer parts of the survey strip. In all survey visits the vast majority of individuals of these two species were positively identified. For the purposes of estimating abundance the unidentified birds in a survey visit were included in estimates by apportioning them in accordance to the ratio of positively identified individuals on that survey visit (full details in Annex 1). This method is recommended by Maclean *et al*. (2009) and was considered to be the best way of dealing with this issue as it makes best use of the available data without introducing obvious biases.

Regional population context

42. There is no guidance or accepted division of the seas around Scotland into regional units that can be used to provide consistent context for evaluating results. This is a subject that SNH is currently developing guidance on. Providing context by comparing survey results with the numbers of birds in the relevant SNH Natural Heritage Zone (NHZ), in line with convention for on-shore renewable development, is not considered appropriate for two reasons. First, although the Project is located approximately centrally within NHZ 14 (Argyll West and Islands), it is approximately equally as close to seabird colonies in Northern Ireland as it is to Scottish colonies in NHZ 14. Second, for species with particularly large foraging ranges (i.e., mean maximum foraging ranges in excess of 150 km, such as gannet, fulmar and Manx shearwater), it is obvious that NHZs (including NHZ 14) are inappropriately small as individual of these species are likely to range well beyond the boundaries of an individual zone during their day-to-day activities.

43. For all species with mean maximum foraging range (Thaxter *et al*. 2012) of less than 150 km, the regional breeding population is defined as the sum of the population in Argyll and Bute and County Antrim as reported in the Seabird 2000 census (Mitchell *et al*. 2004). Argyll and Bute approximately corresponds to NHZ 14. County Antrim corresponds to the closest section of coastline in Northern Ireland and includes Rathlin Islands, the largest seabird colony in Northern Ireland. For the three species with mean maximum foraging ranges in excess of 150 km (gannet, fulmar and Manx shearwater) the number breeding in southern half of western Scotland (South of a line between the Sound of Harris and Skye) and all of Northern Ireland is considered to be a more appropriate regional breeding population. Specifically in the case of gannet, the only colonies within this area are Ailsa Craig and Scare Rocks and these are also the only colonies within the mean maximum foraging distance (229 km) from the project site. Specifically in the case of Manx Shearwater, the defined region includes colonies on Rum, Canna, Treshnish Islands, Sanday and the Copeland Islands.

44. The size of regional populations present in the winter not known precisely. However, winter distributions and density of seabird species around the UK as a whole are relatively well

understood (e.g., Kober *et al*., 2009) but regional populations sizes have not been calculated. The marine extent of NHZ 14 effectively reaches as far as the Irish coast and is approximately 12,000 km^2. This area multiplied by the average density was used to give an approximate indication of the total numbers of most species likely to be present in the region in winter. Arguably a larger area than the marine extent of NHZ 14 should be used for the wintering population regional context. However, this is academic as the conclusions of the environmental assessment would not be affected (defining a larger winter region would inevitably dilute any regional impact arising from the project over a wider area and a larger number of birds).

45. For shag and black guillemot, species that are largely sedentary or move only short distances (Wernham *et al*. 2002) the size of the regional wintering population is assumed to be the same as the breeding population.

Results

Survey Effort

46. The survey programme planned to undertake a single survey visit each month over a two year period starting in October 2010. However, persistent poor weather and high sea states prevented delayed the start of the survey programme until November to2010 and on several subsequent occasions resulted in postponed or cancelled survey work. On some occasions it was possible to make up for a missed survey month in the following month, but this was not always possible. In particular, it proved not possible to undertaken any survey work in the whole period from September to December 2011. A total of 20 survey visits were completed over the two year period (Table 1).

47. 90% of planned breeding season visits were achieved (Table 2); this is arguably the more important half of the year due to the possible presence of birds breeding in the study area from SPA populations.

48. The shortfall of visits in the autumn and winter months of Year 2 is unfortunate, but these periods received relatively good coverage in Year 1, the results of which revealed low birds densities in the survey area. The autumn/early winter gap in Year 2 coverage is not considered likely to undermine the survey conclusions because it falls out with the breeding season and this period was well covered (three surveys) in Year 1.

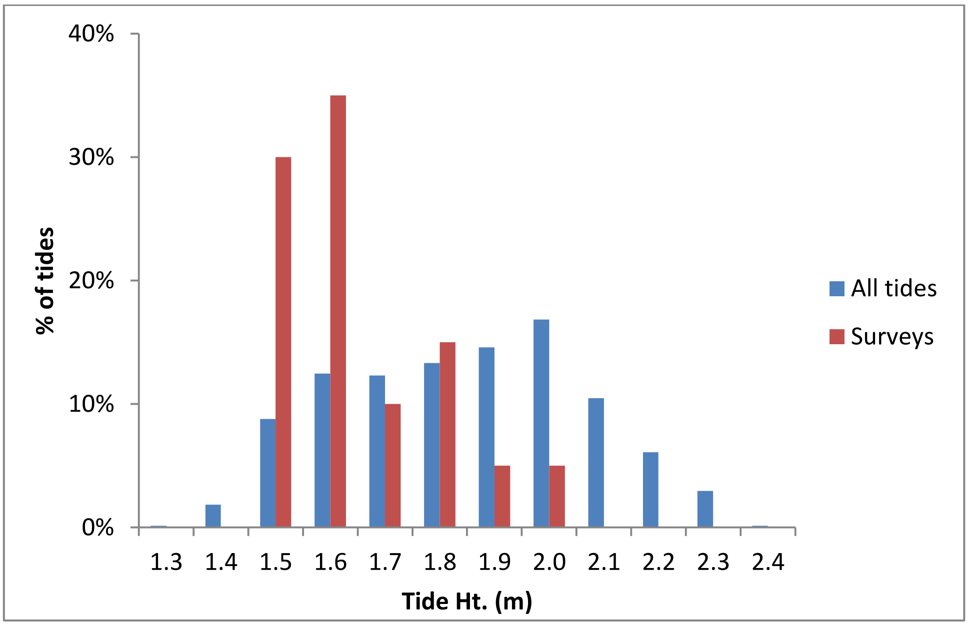
49. The Rathlin Island ‘SPA corridor’ was surveyed on four occasions in Year 1 (11 May, 23 June, 21 July and 19 August 2010) and three occasions in Year 2 (28th April, 29th June and 27th July 2011).

50. The Colonsay ‘SPA corridor’ was surveyed on three occasions in Year 1 (22 June, 20 July and 18 August 2010) and on four occasions in Year 2 (27th April, 8th June, 28th June and 26th July 2011).

Tidal bias

51. For operational and safety reasons the main boat operator advised against surveying in peak spring tides periods. This meant that there was inevitably a bias towards sampling in neap and intermediate tide series. It is not known if this bias affected the results, however it is considered unlikely that it had a significant effect. The distribution of birds within the survey area shows no clear correlations with tidal current strength (the development area was chosen because it has particularly strong currents).

52. The extent of bias towards neap and intermediate tides is examined in the histogram below.



Species Accounts

53. The accounts that follow discuss the survey results for the 13 seabird species that were either commonly occurring or of particular conservation importance. Species are presented in the Voous taxonomic order. Results for four species, namely common guillemot, razorbill, puffin and kittiwake are examined and discussed in greater depth than other species because of the SPA interest of these species.

54. Records of seabird species that were seen only irregularly and in low numbers are summarised in Table 3 but are not discussed further as these species are judged to have no relevance to the proposed development.

Fulmar

55. The average density of fulmar present in Year 1 and Year 2 breeding seasons was 0.36 birds/km^2, equivalent to an average of 0.8 birds in the DA and 4.8 birds in DA+1km (Table 4 and 5). These numbers represent <0.01% and approximately 0.01% respectively of the regional breeding population of 21,704 pairs (Table 6).

56. The average density of fulmar present in Year 1 and Year 2 autumn/winter periods was 0.26 birds/km^2, equivalent to an average of 0.6 birds in the DA and 3.4 in DA+1km (Table 7). These numbers <0.01% and approximately 0.03% respectively of the assumed regional wintering population of approximately 12,000 birds (Table 7).

57. The densities of fulmars recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 4 and 5) (Kober *et al.* 2000).

58. Approximately 18% of fulmars were recorded on the sea (Table 8).

59. Fulmars were distributed approximately evenly across the main survey area (Figures 2 and 3).

Manx shearwater

60. Manx shearwaters were present in the survey area in moderate numbers during the spring and summer months (April to August) and was the third commonest species encountered in the main survey area. Manx shearwaters were not recorded in the autumn and winter months.

61. The average density of Manx shearwaters present in Year 1 and Year 2 breeding seasons was 0.96 birds/km^2 (Table 4), equivalent to an average of 2.2 birds in the DA and 12.6 birds in DA+1km. Both these numbers represent <0.01% of the regional breeding population of 126,366 pairs (Table 6).

62. Approximately 13% of Manx shearwaters were recorded on the sea (Table 8).

63. Manx shearwater range very widely, both within and outside the breeding season and before they attain breeding age. Therefore, the birds seen in the survey area are likely to originate from several colonies in the defined region including the very large colony on Rum (120,000 pairs (AOSs) and the Copeland Islands (4,800 pairs) (Mitchell *et al.* 2004) as well as various smaller closer colonies.

64. The densities of Manx shearwater recorded in the main survey area in breeding season and are in line with previous survey results for this species in the region (Tables 4, Kober *et al.* 2000).

65. Manx shearwaters were distributed unevenly across the main survey area with the greatest number of records in the eastern half of the survey area, especially in Year 2, which includes the development area (Figure 4).

Storm petrel

66. Storm petrels were only recorded in the surveys area between April and August, and then only in small numbers, with a total of 11 birds being seen over the two survey years of which seven were in transect at the time.

67. The average density of storm petrels present in Year 1 and Year 2 breeding seasons was 0.03 birds/km^2 (Table 4), equivalent to an averages of approximately 0.1 birds in the DA and 0.5 birds in DA+1km . Both these numbers represent <0.01% of the regional breeding population of 5,248 pairs (Table 6).

68. All of the storm petrels recorded were flying (Table 8).

69. The densities of storm petrel recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 4 and 5, Kober *et al.* 2000).

70. The closest large storm petrel breeding colony is located on the Treshnish Isles, off Mull with 5,040 pairs (AOSs), there are also approximately 200 pairs (AOSs) breeding on Sanda (Argyll) (Mitchell *et al*. 2004).

71. Storm petrels were distributed approximately evenly across the main survey area (Figure 5).

Gannet

72. The average density of gannets present in Year 1 and Year 2 breeding seasons was 0.71 birds/km^2, equivalent to averages of 1.6 birds in the DA and 9.4 birds in DA+1km. These

numbers represent <0.01% and approximately 0.01% respectively of the regional breeding population of 34,408 pairs (Mitchel *et al*. 2004) (Table 6).

73. The average density of gannets in the Year 1 and Year 2 autumn/winter periods was 0.14 birds/km^2 (Table 4), equivalent to averages of 0.3 birds in the DA and 1.8 in DA+1km. These numbers represent approximately 0.01% and approximately 0.03% respectively of the assumed regional wintering population of approximately 6,000 birds (derived from Kober *et al.* 2000) (Table 7).

74. The densities of gannets recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 5 and 5, Kober *et al.* 2000).

75. Approximately 12% of gannets (corrected for under detection) were recorded on the sea (Table 8).

76. Gannets were distributed approximately evenly across the main survey area (Figures 6 and 7).

77. Ailsa Craig (located 107 km SE) and 61,000 pairs (AONs) is by far the largest breeding colony within in the defined region. The distance to this colony is less than the mean maximum foraging distance (Thaxter *et al.* 2012), and is considered to be the most likely origin of adults present in the breeding season.

Shag

78. The average density of shags present in Year 1 and Year 2 breeding seasons was 0.13 birds/km^2, equivalent to an average of 0.3 birds in the DA and 1.7 birds in DA+1km. These numbers represent <0.01 % and approximately 0.02 % respectively of the regional breeding population of pairs (Mitchel *et al*. 2004) (Table 6).

79. The average density of shags in Year 1 and Year 2 autumn/winter periods was 0.33 birds/km^2 (Table 4), equivalent to averages of 0.7 birds in the DA and 4.3 in DA+1km. These numbers represent approximately 0.01% and 0.04% respectively of the assumed regional wintering population of approximately 12,000 birds (derived from Kober *et al.* 2000) (Table 7).

80. The densities of shags recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 4 and 5, Kober *et al.* 2000).

81. Approximately 93% of shags were recorded on the sea (Table 8).

82. Shags were not evenly distributed in the survey area. The majority of records of birds in transect were in the eastern third of the survey area, the part with the shallowest depths and closest to the coast of Islay.

Herring gull

83. Herring gulls were recorded only on the winter months, when they were present in small numbers.

84. The average density of herring gulls present in Year 1 and Year 2 autumn/winter periods was 0.13 birds/km^2 (Table 4), equivalent to averages of 0.3 birds in the DA and 1.7 in DA+1km.

These numbers represent <0.01% of the assumed regional wintering population of approximately 36,000 birds (derived from Kober *et al.* 2000) (Table 7).

85. The densities of herring gulls recorded in the main survey area in the autumn/winter period are at least ten times lower than the approximate average densities across the region reported by Kober *et al.* (2000) (Tables 8).

86. Approximately 21% of herring gulls were recorded on the sea (Table 8).

87. Herring gulls were distributed approximately evenly across the main survey area.

Lesser black-backed gull

88. Lesser black-backed gulls were only recorded in the spring and summer months and then only in very small numbers.

89. The average density of lesser black-backed gulls present in Year 1 and Year 2 breeding seasons was 0.02 birds/km^2 (Table 4), equivalent to an average of 0.05 birds in the DA and 0.3 birds in DA+1km. These numbers represent <0.01. % of the regional breeding population of 3,720pairs (AONs) (Mitchell *et al.* 2004).

90. The densities of lesser black-backed gulls recorded in the main survey area in breeding season period are in line with the approximate average densities across marine habitats in the region reported by Kober *et al.* (2000) (Tables 7).

91. Approximately 21% of lesser black-backed gulls were recorded on the sea (Table 8).

Great black-backed gull

92. Great black-backed gulls were recorded in the main survey area very infrequently in the breeding season but were regularly present in very small numbers in the autumn/winter period.

93. The average density of great black-backed gulls present in Year 1 and Year 2 breeding seasons was 0.01 birds/km^2 (Table 4), equivalent to an average of 0.01 birds in the DA and 0.1 birds in DA+1km. These numbers represent approximately <0.01% of the regional breeding population of 1,736 pairs (Mitchel *et al*. 2004) (Table 6).

94. The average density of great black-backed gulls present in Year 1 and Year 2 autumn/winter periods was 0.08 birds/km^2, equivalent to an average of 0.2 birds in the DA and 1.1 birds in DA+1km. These numbers represent approximately 0.01% and approximately 0.04% respectively of the assumed regional wintering population of approximately 3,000 birds (derived from Kober *et al.* 2000) (Table 7).

95. The densities of great black-backed gulls recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 6 and 7, Kober *et al.* 2000).

96. Approximately 50% of great black-backed gulls were recorded on the sea (Table 8).

97. Great black-backed gulls were distributed approximately evenly across the main survey area.

Kittiwake

98. Kittiwakes were recorded using the survey area throughout the year.

99. The average density of kittiwakes present in Year 1 and Year 2 breeding seasons was 0.34 birds/km^2(Table 4), equivalent to an average of 0.8 birds in the DA and 4.5 birds in DA+1km. These numbers represent approximately <0.01 % and approximately 0.01 % respectively of the assumed regional breeding population of 21,085 pairs (Mitchel *et al*. 2004) (Table 6).

100. The regional breeding population figure of 21,085 pairs used above is based on the Seabird 2000 census results. In the decade or so since these counts kittiwake numbers have declined in Scotland, on average by approximately -44% (derived from SNH 2012 and Mitchell *et al* 2004). The current size of the regional breeding population is unknown. If it has declined at the same rate as the sample of colonies elsewhere in Scotland that have been recently counted, it would now be around 12,000 pairs. This species has been in overall decline in Britain and Ireland since the mid 1980s but the size of population change varies between regions. Indeed, between the last two national censuses (Seabird Colony Register Census 1985-88 and the Seabird 2000 1998-2002) the numbers of kittiwake breeding in the region (Argyll & Bute and County Antrim) increased by 21%, which sharply contrasts to the overall decline of -23% for the Britain and Ireland as a whole over the same period (Mitchel *et al.* 2004).

101. The average density of kittiwake present in Year 1 and Year 2 autumn/winter periods was 0.97birds/km^2, equivalent to an average of 2.2 birds in the DA and 12.8 in DA+1km (Table 7). These numbers represent approximately 0.03% and approximately 0.2% respectively of the assumed regional wintering population of approximately 7,200 birds (derived from Kober *et al.* 2000) (Table 7).

102. The average breeding season density of 0.34 birds/km^2 of kittiwakes present in the main survey area is well below the approximate average density of 1.5 birds/km^2 across the region derived from the maps produced by Kober *et al.* (2000) (Table 4). The average winter density in the survey area is in line with results for the region derived from the maps produced by Kober *et al.* (2000) (Table 5).

103. Approximately 3% of kittiwakes were sea sitting on the sea when recorded (Table 8).

104. The most striking feature of the Colonsay SPA corridor results for both Y1 and Y2 is the generally very low densities (typically <0.2 birds/km^2) of kittiwakes recorded in all distance bands except the closest band where densities were somewhat higher but still low (approximately 0.5km^2) (Table 9).

105. Kittiwake densities along the Rathlin Island SPA corridor in Y1 and Y2 were generally greater than along the Colonsay corridor, nevertheless beyond 30 km from the colony the density consistently was low (<0.5 birds/km^2) and similar to that in the main Survey Area. In the distance bands closer to the colony, densities were very variable but at times were relatively high (>2 birds/km^2) (Table 10).

106. Kittiwakes were distributed approximately evenly across the main survey area (Figures 8 and 9). The seasonal and distribution and density patterns were similar between the two survey years.

Common guillemot

107. Common guillemot was the commonest species encountered on the site and is the commonest seabird species occurring around the UK.

108. Common guillemot could not always be distinguished from razorbills during surveys and these unidentified birds were recorded as 'unidentified large auks'. Overall 'unidentified large auks' accounted for 8.7% of the total of these two species. For the purposes of estimating abundance, unidentified birds in a survey visit were included in estimates by apportioning them in accordance to the ratio of positively identified individuals on that survey visit.

109. The average density of common guillemots present on the sea in Year 1 and Year 2 breeding seasons was 1.58 birds/km^2 (Table 4), equivalent to an average of 3.6 birds in the DA and 20.8 birds in DA+1km. These numbers represent <0.01 % and approximately 0.01% respectively of the regional breeding population of 141,243 pairs (Mitchel *et al*. 2004) (Table 6). In addition there was on average 0.26 birds/km^2 in flight over the survey area, equivalent to an average of 0.6 birds in the DA and 3.4 birds in DA+1km.

110. Common guillemot was not recorded in the post-breeding period (August and September) (note though, that there were no surveys in September in either year).

111. The average density of common guillemots present on the sea in Year 1 and Year 2 autumn/winter periods was 10.7 birds/km^2, which translates to an average of 24.3 birds in the DA and 140.3 in DA+1km (Table 7). These numbers represent approximately 0.1% and approximately 0.6% respectively of the assumed regional wintering population of approximately 24,000 birds (derived from Kober *et al.* 2000) (Table 7). In addition there was on average 0.53 birds/km^2 in flight over the survey area in the autumn/winter periods, equivalent to an average of 1.2 birds in the DA and 7.0 birds in DA+1km.

112. The average density of common guillemots recorded in the main survey area in breeding season (1.8 birds/km^2, includes flying birds) is well below the approximate average density of 10 birds/km^2 across the region derived from the maps in Kober *et al.* (2000) (Table 4). In contrast, the average winter density in the survey area (11.9 birds/km^2, includes flying birds) is well above the approximate average density of 1 birds/km^2 across the region derived from the maps in Kober *et al.* (2000) (Table 5).

113. Approximately 91% of common guillemots were recorded on the sea (Table 8).

114. In the breeding season common guillemots were distributed across the main survey area but were slightly more numerous in the eastern half (Figure 10). In the autumn and winter months of both years common guillemots were concentrated in the eastern third of the survey area, especially those parts covered by middle four transects (Figure 11). The part of the survey area with the highest autumn/winter densities is the part that is closest to Islay and is strongly correlated with the area that is less than 30m deep.

115. From April to June (the main period of breeding colony attendance) 47% guillemots flying over the survey area were heading either S or SE. This may suggest a link to a breeding site along this heading. Rathlin Island is the closest large colony and this lies 50 km SE of the centre of the survey area. In contrast there was no tendency for flights of guillemots to be directed to the north-east or south-west as might be expected if there was a link to the breeding colony on Colonsay situated approximately 60 km to the NE of the centre of the survey area.

116. Common guillemot densities along the Colonsay SPA corridor in Y1 showed a clear pattern of declining densities with increasing distance from the colony, with densities typically of about 1

birds/km^2 in the three distance bands closest to the colony and of about 0.1 birds/km^2 in the furthest distance band (Table 11). The pattern in Y2 was less marked, with the highest densities occurring in the intermediate distance bands (10-40 km) and the lowest densities in the furthest (>40km) distance bands from the colony. The average densities in Y2 were typically about three time greater than in Y1 but the pattern of declining densities with increasing distance was apparent in both years. The difference in average abundance between the two years is likely to reflect differences in dates of survey. The results suggest that most guillemot breeding on Colonsay feed within 40 km of the colony and that relatively few are likely to feed as far as away as the development area.

117. Common guillemot densities along the Rathlin Island SPA corridor in Y1 and in Y2 showed a pattern of declining densities with increasing distance from the colony, with densities typically in the closest distance band surveyed (10-20 km) being on average approximately five times greater than in the furthest distance bands (30-40 and 40-50 km) (Table 12). The average densities in Y2 were greater than in Y1 but the pattern of declining densities with increasing distance was apparent in both years. The difference in average abundance between the two years is likely to reflect differences in the dates of survey. The results suggest that most guillemot breeding on Rathlin Island feed within 30 km of the colony and that relatively few are likely to feed as far as away as the development area.

118. The densities along the Rathlin Corridor were typically greater, particularly in the further distance bands, than along the Colonsay corridor, and this perhaps indicating that guillemots recorded in the main Survey Area were more likely to originate from Rathlin Island.

Razorbill

119. Razorbills were recorded throughout the year and were the second most common species present.

120. Razorbill could not always be distinguished from common guillemot during surveys and these unidentified birds were recorded as ‘unidentified large auks’. Overall ‘unidentified large auks’ accounted for 8.7% of the total of these two species. For the purposes of estimating abundance, unidentified birds in a survey visit were included in estimates by apportioning them in accordance to the ratio of positively identified individuals on that survey visit.

121. The average density of razorbills present on the sea in Year 1 and Year 2 breeding seasons was 0.7 birds/km^2 (Table 4), equivalent to an average of 1.6 birds in the DA and 9.2 birds in DA+1km. These numbers represent <0.01 % and approximately 0.01% respectively of the regional breeding population of 33,140 pairs (Mitchel *et al*. 2004) (Table 6). In addition there was on average 0.36 birds/km^2 in flight over the survey area, equivalent to an average of 0.8 birds in the DA and 4.8 birds in DA+1km.

122. The average density of razorbills present on the sea in Year 1 and Year 2 autumn/winter periods was 2.45 birds/km^2 equivalent to an average of 0.6 birds in the DA and 3.4 in DA+1km (Table 7). These numbers represent approximately 0.08% and approximately 0.45% respectively of the assumed regional wintering population of approximately 7,200 birds (derived from Kober *et al.* 2000) (Table 7). In addition there was on average 0.87 birds/km^2 in flight over the survey area, equivalent to an average of 2.0 birds in the DA and 11.4 birds in DA+1km.

123. The average density of razorbills recorded in the main survey area in breeding season (1.1 bird/km^2, includes flying birds) is slightly below the approximate average density of 1.5

birds/km^2 across the region derived from the maps in Kober *et al.* (2000) (Table 4). In contrast, the average winter density in the survey area (3.3 birds/km^2, includes flying birds) is well above the approximate average density of 0.75 birds/km^2 across the region derived from the maps in Kober *et al.* (2000) (Tables 5).

124. Razorbills were not recorded in the post-breeding period (August and September) (note though, that there were no surveys in September in either year).

125. Approximately 60% of razorbills were recorded on the sea (Table 8); these birds were likely to be feeding.

126. The overall density estimate for razorbills in the main survey area was slightly higher in Year 2 compared with Year 1

127. In the earlier part of the breeding season (April-June) flying razorbills were predominantly recorded heading north. By contrast during the latter part of the breeding period (July-August) only a small proportion of birds were heading in a northerly direction, with the majority (55%) of those recorded flying on the main survey site heading south.

128. In the breeding season razorbills were evenly distributed across the main survey area (Figure 12). In the autumn and winter months of both years razorbills were concentrated in the eastern third of the survey area, especially those parts covered by middle three transects (Figure 13). The part with the highest autumn/winter densities is the part that is closest to Islay and is strongly correlated with the area that is less than 30m deep.

129. Razorbill densities along the Colonsay SPA corridor in Y1 and in Y2 showed no clear trend with increasing distance from the colony (Table 13). In Y1 densities were consistently low (<0.5 birds/km^2) in all distance bands. In Year 2, densities were notably greater (at 1 – 1.5 bird/km2) in the 10-20, 20-30, and 30-40km distance bands distance bands than in the closest or furthest bands and this possibly caused by birds breeding on the small colonies on the west coast of Islay feeding in these central distance bands. Razorbill is not a qualifying feature at the North Colonsay and Western Cliffs SPA.

130. Razorbill densities along the Rathlin Island SPA corridor in Y1 showed no clear trend with increasing distance from the colony (Table 14). In contrast, in Y2 there was a marked pattern for densities to decline with increasing distance from the colony; at distances closer than 30km densities were 2 to 10 birds/km^2 compared to <0.5birds/km^2 further away. The results suggest that most razorbill breeding on Rathlin Island feed within 30 km of the colony and that relatively few are likely to feed as far as away as the development area.

131. The densities along the Rathlin Corridor were typically several times greater than along the Colonsay corridor, and this perhaps indicates that razorbills recorded in the main Survey Area were more likely to originate from Rathlin Island.

Black guillemot

132. Black guillemots were present in the survey area in very small numbers.

133. The average density of black guillemots present in Year 1 and Year 2 breeding seasons was 0.04 birds/km^2 (Table 4), equivalent to an average of 0.1 birds in the DA and 0.5 birds in DA+1km (Table 6). These numbers represent <0.01 % and approximately 0.01 % respectively of the regional breeding population of 3,911 pairs (Mitchel *et al*. 2004) (Table 6).

134. The average density of black guillemots in Year 1 and Year 2 autumn/winter periods was 0.1 birds/km^2, which translates to an average of 0.2 birds in the DA and 1.3 birds in DA+1km (Table 7). There is no published estimate for the regional wintering population of black guillemot (e.g., Kober *et al*. (2000) do not report results for this species). However, as this species is largely sedentary (Wernham *et al*. 2002) it is likely that the winter population is similar to the breeding population. Therefore, these numbers represent <0.01% and approximately 0.16% respectively of the assumed regional wintering population of approximately 8,000 birds (Table 7).

135. Approximately 92% of black guillemots were recorded on the sea (Table 8).

136. Black guillemots were only recorded in the central eastern part of the survey area (Figures 14 and 15), where it is closest to the coast of Islay. This is also the part of the survey area with the shallowest depths.

Puffin

137. Puffins were recorded in the survey area in small numbers during the breeding season (March to August) and were very scarce in the autumn and winter months.

138. The average density of puffins present on the sea in Year 1 and Year 2 breeding seasons was 0.82 birds/km^2 (Table 4), equivalent to an average of 1.9 birds in the DA and 10.7 birds in DA+1km (Table 6). These numbers represent approximately 0.02 % and approximately 0.13% respectively of the regional breeding population of 4,207 pairs (Mitchel *et al*. 2004) (Table 6). In addition there was on average 0.08 birds/km^2 in flight over the survey area, equivalent to an average of 0.2 birds in the DA and 1.0 birds in DA+1km.

139. The average densities of puffin present (on sea and in flight) in Year 1 and Year 2 autumn/winter periods was 0.1 birds/km^2, equivalent to an average of 0.2 birds in the DA and 1.3 in DA+1km (Table 7). These numbers represent approximately 0.02% and approximately 0.11% respectively of the assumed regional wintering population of approximately 1,200 birds (derived from Kober *et al.* 2000) (Table 7).

140. The densities of puffins recorded in the main survey area in breeding season and autumn/winter period are in line with previous survey results for this species in the region (Tables 4 and 5, Kober *et al.* 2000).

141. Approximately 83% of puffins were recorded on the sea (Table 8).

142. Puffins were distributed approximately evenly across the main survey area (Figures 16 and 17).

143. During the earlier part of the breeding season (April to June period) there was a tendency for puffins to fly South compared to other directions (36% of flying birds). Other than this, puffins were recorded in all directions except North East (NE) but there was no direction predominated either generally over the year or in a particular season.

144. Puffin densities along the Colonsay SPA corridor in Y1 were extremely low, and there were too few records to establish any clear pattern (Table 15). In Y2 numbers, whilst remaining low, were nevertheless much greater than in Y1. In Y2 densities were very low <0.4 birds/km^2) in the closest (<20km) and furthest (50-60km) distance bands and were moderately high (>2birds/km^2) in the 30-40km band. Puffin is not a qualifying feature at the North Colonsay and Western Cliffs SPA, where this species breeds only in small numbers.

145. Puffin densities along the Rathlin Island SPA corridor in Y1 were generally very low and showed no clear trend with increasing distance from the colony, densities in the 40-50 km band were low but greater than in the closer bands (Table 16). In contrast, in Y2 much greater numbers were recorded and there was a marked pattern for densities to decline with increasing distance from the colony, from 3 birds/km^2 in the 10-20 km distance band down to 0.2 birds/km^2 in the 40-50km band. The results suggest that in Y2 most razorbill breeding on Rathlin Island fed within 40 km of the colony and that relatively few fed as far as away as the development area.

Conclusions

146. In the breeding season estimated numbers of individuals present in the main survey area are small or very small in the context of regional population sizes for all seabird species (Table 6). This suggests that the development area and 1km buffer is of low importance to breeding seabird populations.

147. In the autumn and winter period the estimated average numbers of individuals present in the main survey area are small or very small for all species (Table 7). However, some eastern parts of the survey area, approximately those corresponding to the area with depths of less than 30 m, held moderately high densities of common guillemot and razorbill in winter. These localised winter concentrations of common guillemot and razorbill are arguably the most important ornithological feature of the main survey area (Figures 11 and 13).

148. The results of the breeding season surveys along the two SPA corridors provide evidence of the likely importance of the development area to breeding auks and kittiwakes from the North Colonsay and Western Cliffs SPA and the Rathlin Island SPA (Tables 9 to 12). Overall, the SPA corridor survey results suggest that the development area was of relatively low importance for these species, though there were interesting year-to-year and between species differences in how the pattern of use changed with distance from these colonies.

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Tables

Table 1. Survey visits undertaken of the Development Survey Area and Colonsay and Rathlin Island SPA corridors during Year 1 and Year 2 of survey work.

Survey Visit	Main Survey Area							Cable route	Colonsay corridor	Rathlin corridor
	T1	T2	T3	T4	T5	T6	T7			
Year 1										
11/11/2009	yes	yes	yes	yes	yes	yes	yes	yes	no	no
28/11/2009	yes	yes	yes	yes	yes	yes	yes	yes	no	no
15/12/2009	no	no	no	yes	yes	yes	yes	yes	no	no
06/02/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no
09/03/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no
09/04/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no
11/05/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	yes
22 & 23/06/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
20 & 21/07/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
18 &19/08/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
13/10/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no
Year 2										
14/12/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no
27/01/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no
03/03/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no
29/03/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no
27 & 28/04/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
08/06/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	no
28 & 29/06/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
26 & 27/07/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
23/08/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no

Table 2. The number of survey visits that were planned and that were taken each season in Years 1 and 2.

Season	Definition	Planned survey visits	Surveys undertaken	% achieved
Spring and summer (approximates to seabird breeding season*)	April to August	10	10	100%
Post-breeding/Autumn	September to November	6	3	50%
Winter	December to March	8	7	75%

*April-August approximates to the period when most seabird species are attending breeding colonies. Gannet and members of the petrel family typically continue to attend colonies until September.

Table 3. Seabird species recorded within the survey area on fewer than ten occasions during Year 1 and Year 2 surveys.

Species	Observations
Red-throated diver	Single flying off transect on 13 October 2010, 29 March 2011 and 8 June 2011.
Great northern diver	Seen on five occasions: singles flying in transect on 11 and 28 November 2009, and two flying off transect on 13 October 2010. A single bird flying off transect on 14 December 2010 and 4 birds (3 together) flying off transect on 27 April 2011.
Sooty shearwater	Single birds were seen flying off transect 18 August 2010 and 26 July 2011.
Cormorant	A single bird seen flying off transect, 22 June 2010.
Great skua	Singles seen flying off transect on: 18 August, 13 October 2010 and 27 April 2011.
Arctic skua	Single birds seen flying off transect on 22 June 2010 and two singles flying off transect on 23 August 2011.
Common gull	Single birds flying in transect on 14 December 2010, 27 January and 3 March 2011. Single bird seen flying off transect, 13 October 2010 and 14 December 2010, and three birds flying off transect, 27 April 2011.
Arctic tern	Single adult and juvenile flying off transect, 18 Aug 2010.
Little auk	Two on water in transect, 28 November 2009.

Table 4. Breeding season (colony attendance period) mean density estimates of each seabird species derived from Distance Sampling design-based estimate for whole survey area (Method 1) and sub-divisions of this (Methods 2 to 4, see text for details). Colony attendance period defined as April to August, except for guillemot and razorbill for which it is defined as April to July.

Species	Year	Mean of density estimates (birds/km^2)			
		Survey Area Method 1	DA Band Method 2	DA+1 Band Method 3	DA+1km Method 4
Fulmar, all	Y1&Y2	**0.36**	**0.34**	**0.46**	**0.13**
	Y1	0.41	0.29	0.44	0.17
	Y2	0.32	0.39	0.48	0.09
Manx shearwater, all	Y1&Y2	**0.96**	**0.97**	**1.27**	**1.75**
	Y1	0.26	0.10	0.26	0.35
	Y2	1.65	1.84	2.27	3.15
Gannet, all	Y1&Y2	**0.71**	**0.44**	**0.66**	**0.87**
	Y1	0.53	0.58	0.57	1.30
	Y2	0.90	0.29	0.75	0.43
Shag, all	Y1&Y2	**0.13**	**0.09**	**0.08**	**0.15**
	Y1	0.11	0.11	0.09	0.15
	Y2	0.14	0.06	0.07	0.15
Great black-backed gull, all	Y1&Y2	**0.01**	**0.02**	**0.01**	**0.04**
	Y1	0.00	0.00	0.00	0.00
	Y2	0.01	0.03	0.03	0.09
Kittiwake, all	Y1&Y2	**0.34**	**0.41**	**0.46**	**0.22**
	Y1	0.14	0.03	0.10	0.09
	Y2	0.55	0.80	0.81	0.35
Arctic tern, all	Y1&Y2	0.10	0.10	0.21	0.70
	Y1	0.00	0.00	0.00	0.00
	Y2	0.20	0.30	0.41	1.39
Guillemot, on sea	Y1&Y2	**1.58**	**2.54**	**2.09**	**1.69**
	Y1	1.39	2.00	1.66	1.31
	Y2	1.78	3.08	2.53	2.06
Guillemot, fly	Y1&Y2	**0.26**	**0.03**	**0.31**	**0.76**
	Y1	0.39	0.06	0.56	1.52
	Y2	0.13	0.00	0.06	0.00
Razorbill, on sea	Y1&Y2	**0.70**	**0.34**	**0.71**	**0.80**
	Y1	0.86	0.35	0.95	0.61
	Y2	0.55	0.34	0.48	1.00
Razorbill, fly	Y1&Y2	**0.36**	**0.70**	**0.61**	**0.87**
	Y1	0.30	0.91	0.63	0.54
	Y2	0.42	0.48	0.58	1.20
Puffin, on sea	Y1&Y2	**0.82**	**1.04**	**0.80**	**1.02**
	Y1	0.79	0.73	0.88	0.37
	Y2	0.84	1.35	0.72	1.68
Puffin, fly	Y1&Y2	**0.08**	**0.05**	**0.05**	**0.04**
	Y1	0.05	0.10	0.10	0.09
	Y2	0.11	0.00	0.00	0.00
Tystie, all	Y1&Y2	**0.04**	**0.02**	**0.03**	**0.04**

	Y1	0.07	0.03	0.05	0.09
	Y2	0.00	0.00	0.00	0.00

Table 5. Autumn and winter period mean density estimates of each seabird species derived from Distance Sampling design-based estimate for whole survey area (Method 1) and sub-divisions of this (Methods 2 to 4, see text for details).. The highest density estimate is highlighted in yellow and is the one use to estimate abundance.

Species	Year	Mean of density estimates (birds/km^2)			
		Survey Area Method 1	**DA Band Method 2**	**DA+1 Band Method 3**	**DA+1km Method 4**
Fulmar, all	Y1&Y2	**0.26**	**0.10**	**0.20**	**0.28**
	Y1	0.32	0.12	0.25	0.34
	Y2	0.10	0.05	0.09	0.14
Gannet, all	Y1&Y2	**0.14**	**0.05**	**0.10**	**0.09**
	Y1	0.13	0.05	0.11	0.06
	Y2	0.14	0.05	0.09	0.14
Shag, all	Y1&Y2	**0.33**	**0.09**	**0.16**	**0.15**
	Y1	0.29	0.08	0.16	0.00
	Y2	0.42	0.10	0.15	0.51
Great black-backed gull, all	Y1&Y2	**0.08**	**0.05**	**0.11**	**0.12**
	Y1	0.04	0.00	0.05	0.00
	Y2	0.18	0.18	0.25	0.41
Herring gull, all	Y1&Y2	**0.13**	**0.08**	**0.13**	**0.28**
	Y1	0.08	0.07	0.07	0.25
	Y2	0.24	0.11	0.27	0.35
Kittiwake, all	Y1&Y2	**0.97**	**0.25**	**0.30**	**0.55**
	Y1	1.32	0.31	0.38	0.65
	Y2	0.16	0.11	0.13	0.29
Guillemot, on sea *	Y1&Y2	**10.68**	**7.09**	**9.49**	**15.60**
	Y1	9.20	4.49	4.97	6.03
	Y2	14.14	13.17	20.04	37.94
Guillemot, fly *	Y1&Y2	**0.53**	**0.26**	**0.32**	**0.39**
	Y1	0.50	0.33	0.34	0.56
	Y2	0.62	0.08	0.29	0.00
Razorbill, on sea *	Y1&Y2	**2.45**	**0.84**	**2.84**	**4.03**
	Y1	1.60	1.00	0.93	0.00
	Y2	4.44	0.49	7.31	13.44
Razorbill, fly *	Y1&Y2	**0.87**	**0.53**	**0.98**	**0.30**
	Y1	0.55	0.20	0.68	0.25
	Y2	1.61	1.29	1.68	0.43
Puffin, all	Y1&Y2	**0.10**	**0.02**	**0.01**	**0.04**
	Y1	0.13	0.00	0.00	0.00
	Y2	0.02	0.05	0.04	0.14
Tystie, all	Y1&Y2	**0.03**	**0.00**	**0.00**	**0.00**
	Y1	0.03	0.00	0.00	0.00
	Y2	0.04	0.00	0.00	0.00

Table 6. The estimated mean number of birds present in the development area (DA) and development area buffered to 1 km (DA+1km) during the breeding season compared to the assumed regional population. For fulmar, Manx shearwater and gannet the regional population is defined as south-west Scotland (Skye southwards) and Northern Ireland. For all other species the region is defined as Argyll & Bute and County Antrim. Population sizes are from Seabird 2000 census (Mitchell *et al*. 2004).

Species	Scotland regional colonies popltn. (pairs/AOBs)	N. Ireland regional colonies popltn. (pairs/AOBs)	Regional population total (pairs)	Mean no. in DA (birds, 2.3km^2)	Mean no. in DA+1km (birds, 13.1 km^2)	Mean % of regional popltn. in DA	Mean % of regional popltn. in DA+1km
Fulmar	15,712	5,992	21,704	0.8	4.8	<0.01%	0.01%
Manx shearwater	121,733	4,633	126,366	2.2	12.6	<0.01%	<0.01%
Gannet	34,408	0	34,408	1.6	9.4	<0.01%	0.01%
Shag	3,341	281	3,622	0.3	1.7	<0.01%	0.02%
Great black-backed Gull	1,736	16	1,752	0.01	0.1	<0.01%	<0.01%
Kittiwake	8,976	12,109	21,085	0.8	4.5	<0.01%	0.01%
Arctic tern	1,823	4	1,827	0.2	1.3	0.01%	0.04%
Guillemots on sea	42,697	98,546	141,243	3.6	20.8	<0.01%	0.01%
Guillemot, flying				0.6	3.4	<0.01%	<0.01%
Razorbill, on sea	9,056	24,084	33,140	1.6	9.2	<0.01%	0.01%
Razorbill, flying				0.8	4.8	<0.01%	0.01%
Puffin, on sea	2,597	1,610	4,207	1.9	10.7	0.02%	0.13%
Puffin, flying				0.2	1.0	<0.01%	0.01%
Black guillemot	3,046	865	3,911	0.1	0.5	<0.01%	0.01%

Table 7. The estimated mean number of birds present in the development area (DA) and development area buffered to 1 km (DA+1km) during the autumn and winter compared to the assumed regional population. In the case of shag and black guillemot the regional population is assumed to be the same as the regional breeding population. For all other species the approximate regional autumn/winter population is derived from densities in Kober *et al*. 2010 multiplied by an area of 12,000 km^2, the approximate seaward extent of NHZ14 and the coast of Northern Ireland.

Species	Approx. mean regional density (birds/km^2)	Approx. regional total (birds)	Mean density in Survey Area (birds/km^2)	Mean no. in DA (2.3km^2)	Mean no. in DA+1km (13.1 km^2)	Mean % of regional popltn. in DA	Mean % of regional popltn. in DA+1km
Fulmar	1	12,000	0.26	0.6	3.4	<0.01%	0.03%
Gannet	0.5	6,000	0.14	0.3	1.8	0.01%	0.03%
Shag	1	12,000	0.33	0.7	4.3	0.01%	0.04%
Great black-backed Gull	0.25	3,000	0.08	0.2	1.1	0.01%	0.04%
Herring Gull	3	36,000	0.13	0.3	1.7	<0.01%	0.00%
Kittiwake	0.6	7,200	0.97	2.2	12.8	0.03%	0.18%
Guillemot, on sea	2	24,000	10.68	24.3	140.3	0.10%	0.58%
Guillemot, flying			0.53	1.2	7.0	<0.01%	0.03%
Razorbill, on sea	0.6	7,200	2.45	5.6	32.2	0.08%	0.45%
Razorbill, flying			0.87	2.0	11.4	0.03%	0.16%
Puffin	0.1	1,200	0.10	0.2	1.3	0.02%	0.11%
Black guillemot	1	12,000	0.03	0.1	0.4	<0.01%	<0.01%

Table 8. The numbers of seabirds recorded in transect in main survey area that were in flight or sitting on the sea. Data for Year 1 and Year 2 combined.

Species	No. in flight	% in flight	No. sitting on sea	% on sea
Fulmar	77	81.9%	17	18.1%
Manx shearwater	132	87.4%	19	12.6%
Storm petrel	7	100.0%	0	0.0%
Gannet	122	88.4%	16	11.6%
Shag	3	7.0%	40	93.0%
Lesser black-backed gull	5	100.0%	0	0.0%
Herring gull	15	78.9%	4	21.1%
Great black-backed gull	6	50.0%	6	50.0%
Kittiwake	204	96.7%	7	3.3%
Arctic Tern	16	100.0%	0	0.0%
Common guillemot	104	8.9%	1071	91.1%
Razorbill	166	40.1%	248	59.9%
Guillemot/razorbill (unidentified)	32	46.4%	37	53.6%
Black guillemot	1	8.3%	11	91.7%
Puffin	14	16.9%	69	83.1%

Table 9. The numbers and estimated density of **kittiwakes** recorded in transect in each 10-km distance band out from **North Colonsay and Western Cliffs SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month.

Year, 10km-band from SPA	**Survey effort (km)**	**Total birds seen in transect on each survey visit**					**Grand total**	**Density estimate (birds/km^2)**
Year 1		**April**	**May**	**June**	**July**	**Aug**		
0-10	10.5	NS	NS	2	3	0	5	0.53
10-20	20.0	NS	NS	0	0	0	0	0.00
20-30	20.0	NS	NS	0	0	0	0	0.00
30-40	20.6	NS	NS	0	1	1	2	0.11
40-50	20.8	NS	NS	0	0	3	3	0.16
50-60	22.6	NS	NS	1	0	0	1	0.05
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
0-10	10.5	2	0	3	0	NS	5	0.40
10-20	20.0	3	0	1	0	NS	4	0.17
20-30	20.0	2	0	0	3	NS	5	0.21
30-40	20.6	14	2	1	1	NS	18	0.73
40-50	20.8	1	0	0	0	NS	1	0.04
50-60	22.6	1	0	0	0	NS	1	0.04

Table 10. The numbers and estimated density of **kittiwakes** recorded in transect in each 10-km distance band out from **Rathlin Island SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month. * The survey kilometres for May in Year 1 are half that shown because only one of the two transects were surveyed.

Year, 10km-band from SPA	**Survey effort (km)**	**Total birds seen in transect on each survey visit**					**Grand total**	**Density estimate (birds/km^2)**
Year 1		**April**	**May***	**June**	**July**	**Aug**		
10-20	16.2	NS	0	4	2	1	7	0.41
20-30	20.0	NS	0	14	0	3	17	0.81
30-40	20.0	NS	0	3	2	1	6	0.29
40-50	21.2	NS	0	4	0	4	8	0.33
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
10-20	16.2	2	NS	34	1	NS	37	2.54
20-30	20.0	0	NS	0	0	NS	0	0
30-40	20.0	1	NS	2	2	NS	5	0.27
40-50	21.2	0	NS	8	0	NS	8	0.42

Table 11. The numbers and estimated density of **common guillemots** recorded in transect in each 10-km distance band out from **North Colonsay and Western Cliffs SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May**	**June**	**July**	**Aug**		
0-10	10.5	NS	NS	0	11	0	11	1.11
10-20	20.0	NS	NS	12	2	0	15	0.81
20-30	20.0	NS	NS	8	15	0	23	1.28
30-40	20.6	NS	NS	0	1	0	1	0.05
40-50	20.8	NS	NS	1	0	0	1	0.05
50-60	22.6	NS	NS	4	0	0	4	0.21
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
0-10	10.5	3	0	4	3	NS	10	0.79
10-20	20.0	1	2	24	11	NS	38	1.58
20-30	20.0	0	0	5	86	NS	91	3.79
30-40	20.6	17	5	3	12	NS	37	1.50
40-50	20.8	2	5	0	10	NS	17	0.68
50-60	22.6	0	3	4	0	NS	7	0.26

Table 12. The numbers and estimated density of **common guillemots** recorded in transect in each 10-km distance band out from **Rathlin Island SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month. * The survey kilometres for May in Year 1 are half that shown because only one of the two transects were surveyed.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May***	**June**	**July**	**Aug**		
10-20	16.2	NS	1	34	1	0	36	2.10
20-30	20.0	NS	0	29	3	0	32	1.53
30-40	20.0	NS	1	1	4	0	6	0.29
40-50	21.2	NS	0	18	3	0	21	0.85
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
10-20	16.2	5	NS	127	20	NS	152	10.43
20-30	20.0	2	NS	6	19	NS	27	1.50
30-40	20.0	0	NS	5	7	NS	12	0.67
40-50	21.2	0	NS	12	5	NS	17	0.89

Table 13. The numbers and estimated density of **razorbills** recorded in transect in each 10-km distance band out from **North Colonsay and Western Cliffs SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May**	**June**	**July**	**Aug**		
0-10	10.5	NS	NS	1	4	0	5	0.50
10-20	20.0	NS	NS	3	1	0	5	0.27
20-30	20.0	NS	NS	1	2	0	3	0.19
30-40	20.6	NS	NS	1	1	0	2	0.11
40-50	20.8	NS	NS	0	2	0	2	0.11
50-60	22.6	NS	NS	7	0	0	7	0.34
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
0-10	10.5	7	0	0	0	NS	7	0.56
10-20	20.0	7	0	0	7	NS	14	0.58
20-30	20.0	0	0	0	20	NS	20	0.83
30-40	20.6	15	1	0	7	NS	23	0.93
40-50	20.8	0	2	0	0	NS	2	0.08
50-60	22.6	2	2	1	0	NS	5	0.18

Table 14. The numbers and estimated density of razorbills recorded in transect in each 10-km distance band out from Rathlin Island SPA towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month. * The survey kilometres for May in Year 1 are half that shown because only one of the two transects were surveyed.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May***	**June**	**July**	**Aug**		
10-20	16.2	NS	0	15	4	0	19	1.13
20-30	20.0	NS	0	21	11	0	31	1.49
30-40	20.0	NS	0	5	0	0	5	0.24
40-50	21.2	NS	0	26	19	0	45	1.83
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
10-20	16.2	1	NS	126	14	NS	141	9.67
20-30	20.0	5	NS	11	31	NS	47	2.61
30-40	20.0	0	NS	8	1	NS	9	0.50
40-50	21.2	4	NS	9	0	NS	13	0.68

Table 15. The numbers and estimated density of **puffins** recorded in transect in each 10-km distance band out from **North Colonsay and Western Cliffs SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May**	**June**	**July**	**Aug**		
0-10	10.5	NS	NS	0	0	0	0	0.00
10-20	20.0	NS	NS	0	1	0	1	0.06
20-30	20.0	NS	NS	0	0	0	0	0.00
30-40	20.6	NS	NS	0	0	0	0	0.00
40-50	20.8	NS	NS	0	1	0	1	0.05
50-60	22.6	NS	NS	0	2	3	5	0.22
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
0-10	10.5	4	0	0	0	NS	4	0.32
10-20	20.0	4	3	2	0	NS	9	0.38
20-30	20.0	11	0	5	1	NS	17	0.71
30-40	20.6	20	29	3	1	NS	53	2.14
40-50	20.8	17	9	4	0	NS	30	1.20
50-60	22.6	4	3	1	2	NS	10	0.37

Table 16. The numbers and estimated density of **puffins** recorded in transect in each 10-km distance band out from **Rathlin Island SPA** towards the proposed development site during breeding season surveys in Year 1 (2010) and Year 2 (2011). 'NS' indicates no survey was undertaken that month. * The survey kilometres for May in Year 1 are half that shown because only one of the two transects were surveyed.

Year, 10km-band from SPA	Survey effort (km)	Total birds seen in transect on each survey visit					Grand total	Density estimate (birds/km^2)
Year 1		**April**	**May***	**June**	**July**	**Aug**		
10-20	16.2	NS	0	1	1.5	0	3	0.15
20-30	20.0	NS	0	1	0	0	1	0.05
30-40	20.0	NS	0	2	0	0	2	0.10
40-50	21.2	NS	0	5	9	14	27	1.10
Year 2		**April**	**June 1**	**June 2**	**July**	**Aug**		
10-20	16.2	13	NS	12	19	NS	44	3.02
20-30	20.0	22	NS	4	9	NS	35	1.94
30-40	20.0	18	NS	2	3	NS	23	1.28
40-50	21.2	2	NS	2	0	NS	4	0.21

Figures

Figure 1 Survey area and transect lines

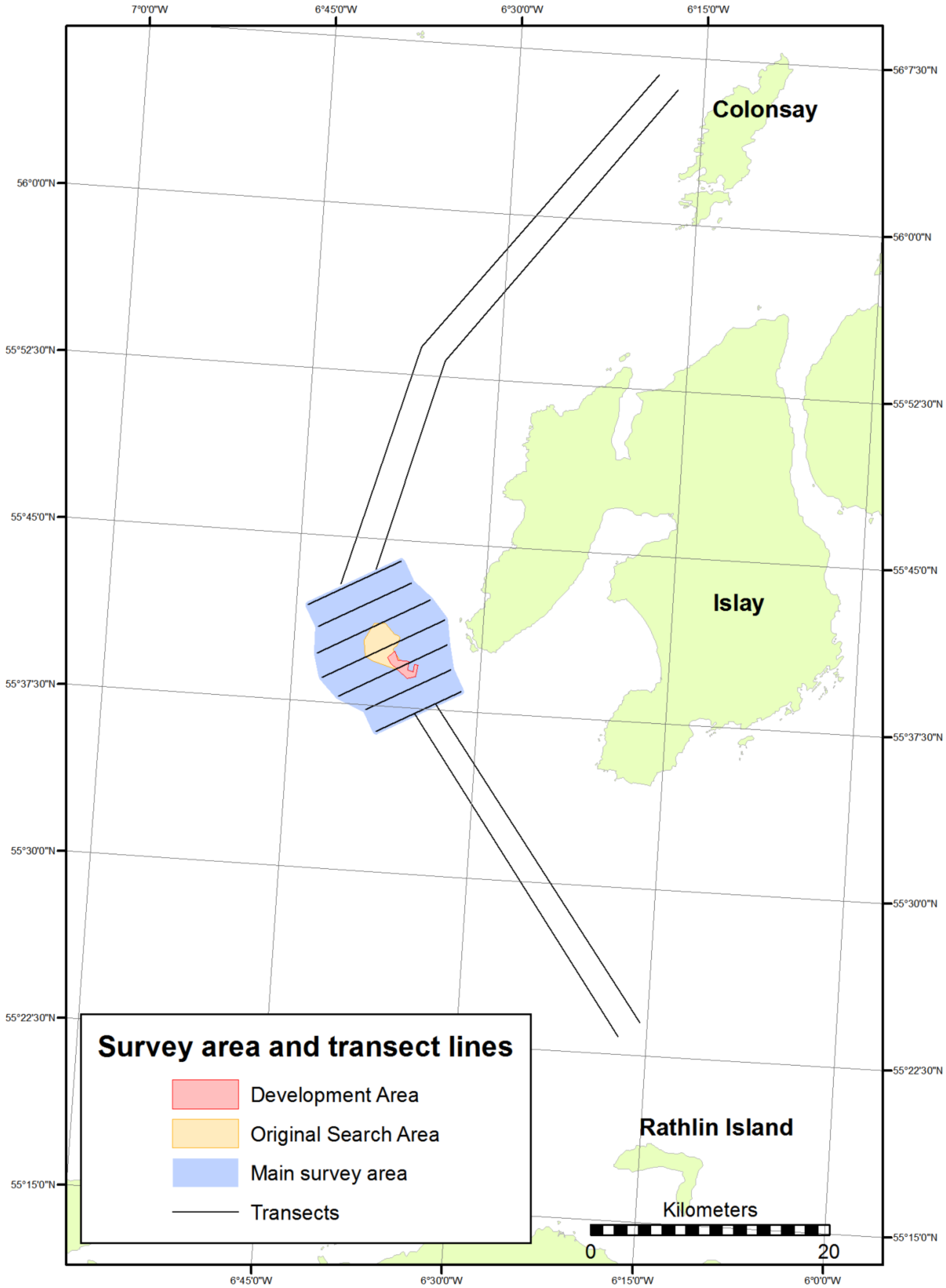


Figure 2 Fulmar breeding season (Apr - Aug)

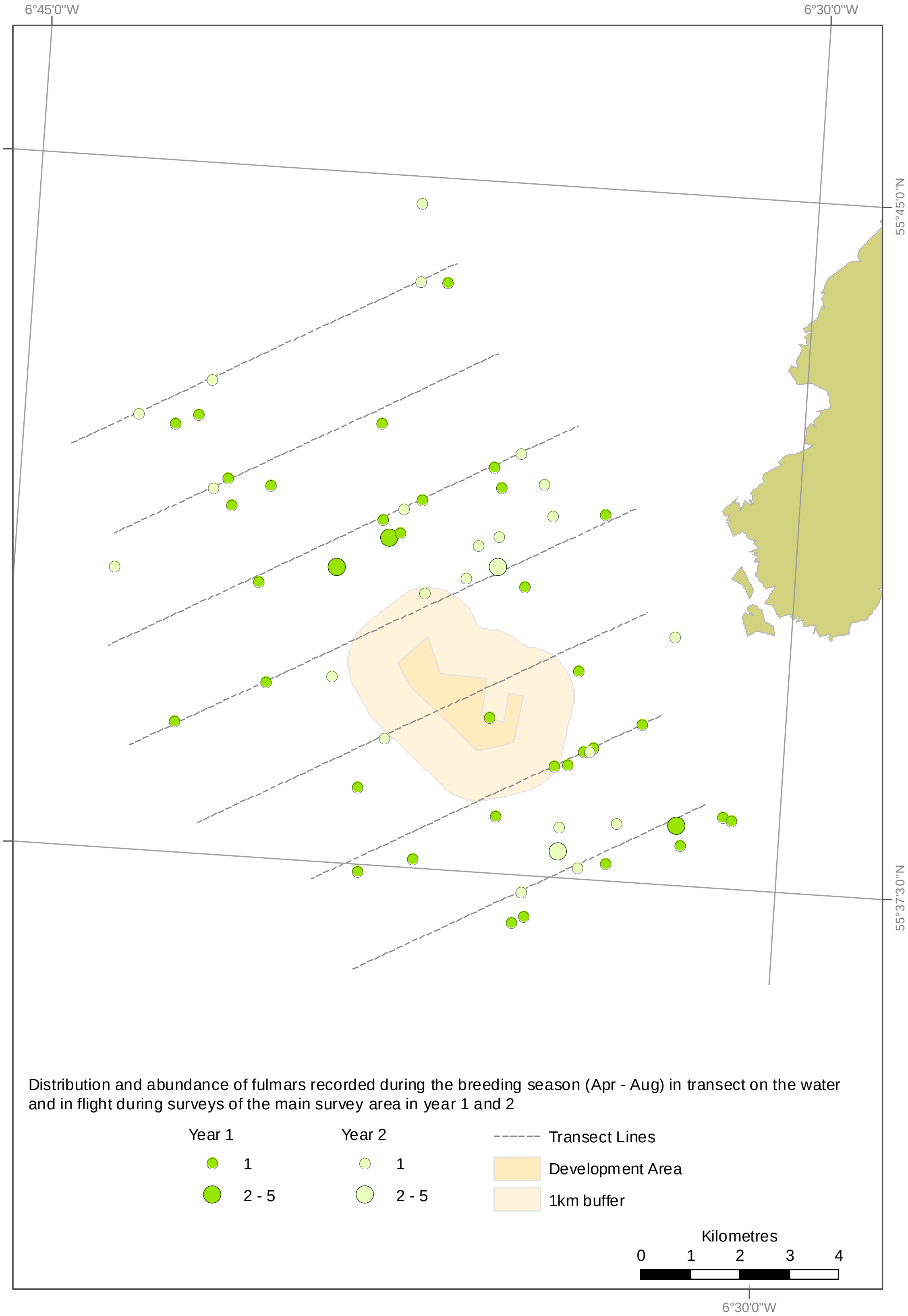
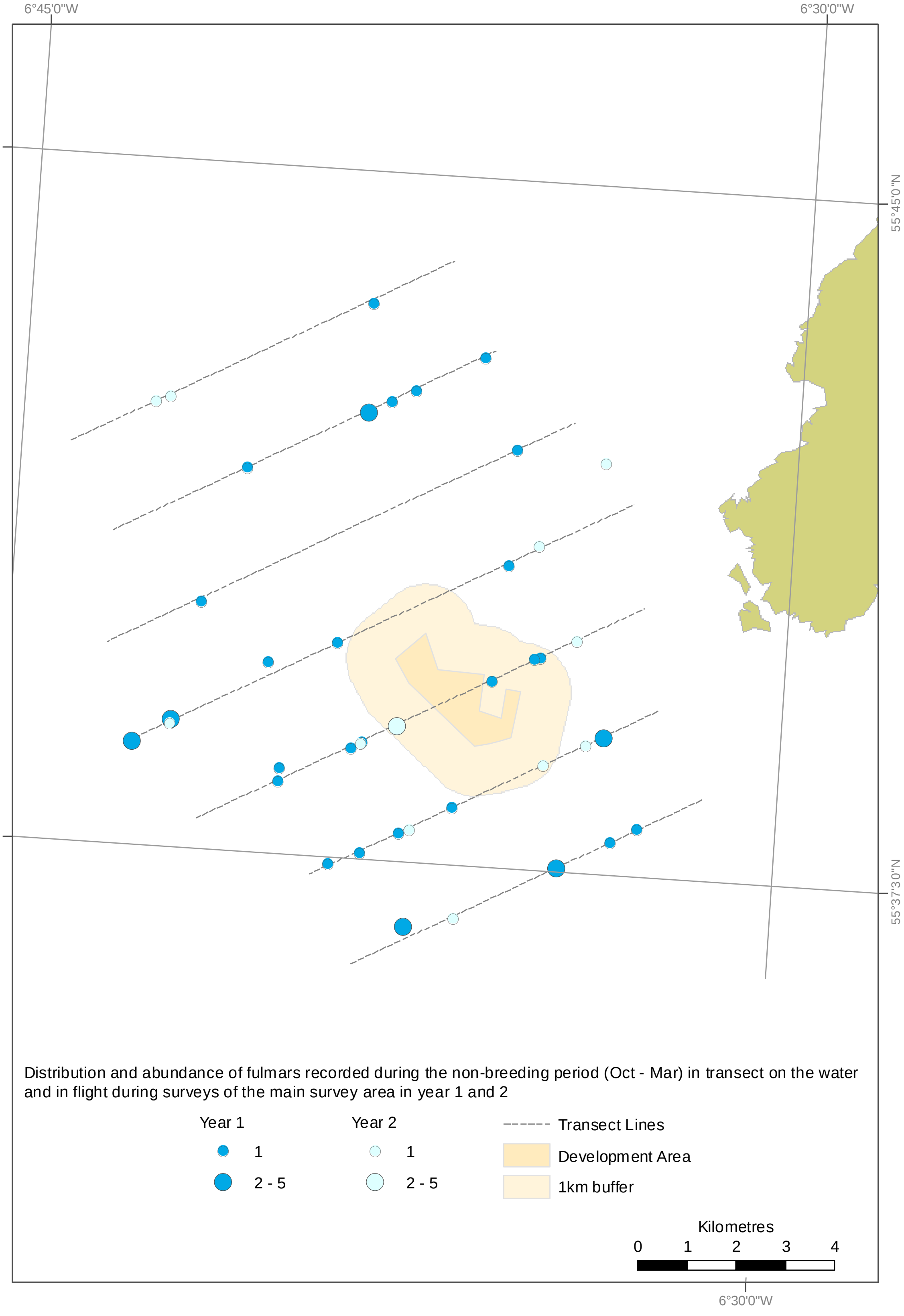


Figure 3 Fulmar non-breeding period (Oct - Mar)



Distribution and abundance of fulmars recorded during the non-breeding period (Oct - Mar) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

Figure 4 Manx shearwater breeding season (Apr - Aug)

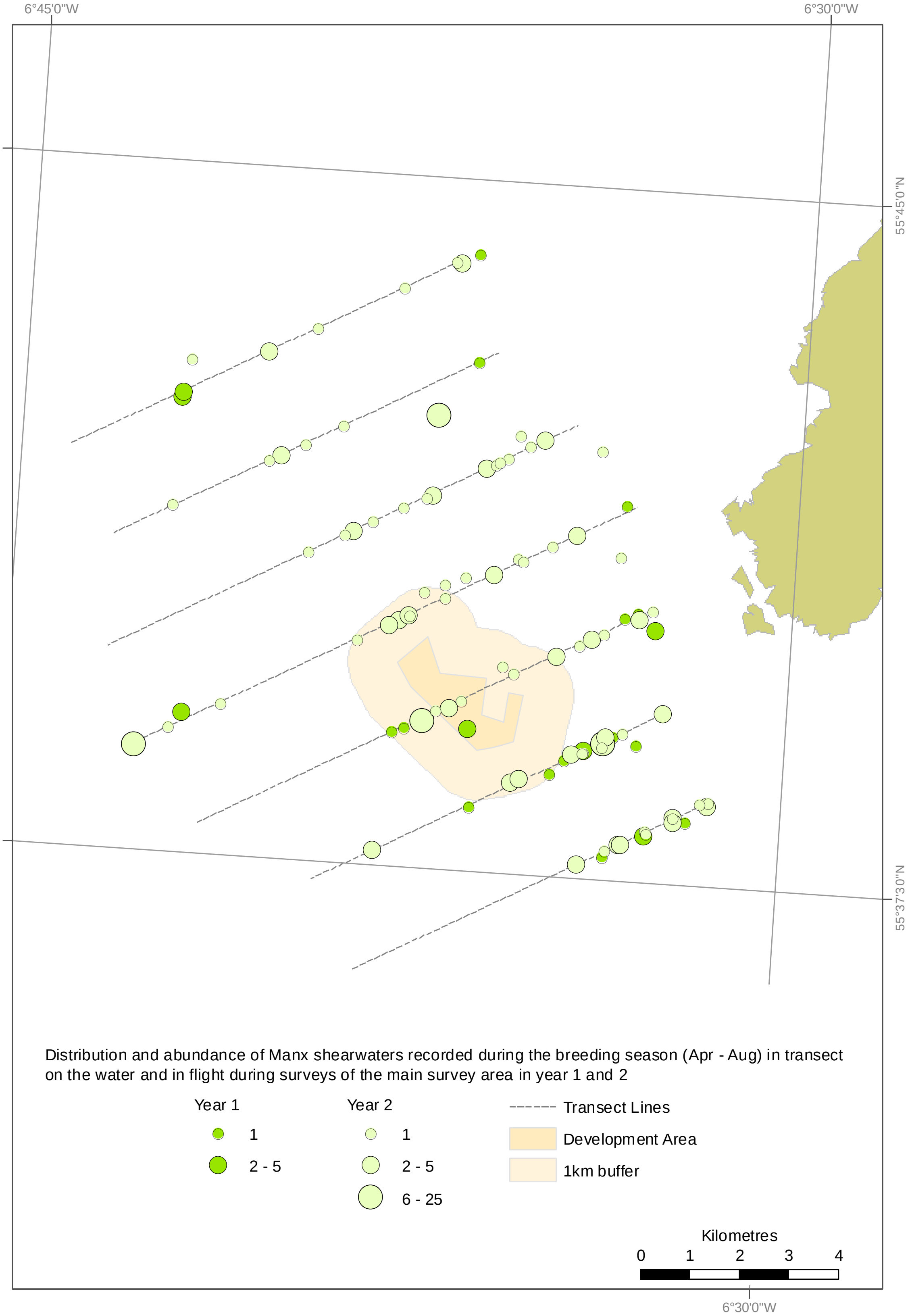
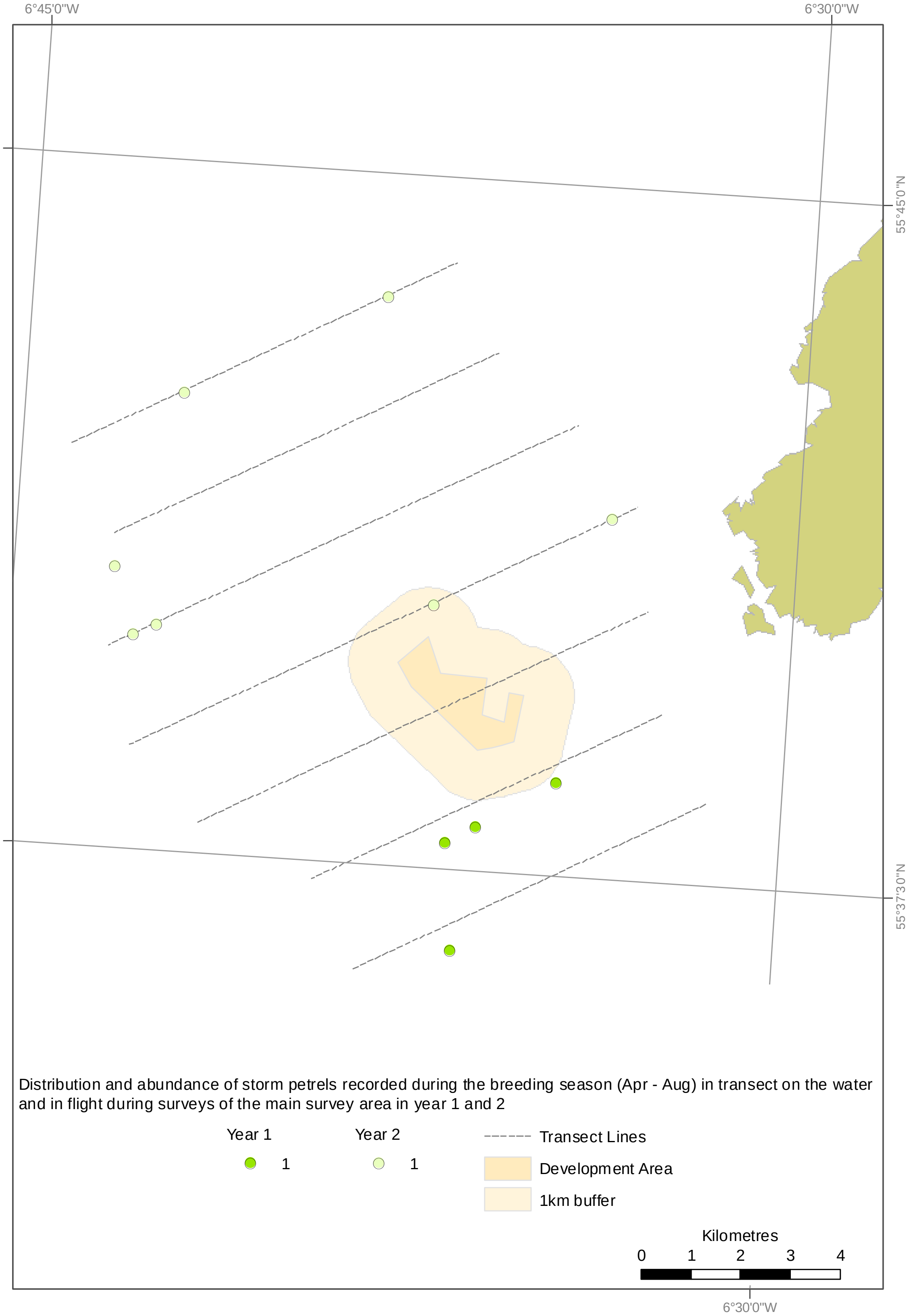


Figure 5 Storm petrel breeding season (Apr - Aug)



Distribution and abundance of storm petrels recorded during the breeding season (Apr - Aug) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

Figure 6 Gannet breeding season (Apr - Aug)

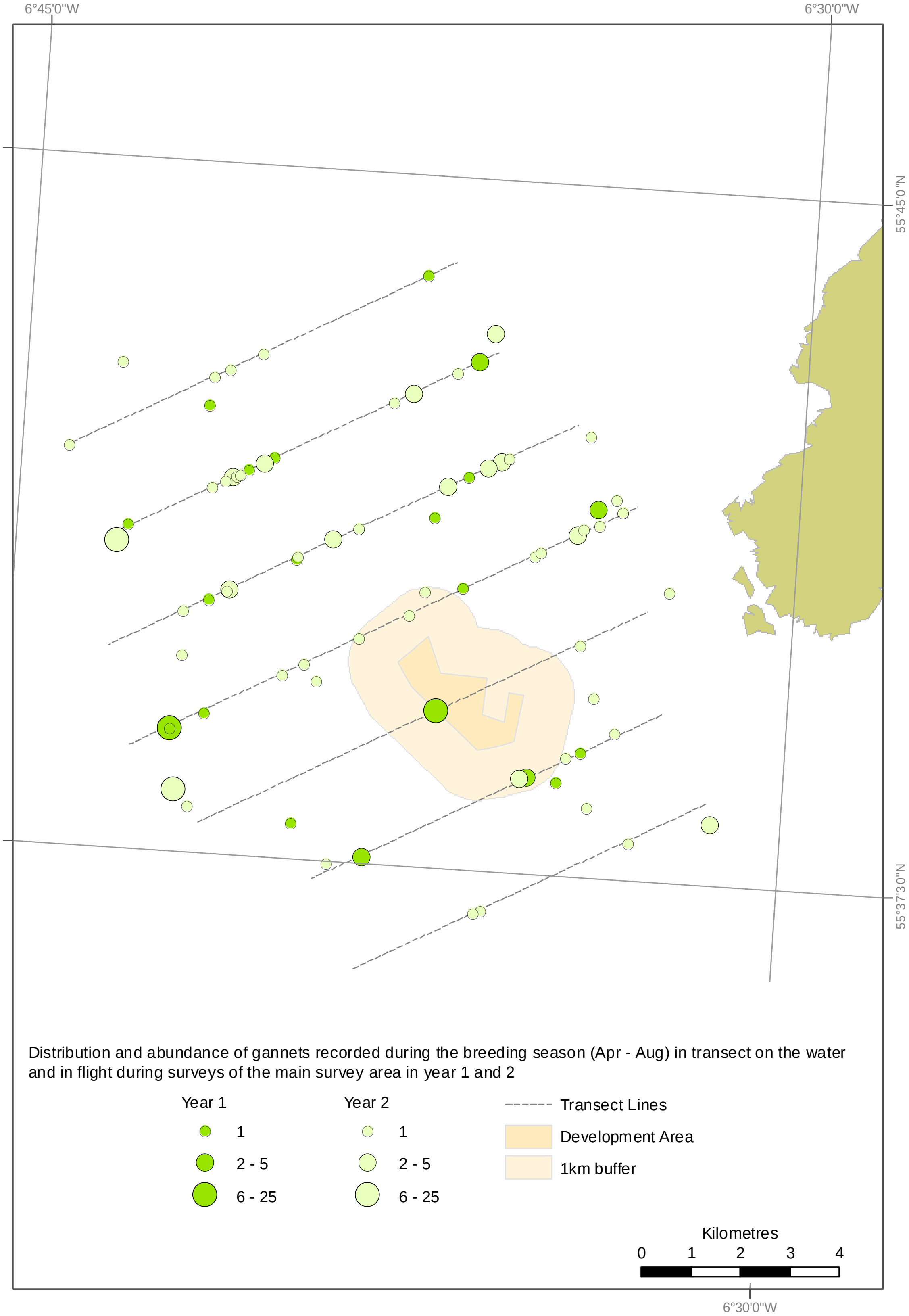
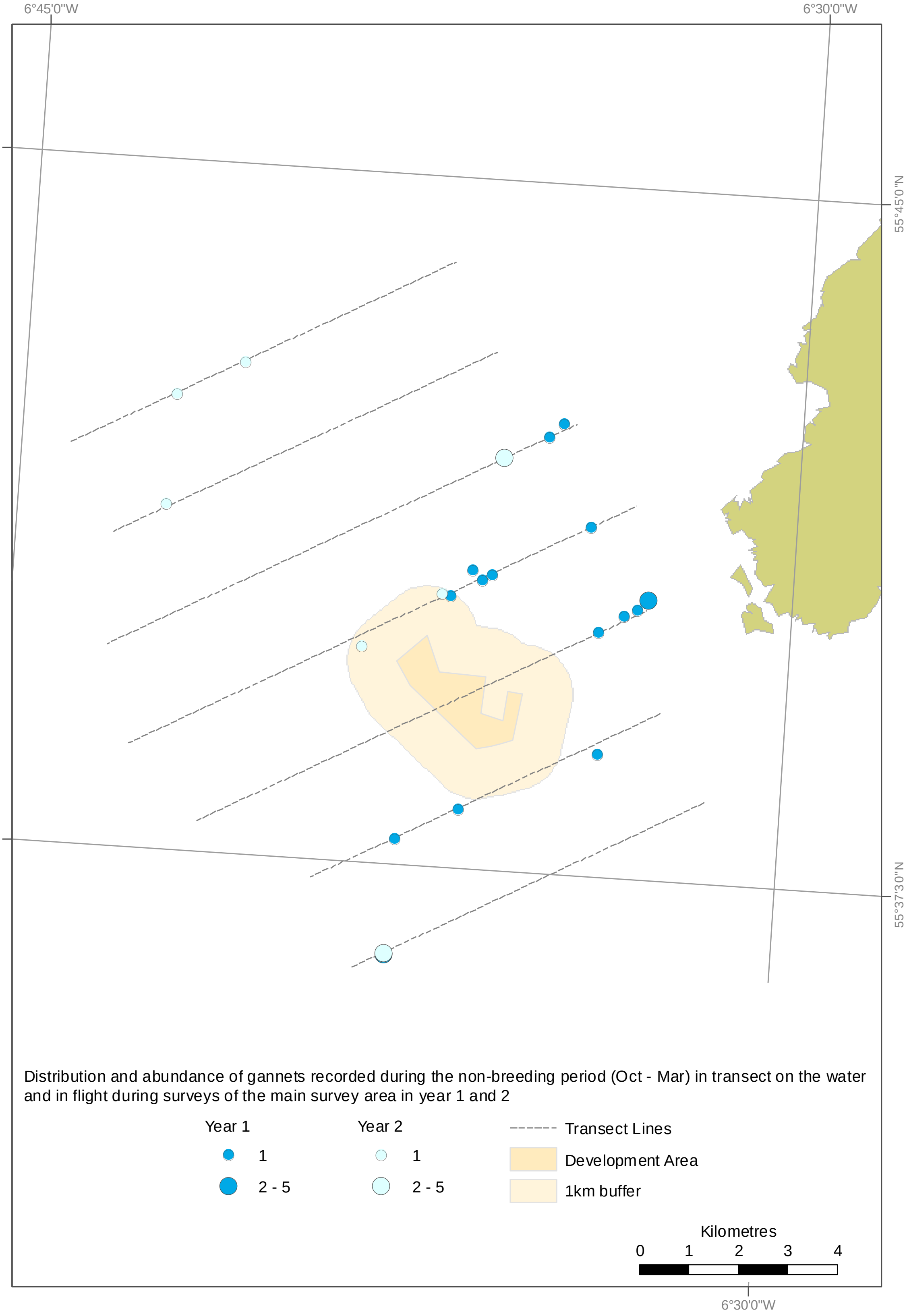
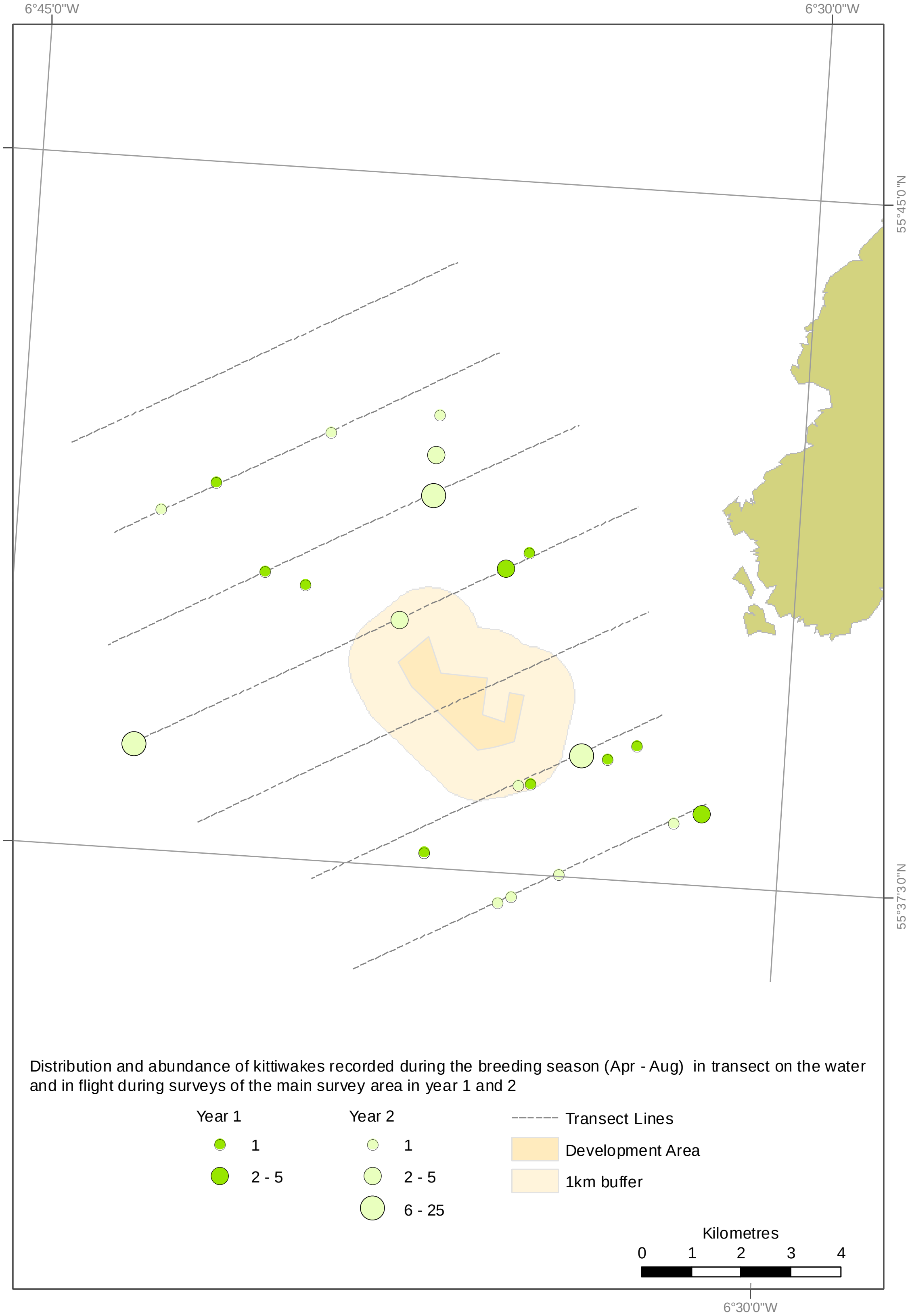


Figure 7 Gannet non-breeding period (Oct - Mar)



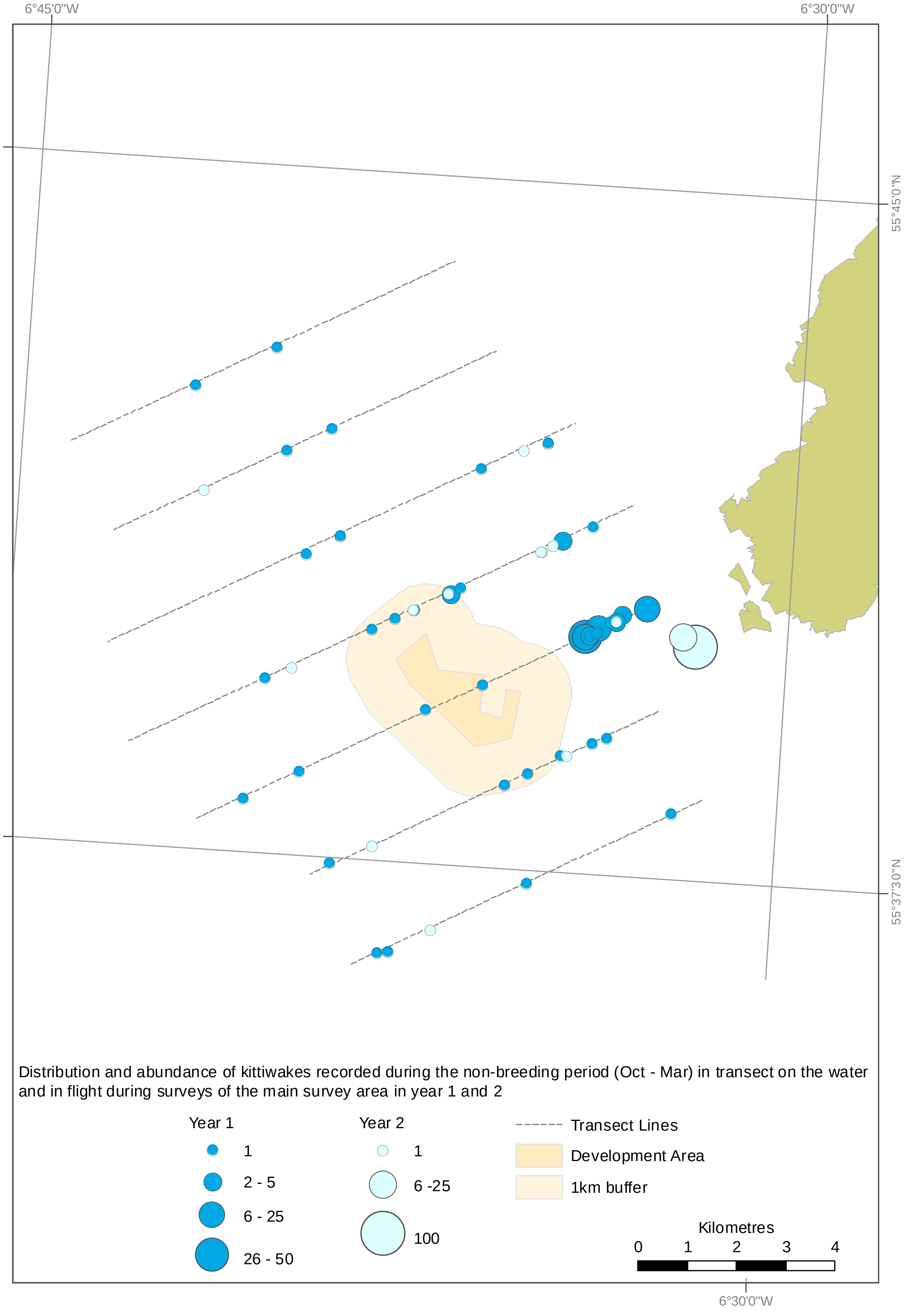
Distribution and abundance of gannets recorded during the non-breeding period (Oct - Mar) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

Figure 8 Kittiwake breeding season (Apr - Aug)



Distribution and abundance of kittiwakes recorded during the breeding season (Apr - Aug) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

Figure 9 Kittiwake non-breeding period (Oct - Mar)



Distribution and abundance of kittiwakes recorded during the non-breeding period (Oct - Mar) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

Year 1: 1; 2 - 5; 6 - 25; 26 - 50

Year 2: 1; 6 -25; 100

Transect Lines

Development Area

1km buffer

Kilometres 0 1 2 3 4

Figure 10 Common guillemot breeding season (Apr - Aug)

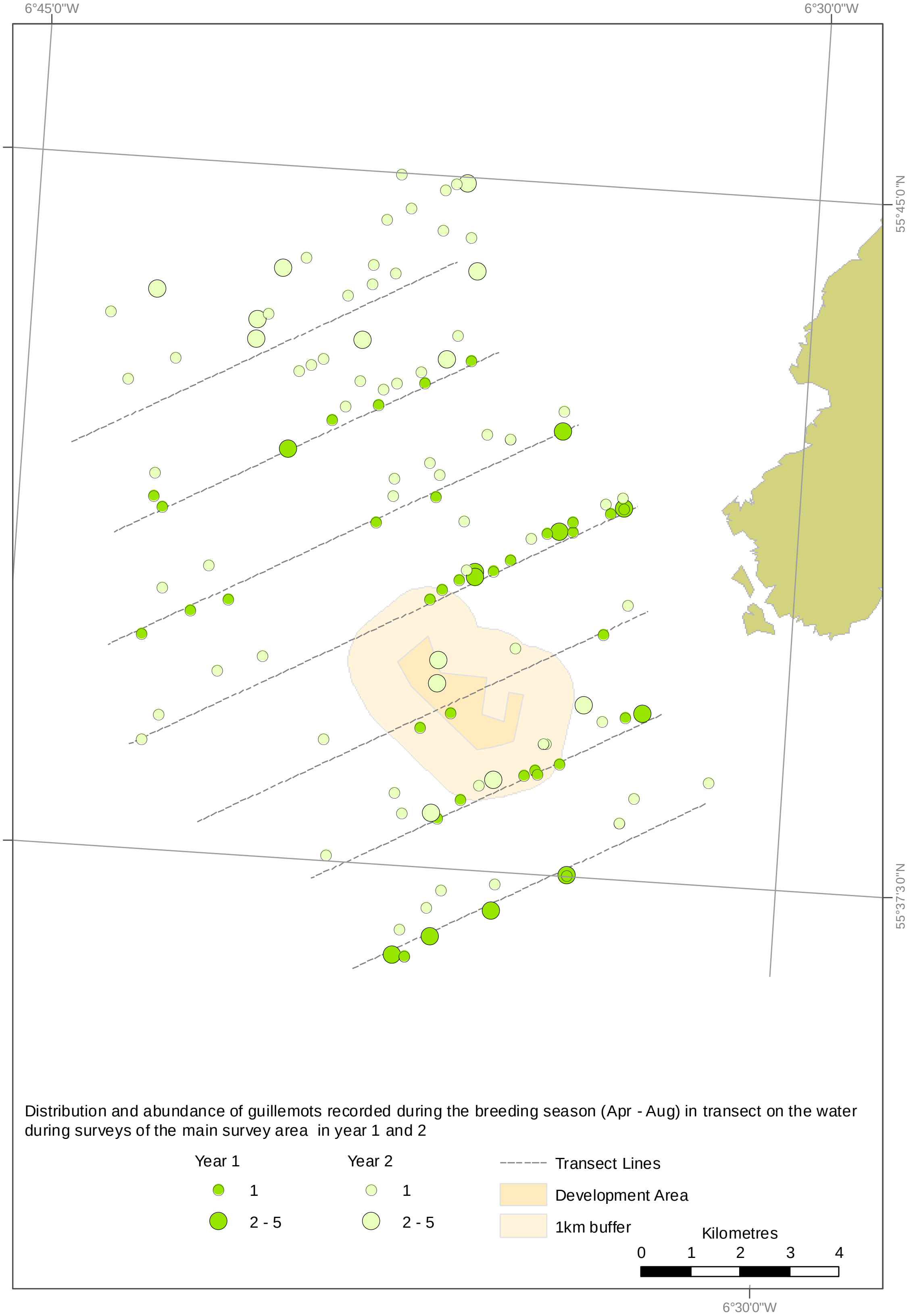


Figure 11 Common guillemot non-breeding period (Oct - Mar)

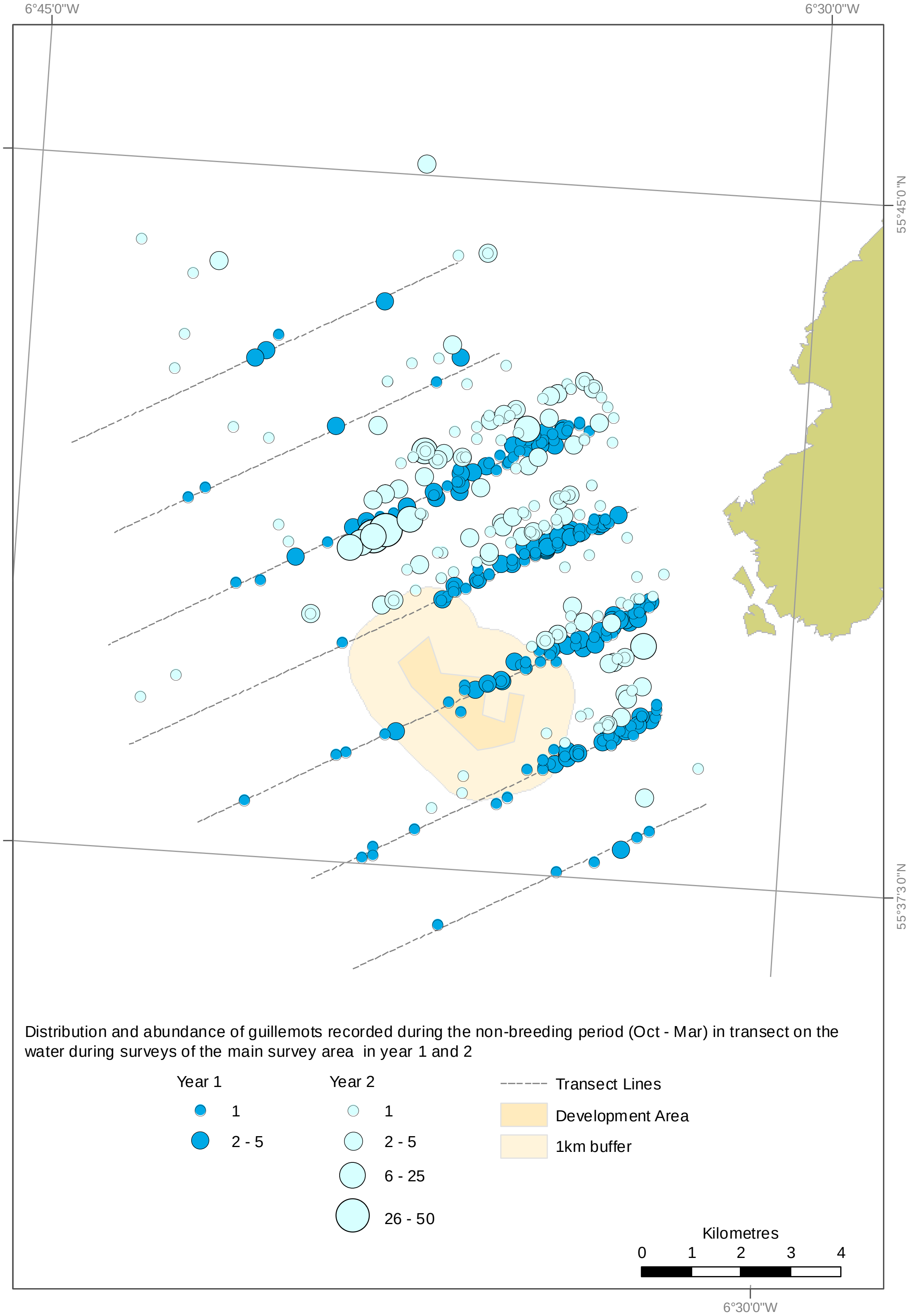
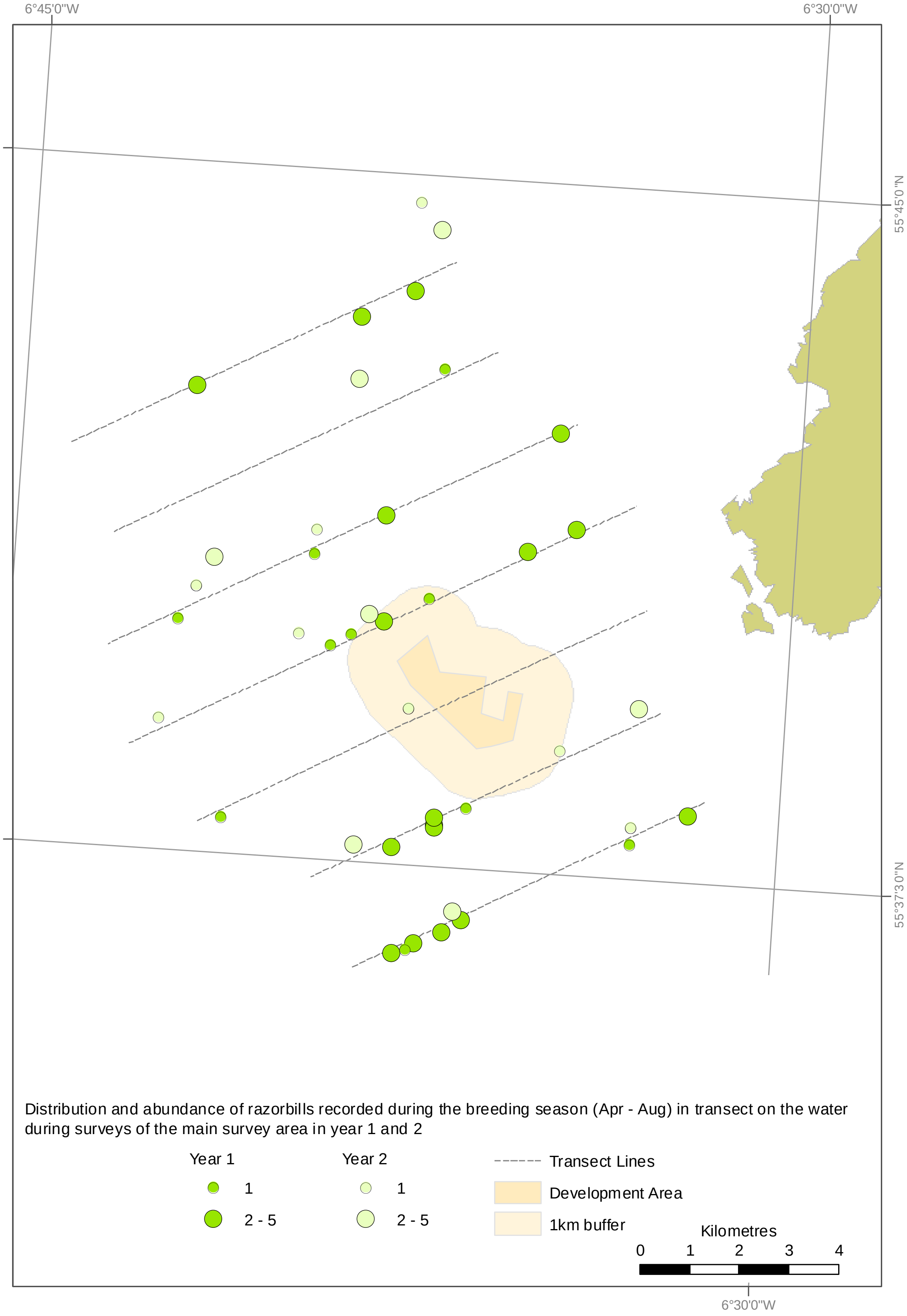


Figure 12 Razorbill breeding season (Apr - Aug)



Distribution and abundance of razorbills recorded during the breeding season (Apr - Aug) in transect on the water during surveys of the main survey area in year 1 and 2

Figure 13 Razorbill non-breeding period (Apr – Aug)

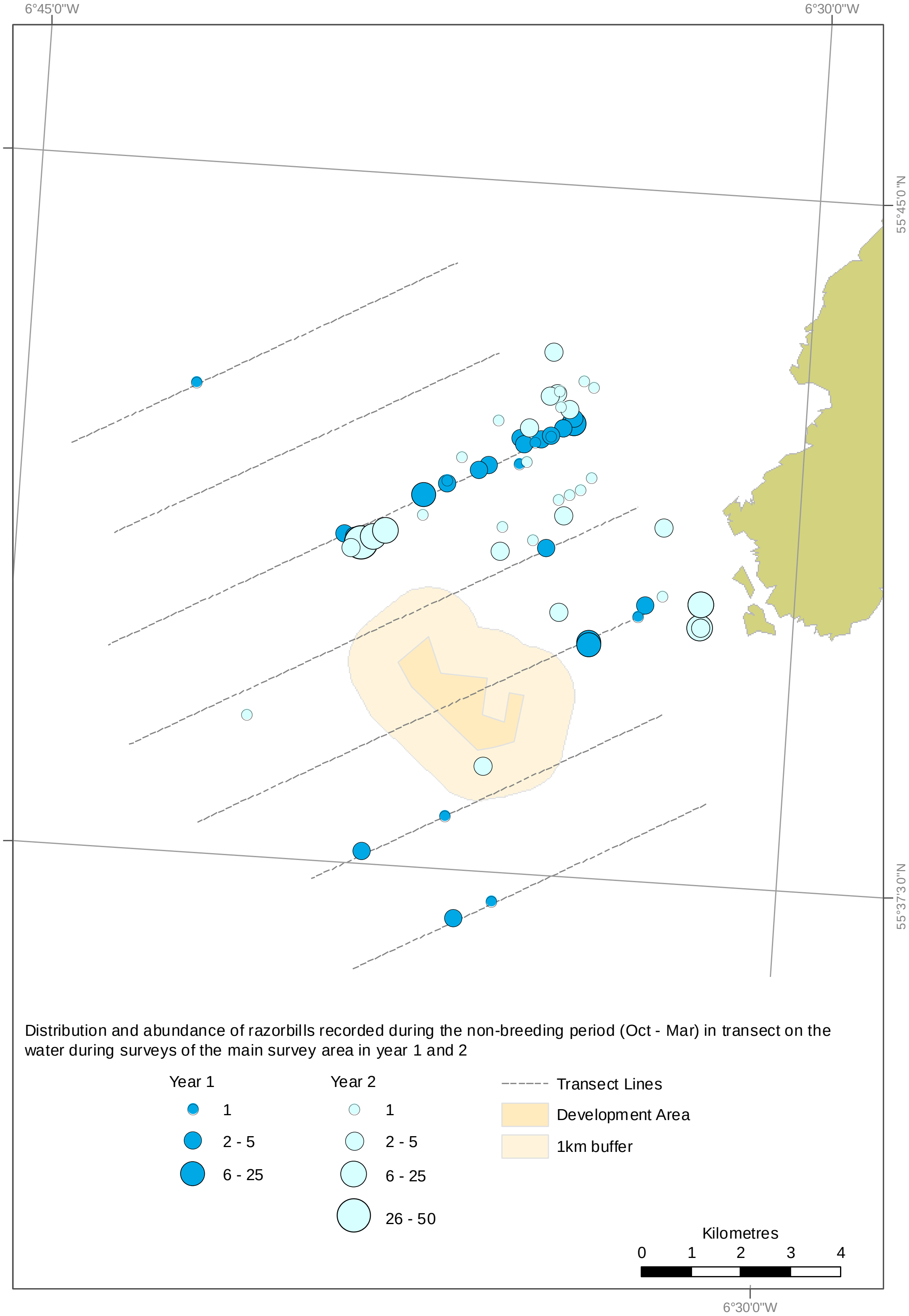


Figure 14 Black guillemot breeding season (Apr - Aug)

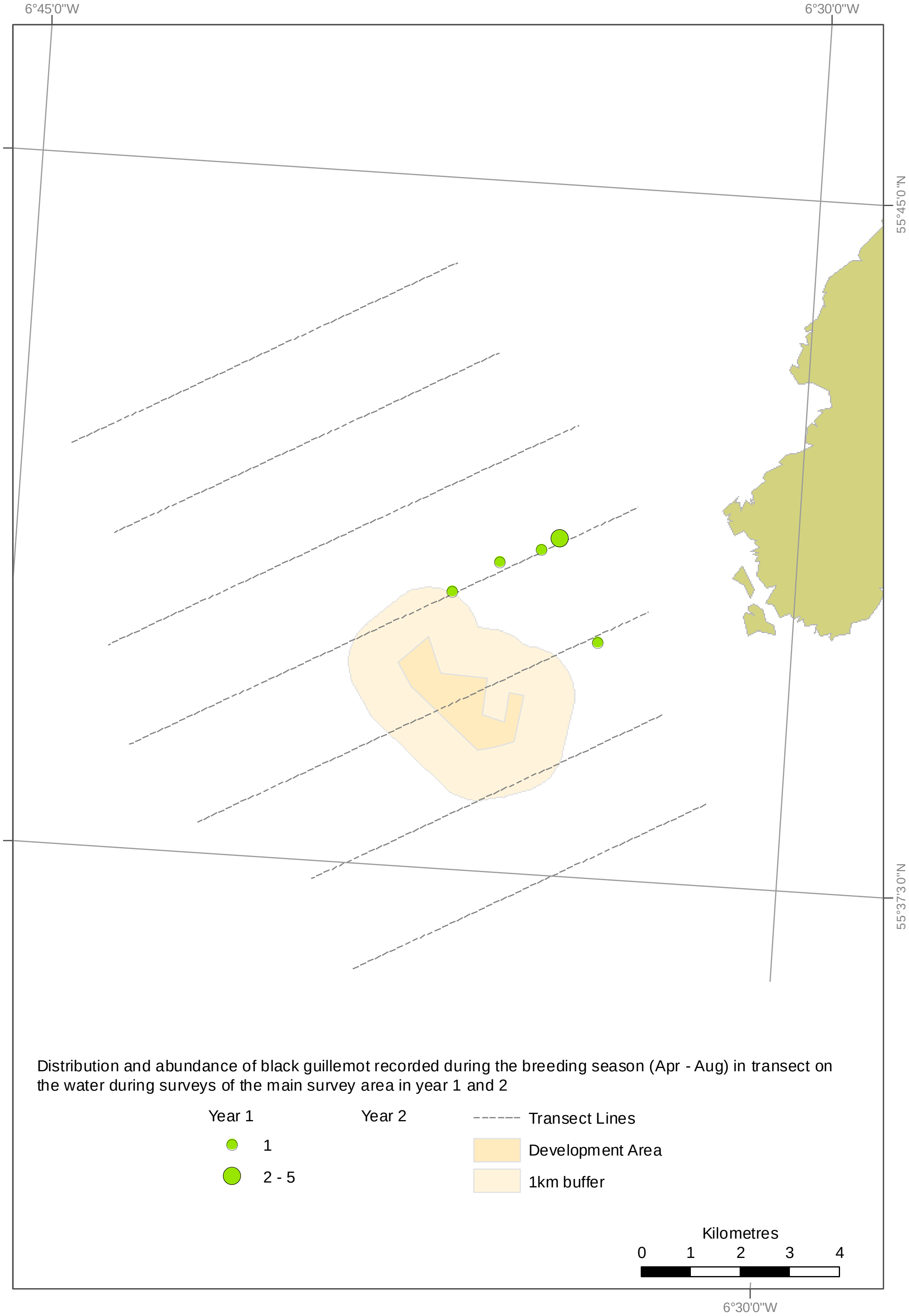


Figure 15 Black guillemot non-breeding period (Oct - Mar)

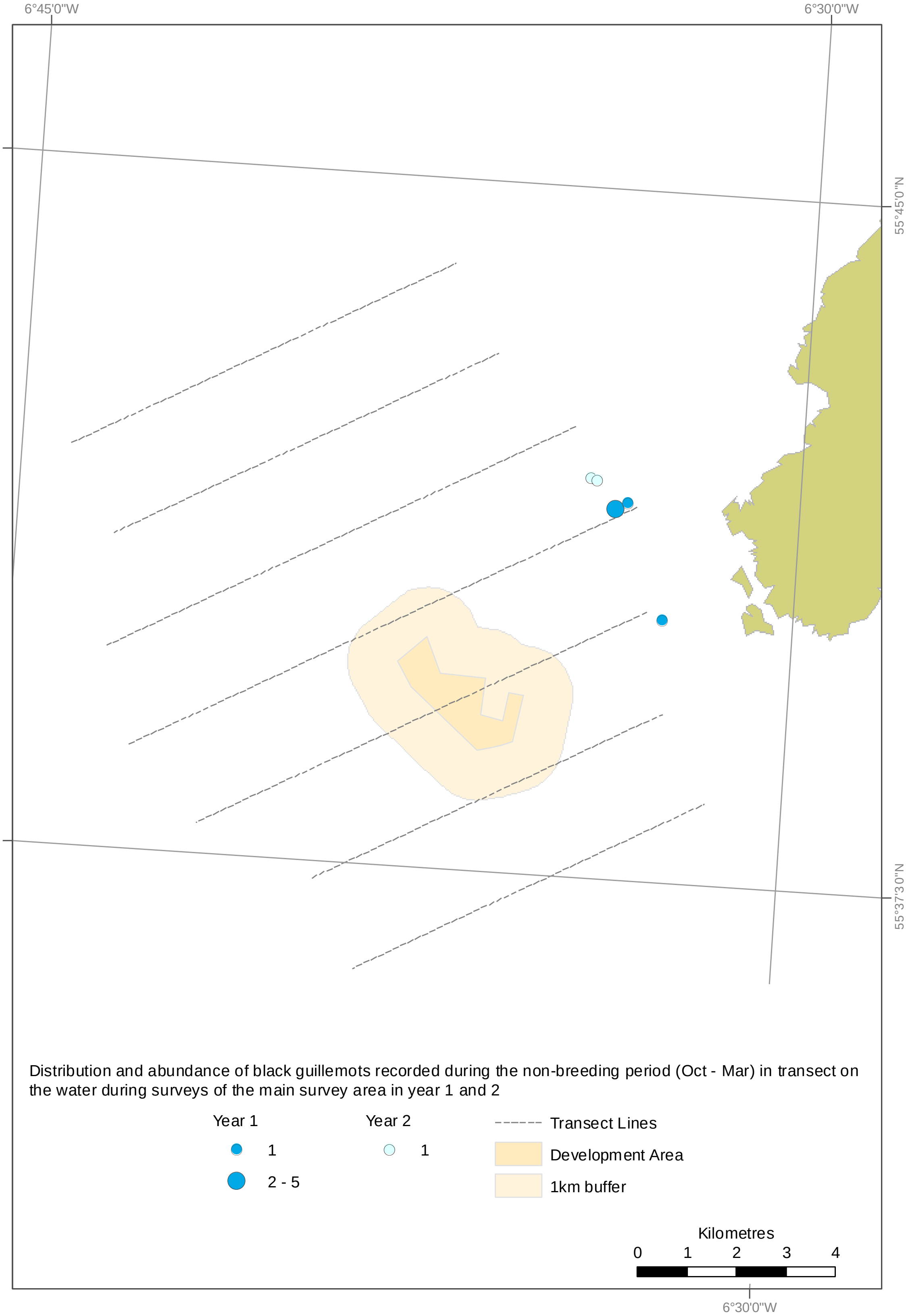
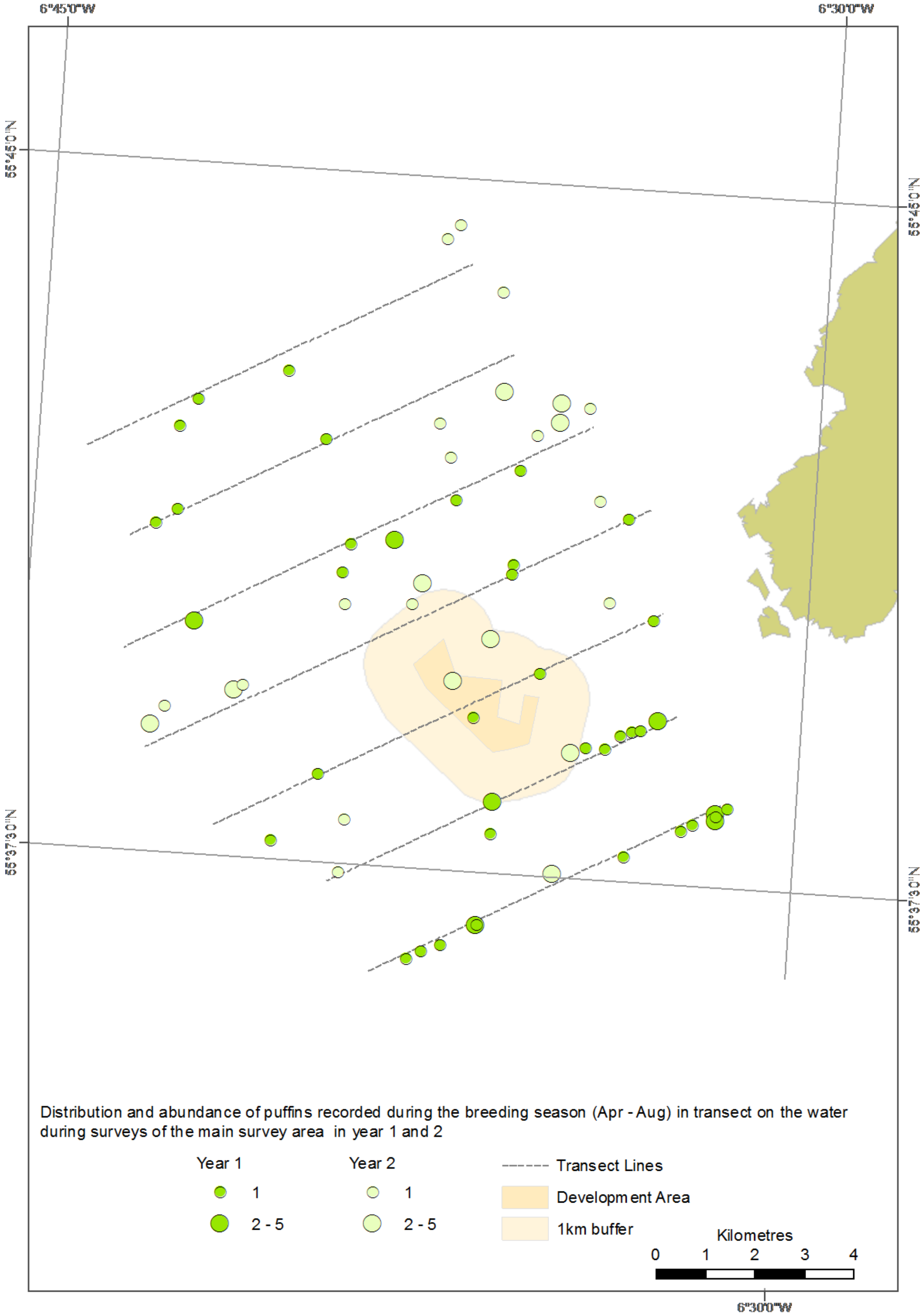
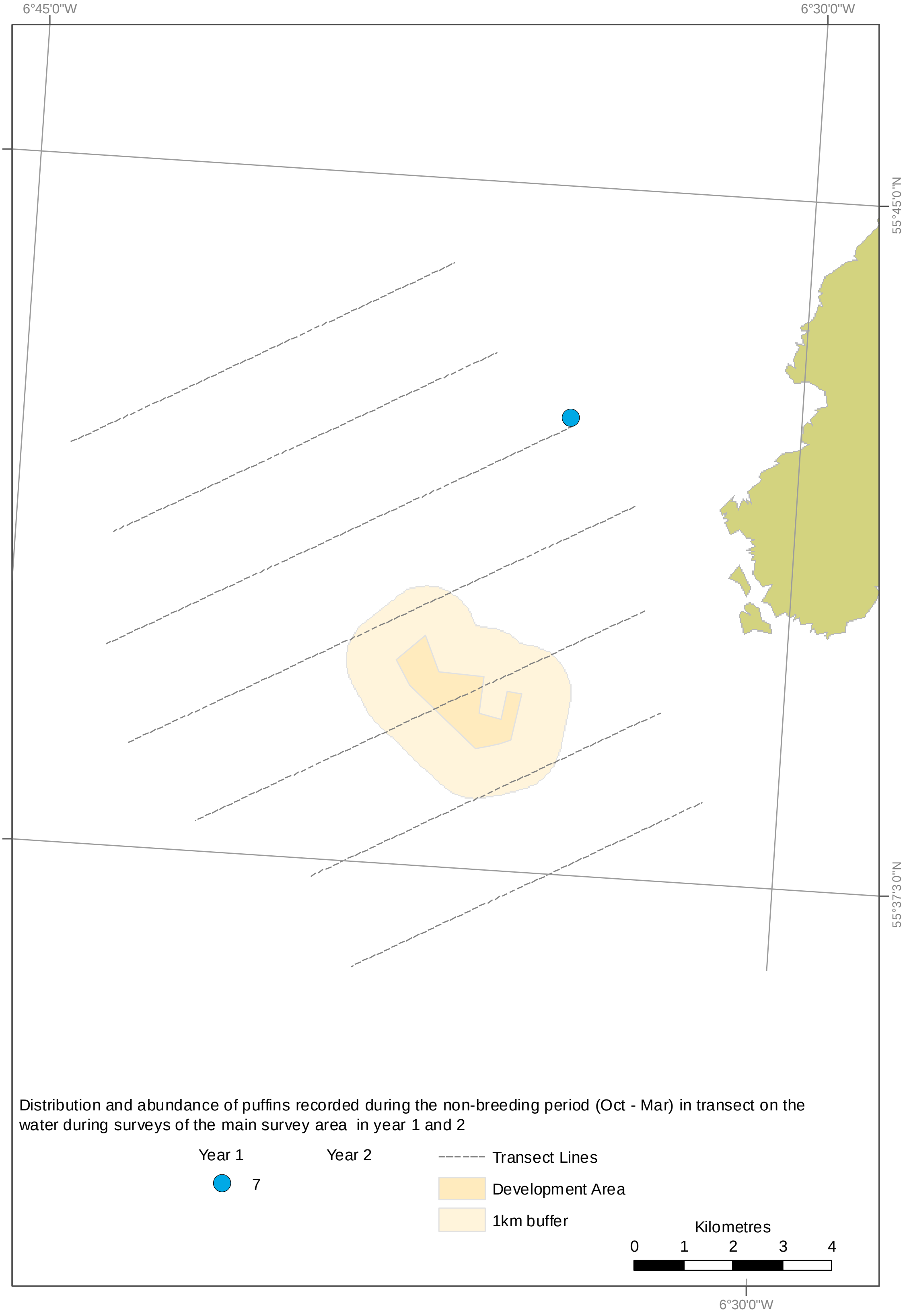


Figure 16 Puffin breeding season (Apr - Aug)



Distribution and abundance of puffins recorded during the breeding season (Apr - Aug) in transect on the water during surveys of the main survey area in year 1 and 2

Figure 17 Puffin non-breeding period (Oct - Mar)



Distribution and abundance of puffins recorded during the non-breeding period (Oct - Mar) in transect on the water during surveys of the main survey area in year 1 and 2

Appendix 1: Survey conditions

10 November 2009

Condition throughout were at the upper-end of being acceptable, at times in the east part of the site they were borderline unacceptable due to the large swell. The survey coincided exactly with a short window of fine relatively calm weather; conditions in previous and succeeding days would have been too rough. The survey also coincided with neap tides.

During the survey, the sea state was classed as 3 or 4 and there was a F4 NW wind. There was also a NW swell. At the western side of the site the swell was 1-2 m, but on the Eastern side, where the water depth is much less, the swell was estimated at 3-5 m. The visibility was good to excellent. The weather was mostly fine with sunny spells and the occasional light rain shower.

28 November 2009

Generally good. The sea state was 1 at the start and for the first two transects (7 & 6), after which it was a 2 throughout the rest of the survey. There was south-westerly swell 1 -2m (2.5-3 at the eastern end of transects 4 & 5). The visibility was very good throughout, with no precipitation.

15th December 2009

Poor. The sea state was 4 for the first transect (7), after which deteriorated to 5, then very rough as the slack water dissipated. There was north-easterly swell 2m. The visibility was very good throughout, with no precipitation, although spray was a problem at times.

6th February 2010

Excellent. The sea state was 2, dropping to 1 along the cable run (there was a short section where the sea-state rose to 3-4, but only briefly along the cable run). There was a long north-westerly swell of 2m. The visibility was very good throughout, with no precipitation.

9th March 2010

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	1m W	2 South
6	1-2	1m W	2 South
5	1	1m W	2 South
4	0-1	1m W	2 South
3	0-1	1m W	2 South
2	1	1m W	2 South
1	1	1m W	1 South
Cable run	1-2	1m W	1 South

The survey conditions were excellent throughout, the sea-state was very good for spotting birds on the water and the winds were light. There was a short 0.5m swell from the east and a long 1.0m swell from the west.

9th April 2010

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	2m SW	SE 1-2
6	2	2m SW	SE 2
5	2	2m SW	SE 2
4	2	2m SW	SE 2
3	2	2m SW	SE 2
2	2	2m SW	SE 2
1	2	2m SW	SE 2
Cable run	2	2m SW	SE 2

The survey conditions were very good throughout, the sea-state was very good for spotting birds on the water and the winds were light.

11th May 2010

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	3	NW 1.5	NW 3
6	3	NW 1.5	NW 3
Cable run	3	NW 1.5	NW 3
5	2-3	NW 1.5	NW 3
4	2-3	NW 1.5	NW 3
3	2	NW 1.5	NW 3
2	2-3	NW 1.5	NW 3
1	3	NW 1.5	NW 3
Rathlin SPA	2 (v.occ. 3-4)	NW 1.0	NW 3

The survey conditions were good throughout.

22nd and 23rd June 2010

Date	Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
22/6	7	1	N	1 S
	6	1-2	0.5 SW	1 S
	Cable run	1	0.5 SW	1 S
	5	1	0.5 SW	1 S
	4	1-2	1 SW	1 S
	3	1	1 SW	1 S
	2	1	0.5 SW	1 S
	1	1	0.5 SW	1 S
	Colonsay SPA 1	1	0.5 SW	1 S
	Colonsay SPA 2	0-1	0.5 SW/N/1 W	1-2 S
23/6	Rathlin SPA 1	1-3	1 S	2 S
	Rathlin SPA 2	1-2	1 SW/N	2 S

The survey conditions were excellent throughout.

20th and 21st July 2010

Date	Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
20/7	7	2	2.0 SW	1 SW
	6	2	2.0 SW	1 SW
	Cable run	2	2.0 SW	1 SW
	5	2	2.0 SW	1 SW
	4	2	2.0 SW	1 SW
	3	2	2.0 SW	1 SW
	2	1	2.0 SW	1 SW
	1	2	2.0 SW	1 SW
	Colonsay SPA 1	0-1	1.5 SW	1 V
	Colonsay SPA 2	0-1	1- 1.5 SW	1 N/1 V, briefly visibility down to 500m
21/7	Rathlin SPA 1	1	0.5 SW	2 N
	Rathlin SPA 2	1	0.5 SW	2 N

The survey conditions were very good to excellent throughout.

18th and 19th August 2010

Date	Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
18/8	7	3	1.5 SW	3 SW
	6	3	1.5 SW	3 SW
	Cable run	3	1.5 SW	3 SW
	5	3	1.5 SW	3 SW
	4	4	1.5 SW	3 SW
	3	4	2 SW	3 SW
	2	3	2 SW	3 SW
	1	2	2 SW	2 SW
	Colonsay SPA 1	2	1.5-2 SW	1 SW/2 W
	Colonsay SPA 2	2-4	1.5-2 SW	2 W
19/8	Rathlin SPA 1	4	1-1.5 SW	4 SW
	Rathlin SPA 2	4	1-1.5 SW	4 SW

The survey conditions were average to good throughout.

12th October 2010

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	1	0.5 NW	1 NW
6	1	1.0 NW	2 NW
Cable run	1	1.0 NW	2 NW
5	2	0.5 NW	3 NW
4	3	0.5 NW	3 NW
3	2	0.5 NW	3 NW
2	2	0.5 NW	3 NW
1	2	0.5 NW	3 N

The survey conditions were average to good throughout.

14th December 2010

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	0.5 W	NW 2
6	2	0.5 W	NW 2
Cable run	2	0.5 W	NW 2
5	3	0.5 W	NW 2-3
4	2-3	0.5 W	NW 3
3	2	0.5 W	N 3
2	3	0.5 W	N 3
1	3	0.5 W	N 3

The survey conditions were good throughout.

27th January 2011

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	1 NW	3 NE
6	2	1 NW	3 NE
Cable run	3	1 NW	3 NE
5	3	1 NW	3 NE
4	3-4	1 NW	3 NE
3	3	1 NW	3 NE
2	3	1 NW	3 NE
1	3	1 NW	3 NE

The survey conditions were good throughout.

2nd March

Transects	Sea-state	Swell Ht. & Direction	Wind Speed & Direction
7	3	3 NW	1 SE
6	3-4	3 NW	1 SE
Cable run	3-4	3 NW	1 SE
5	3	3 NW	2 SE
4	3	3 NW	1 SE
3	3	3 NW	2 SE
2	2	3 NW	2 SE
1	2	3 NW	1 SW

The survey conditions were average throughout and at all times within the ESAS guidelines.

28th March

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	1 W	2 SE
6	2-3	1 W	2 E
Cable run	2	1 W	2 E
5	2	2 W	2 E
4	3	2 W	2 E
3	3	1 W	2 E
2	3-4	1 W	2-3 E
1	4	2 W	3 E

The survey conditions were average throughout.

27th and 28th April 2011

Date	Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
27/4	7	4	1 SE/2 NW	4 SE
	6	4	1 SE/2 NW	4 SE
	Cable run	4	1 SE/2 NW	4 SE
	5	3-4	1 SE/2 NW	4 SE
	4	4	1 SE/2 NW	4 SE
	3	3-4	1 SE/2 NW	4 SE
	2	4	1 SE/2 NW	4 SE
	1	4	1 SE/2 NW	4 SE
	CO1	3-4	1 SE/2 NW	4 SE
	CO2	3-4	1-2 SE	3-4 SE
28/4	RA1	3	1 SE	3 SE
	RA2	3	1 SE/2 NW	3 SE

The survey conditions were average throughout.

8th June 2011

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	1-2	2 E	3 E
6	1-2	2 E	3 E
Cable run	2	2 E	3 E
5	0-2	2 E	3 E
4	2-3	2 NW	3 E
3	2	2 NW	3 E
2	1-2	2 NW	3 E
1	1	2 NW	3 E
CO1	1-2	1-2 NW	2-3 NW
CO2	2-4	1-2 NW	NW 3-4

The survey conditions were average throughout.

28th and 29th June 2011

Date	Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
28/6	7	4	2 W	3 W
	6	4-6	2 W	3 W
	5	3-5	3 W	3 W
	4	4	3 W	3 W
	3	4	3 W	3 W
	2	3	3 W	3 W
	1	3	3 W	3 W
	CO1	2-3	2 NW/2 W	2 SW
	CO2	3	2 W	2-3 SW
29/6	RA1	3	2 W	3 W
	RA2	2-4	2 W	3 W

The survey conditions were very poor within the development site and its buffer, the sea state improved on the SPA transects.

26th and 27th July 2011

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
7	2	1.5 SW	2 N
6	2-3	1.5 SW	2 N
CR	3	1.5 SW	2 N
5	2-3	1.5 SW	2 N
4	4	1.5 SW	2 N
3	4	1.5 SW	3 N
2	4	1.5 SW	3 N
1	4	1.5 SW	3 N
CO1	3-4	1-1.5 SW	3 N
CO2	3	1.5 SW	2-3 N
RA1	2-3	1 W	2 SE
RA2	3-4	1 W	2 SE/2 SW

The survey conditions were average throughout.

23rd August 2011

Transects	Sea-state	Swell Ht & Direction	Wind Speed & Direction
1	2-3	1 W	2-3 SE
2	2-3	1 W	2-3 SE
3	2	1 W/1 SE	2 SE
4	2	1 SE/ 1 NW	2 SE
5	1	1 NW	1 SE
6	2	1 NW	2 SE
CR	2	1 NW	2 SE
7	3	1 NW	3 SE

The survey conditions were good throughout.

Annex 1.

Bird abundance estimates for a proposed tidal development off West Islay based upon Distance Sampling analyses

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Introduction

This document presents the results of distance sampling analyses (Buckland *et al.* 2001, Buckland *et al.* 2004) of bird data collected during boat based surveys of the waters surrounding a proposed tidal energy development off West Islay (Figure 1).

Distance Sampling is a widely-used group of closely related methods for estimating the density and/or abundance of biological populations from data collected usually using line transects or point counts (Buckland *et al.* 2001, 2004). It caters for the fact that animals more distant from the observer are less likely to be detected, and corrects the resulting population estimates accordingly. For distance sampling to be applied, perpendicular distances of clusters of animals from the survey line must be recorded. A detection function is then fitted to these observed distances, and used to estimate the proportion of objects missed within transect. This then allows an absolute estimate of the number and density of animals present to be made. Key assumptions of the standard distance sampling methods applied here are:

- All animals on the transect line (i.e. at distance zero) should be detected.
- There should be no responsive movement prior to detection.
- Distance to animals should be measured without error.
- The detection function should have a wide shoulder (i.e. most animals should be detected out to a reasonable distance).

The Data

This data was collected using standard ESAS methodologies (Camphuysen *et al.* 2004) during 20 surveys between October 2009 and August 2011 (Table 1). Where possible these surveys have taken place at monthly intervals. However on three occasions where poor weather prevented surveys in one month (October 2009, February 2011, May 2011) , two surveys took place in the following month to compensate (Table 1).

The study area surveyed was based upon a 4 km buffer around the original development site as defined in October 2009 (Figure 1). This study area is systematically covered by seven transects (T1 to T7) spaced at 2 km intervals within a randomly positioned grid (Figure 1). The two outermost transects (Transects T1 and T7) were extended beyond the study area boundaries to provide a better basis for analysis in the event of density surface modelling (Buckland *et al.* 2004, Thomas *et al.* 2010) being used to estimate densities and generate distribution maps. In addition to these core transects, a single transect (CR) was regularly surveyed to cover the proposed cable route and four transects (C1,C2, R1 and R2) were surveyed to cover corridors extending towards the Colonsay and Rathlin Island SPAs. The purpose of surveying these corridors was try and establish the likelihood of birds from these SPAs frequenting the development area.

Generally, in each survey all of the core transects (T1) were covered. However, in December 2009, due to poor weather only the four southernmost core transects (T4 to T7) were covered. The cable route (Transect CR) was surveyed during every survey, whilst coverage of the SPA corridors (Transects C1,C2,R1 and R2) was variable and limited to the summer months (Table 1).

To fit the detection functions, sightings from all of these transects have been included. In addition a small number of sightings made in transit between transects have also been included. However, when estimating encounter rates and densities, only sightings made from the core transects T1 to T7 and within the study area (i.e. excluding some sightings on transects T1 and T7 outside the study area) where included.

Sample Sizes

Tables 2 to 4 present sample sizes for all sightings, birds on the water and birds in flight respectively.

Design versus Model based abundance and density estimates

In the key published work on Distance sampling, "An Introduction to Distance Sampling", Buckland *et al.* (2001) recommend that a minimum of 10-20 transects should be surveyed to provide an adequate basis for estimating the variance of the encounter rate and to provide a reasonable number of degrees of freedom for constructing confidence intervals. In subsequent workshops run by CREEM (August 2009 and June 2011) Buckland has recommended that at least 20 transects should be surveyed. For this study, the original survey design document prepared by Craigton/Caloo Ecological Services in October 2009 stated:

> *"At 2 km spacing, the study area is only traversed by 6-7 transects, whereas distance sampling texts recommend 20+ transects, so would be best to use the closest transect spacing possible consist with achieving full survey in one day whilst not creating problems due to birds displaced by surveying one transect increasing counts on next transect."*

With just seven transects design based estimates of encounter rates and thus density and abundance of birds within the study area are likely to be very imprecise. For smaller areas, such as the development area (bisected by one transect), or the development area plus a 1 km buffer (bisected by two transects) design based estimates will be even less precise. Where strata for which density and abundance are to be estimated are covered by only a small number of transects, model based approaches such as density surface modelling (Buckland *et al.* 2004) can potentially yield much more precise (i.e. less variance) and accurate (i.e. less biased) estimates of abundance and density than design based approaches.

Furthermore, whereas the original development area proposed lay at the centre of the study area, the current development area proposed lies close to the study area's south eastern edge. For the original development site, at the centre of the study area, it is not wholly unreasonable to assume it is representative of the study area as a whole. Therefore using design based estimates of density for the whole study area, based upon data from all the core transects, to estimate the abundance of birds within the development site (or the development site plus a 1 km buffer) can perhaps be justified. However, the assumption that the current proposed development site is representative of the study area is much harder to justify when it lies so close to the edge of the study area. This further strengthens the case for estimating the abundance of birds within the development site (or the development site plus a 1 km buffer) using estimates based upon density surface modelling rather than design based estimates.

However, such modelling is potentially time consuming and expensive: thus it should only be carried out for species which potentially could be important to the outcome of the consenting process. Furthermore, to apply density surface modelling not only requires an adequate sample size for fitting the detection function, but also for estimating the encounter rate. Whereas the detection function can be fitted using data combined across all surveys, the encounter rate estimate must be based on data just from the particular survey for which density is being estimated.

As the probability of detection must be modelled separately for birds in flight and birds on the water, density surface models are fitted separately to these two data sets. Overall estimates of density and abundance are then obtained by adding the estimates for birds in flight to those for birds on the water. As the potential impacts of a tidal development on birds in flight are likely to be different from those for birds on the water there are also good biological reasons for modelling the two data sets separately (Although for be species such as gannet and kittiwake which feed whilst in flight, the overall population estimate including birds in flight and birds on the water might provide a better of the number of birds potentially exposed to any threats encountered in or on the water than the population estimate for birds on the water alone).

Thus, sample sizes are calculated separately for birds in flight and birds on the water. In a previous study (Harding 2010) density surface modelling based upon spatial interpolation (i.e. a two dimensional smooth over eastings and northings) was used to calculate abundance and density estimates for seabirds in three separate study areas in the North Sea, for two separate surveys. For some data sets (i.e. species, survey, activity (on water or in flight) combinations), this study encountered serious problems when using density surface models to estimate density and abundance. This included software crashes, poorly fitting models, very high coefficients of variation associated with population size estimates, and large numbers of bootstrap replicates excluded during variance estimation. Although sometimes models could be successfully fitted to smaller data sets these problems mainly occurred in cases where the number of observations was less than c.50. As a general rule of thumb, Buckland *et al.* 2001: suggest, that for reliable fitting of the detection function within conventional distance sampling, a minimum sample size of 60-80 observations/cluster is required. Our experience in this previous study suggests that a similar rule of thumb may apply to the sample sizes required for the reliable fitting of density surface modelling.

If we assume that a minimum of 50 observations are required within a survey for the fitting of a density surface model to be reliable then this suggests are no species/survey combinations for which birds in flight could reliably be modelled using density surface modelling (Table 5b). For birds on the water then the only species for which there are any surveys with sample sizes greater than 50 is guillemot (Table 5a). For this species, there were four out of 20 surveys with sample sizes greater than 50: the February and March surveys in 2010 and the January and June surveys in 2011. If we are more optimistic and assume a minimum sample size of 40 observations is required then this makes no difference to the number of surveys judged to have adequate sample sizes for either birds in flight (Table 5b) or birds on the water (Table 5a). If we are extremely optimistic, and assume a minimum required sample size of 30 observations, then, for birds on flight (Table 5b), where the maximum number of observations recorded during a survey was 27, this still makes no difference to the number of surveys judged to have adequate sample sizes. For birds on the water (Table 5a), if only 30 observation were required to reliably fit a density surface model then this would suggests we might be able to fit a density surface model for one additional survey, March 2011.

As noted above, currently birds in flight must be modelled separately from birds on the water. However it is conceivable that software could be developed which would allow a single detection function to be fitted over the two data sets combined, whether birds where on the water or in flight as a covariate, and appropriate behaviour in the two cases. This would allow a density surface model to be fitted directly to the observations of birds on the water and birds in flight combined, increasing sample sizes. However, this does not materially change the conclusions with respect to the adequacy of sample sizes (Table 5c). Thus, even if we are extremely optimistic and assume a minimum required sample size of 30 the only species/ survey combinations for which sample sizes are likely to be adequate is guillemot in February and March 2010, and January, March and June 2011. Therefore, even if software developments allowed birds on the water and birds in flight to be modelled together, this would not change the conclusions with respect to the adequacy of sample sizes.

Although it might be possible to achieve adequate sample sizes in some occasions by combining data across surveys, generally sample sizes are so low within individual surveys that multiple months will need to be combined to achieve adequate sample sizes within a particular data set, if it is possible at all. To be statistically valid, the distribution and abundance of birds across the surveys to be combined must be similar to one another (i.e. the data must be homogeneous), which is unlikely, particular if data from multiple surveys must be combined. Thus, combining data across surveys is unlikely to solve the problem.

In conclusion, this document generates design based estimates for the abundance of birds. The purpose of these estimates is to allow an assessment to be made for individual species of whether more precise population estimates such as could potentially be achieved using density surface modelling would materially change the conclusions with respect to consenting. However even if desirable, given the sample sizes available, the only individual species for which density surface modelling is likely to be a realistic prospect is guillemot, and then only for birds on the water during the February and March surveys in 2010, and the January, June and, possibly, March surveys in 2011.

Software

All analyses were carried out using programmes written in R (version 2.15.1 (2012-06-22), R Core Team 2012), with the distance sampling analyses performed using functions from the mrds library (Laake *et al.* 2012).

Although the majority of the manipulation of spatial data has been carried out using the libraries available within R (Bivand *et al.* 2008), ESRI Arcview 9.3 was used for some tasks (e.g. buffering of site boundaries, presentation of some maps).

Detection function modelling

The purpose of detection function modelling is to estimate the proportion of animals observers fail to detect, so that estimates of density and numbers can be corrected accordingly. For ESAS data, detection function modelling is only possible for birds on the water as no distance data is recorded for birds in flight. For birds on the water, the ESAS methodology records birds into five distance bands A-E (0-50m,50-100m,100-200,200-300m, 300m+). As no distance data is available for sightings beyond 300m (distance band E), this data cannot be included in the analyses, so that our detection function modelling could only be based on four distance bands at most.

Four distance bands is the absolute minimum for detection function modelling (Buckland *et al.* (2001:262), so that further truncation to remove outliers, or further grouping of data into a smaller number of distance intervals to overcome potential problems such as heaping, errors in distance measurement or evasive movement prior to detection (Buckland *et al.* 2001), were not available as analysis options.

For birds in flight, as no distance data is recorded, no detection function modelling is possible, and so we have assumed a probability of detection of 100%. For birds on the water, we have followed the advice of Maclean *et al.* (2009) and used detection function modelling to estimate the detection probability when there are more than 30 observations (i.e. clusters), and used the generic JNCC correction factors published in Stone *et al.* (1995) otherwise. Thirty observations is considerably less than the 60-80 observations recommended by Buckland *et al.* 2001:228 as the minimum required for reliable fitting of the detection function.

Distance sampling theory assumes that detections are statistically independent events. For seabirds at sea which often occur in aggregations , individual birds are clearly not detected independently of one another, and the unit of analysis for detection function modelling should be the aggregation/cluster of birds as detected. However, seabirds often occur in complex nested aggregations (e.g. two groups of birds within 50 metres of one another forming one aggregation, which itself is part of a larger aggregation) which can be irregularly shaped and extend over distances comparable to or greater than the width of the transect. In this case, defining the size and location of clusters which can be treated as independent detection events is not always obvious. Furthermore, standard ESAS survey methodologies record total counts within each distance band during a recording period, not cluster sizes per se. When a cluster extends over more than one distance band or recording period, or multiple clusters occur within a single recording period, or when a cluster falls mainly outside the transect these counts will not correspond to the cluster size estimates required by distance sampling (Buckland *et al.* 2001). Simulation models suggest that for line transect surveys of primates, where defining the size and location of clusters can also be difficult, treating each individual as a separate detection yields good estimates of density, in spite of violating the assumption that detections are independent of one another (Buckland *et al.* 2009).

Therefore for birds on the water, for each species we fit detection functions both for the case where each count recorded in the data set (e.g. 3 birds in bird A) is treated as a separate detection and for the case where each individual within the data set ((e.g. each of the 3 birds in band A) is treated as a separate detection event. In both cases we fit detection functions to the observed perpendicular distances from the transect line, using grouped data based upon the four predefined distance bands A-D. The form of the detection function is based upon a half normal key function with a cosine adjustment of order 2 (Buckland *et al.* 2001).

With only 17 sightings of birds on the water (Table 2a), for black guillemot, there are insufficient records to estimate detectability from this data, and Stone *et al.* do not give a correction factor for this species. Furthermore, with its very different winter and summer plumages detectability for this species is likely to vary seasonally. Therefore the density and abundance estimates presented here for this species are minimum estimates based on the assumption that all animals present are detected. Actual densities and abundance are likely to be considerably higher.

For species with over 30 sighting, Table 6 gives estimates of detection probability for each species based upon treating the data as clustered, and also treating the data as unclustered. For each species, and for clustered and unclustered data, Figure 4 shows histograms of detection distances for animals on the water within the 300m transect with the fitted detection function superimposed. The histogram bars for the observed data are scaled so that the area under the histogram is equal to the area under the fitted function, facilitating visual comparison of the fitted model and the observed data.

Firstly considering the data analysed as clusters, the detection functions for the various auk taxa (i.e., Guillemot, Razorbill, Puffin, Guillemot and Razorbill, All auks) provide a close fit to the data (Figures 4), and provide precise estimates of the detection of probability, with coefficients of variation of less than 10% (Table 6). These are the most commonly seen species, and all sample sizes are greater than 350 (Table 6, Table 2a). For the remaining taxa (Fulmar, Manx Shearwater, Gannet, Shag, Kittiwake) sample sizes are much smaller (38 to 62 sightings), the detection functions do not fit the data as closely (Figure 4), and the resulting probability of detection estimates are less precise, with higher coefficient of variation values of between 19 and 27% (Table 6). For all taxa, the detection functions based upon treating individuals as the detection event rather than counts appear to fit the data less closely (Figure 4). This is probably because a small number of observations of clusters with large numbers of individuals carry undue weight. However, the coefficients of variation for the detection of probability estimates from analyses assuming individuals are detected independently are still less than those obtained from analyses assuming birds are detecting as clusters. Although pseudo-replication (i.e. treating individuals as individual detection events when they are not) will have led to this reduction in the coefficient of variation, the fact that they have not increased greatly suggest that although the fits are poorer this effect is marginal. Thus, using the probability of detection estimates based upon assuming individuals are detected individually is reasonable.

For Manx shearwaters, Kittiwakes, Guillemots, Razorbills, Guillemots and Razorbills and Auks the estimates for the probability of detection based upon the data analysed as individuals are all considerably higher than the estimates based upon the data analysed as clusters (Table 6). For the other taxa, there is little or no difference in the probability of detection estimates based upon the two data sets, although in all cases but one (Shag – 56% compared to 57%) the estimate based upon the data set analysed as individuals is still higher than the estimate from the data set analysed as clusters. The pattern of higher probability of detection estimates when individuals are assumed to be individually detected rather than clusters is almost certainly because larger clusters are more likely to be detected than smaller clusters, so the probability of detection for clusters underestimates the probability of detection for individuals. Therefore in the following section, where we use these estimates of probability of detection to correct our abundance and density estimates, we use the estimates from the data set where individuals rather than clusters are assumed to be independently detected.

An alternative approach would have been to include cluster size as a covariate within the detection function model. However, we note that such models regularly crash unless cluster size is log transformed, that where sample sizes are small a small number of outliers with large cluster size can have an undue effect on the detection function, and also that with respect to the current purpose (i.e. identifying if there are any species where additional analyses might be necessary) the use of these more complex methods is unlikely to change the conclusions. Therefore, for the current purposes we think relying on data which assumes individuals are individually detected to estimate the probability of detection is adequate.

Estimating Density and Numbers

For each survey, for each taxa, we estimate density and abundance for three different target areas:

1. The whole study area.
2. The development area.
3. The development area plus a one km buffer.

We calculate density and abundance estimates using the Horvitz Thompson like estimator (Thomas *et al.* 2010, Borchers and Burnham 2004) provided by the dht function in the mrds package. We calculate abundance estimates for birds on the water, birds in flight and both combined. The calculation of confidence limits for the abundance estimates for birds on the water and birds in flight combined is given in Appendix A. For guillemots and razorbill, as well as presenting abundance estimates based upon sightings definitely identified as one or other of these two species, we also present abundance estimates which assume that amongst sightings identified as one or other of these two species, the proportion of each species was the same as amongst the positive identifications. The calculation of confidence limits for these estimates is presented in Appendix B. We do not consider the effect of sightings identified as 'auk sp'. on the abundance estimates of guillemot, razorbill and puffin (black guillemots are unlikely to go unidentified), as there was only 1 uncertain auk sp. sighting on the water within the study area.

For birds on the water, for each species with more than 30 records probabilities of detection are estimated on the basis of all sightings, from all transects, and assuming individuals are detected independently (Table 6). For birds in flight, and birds on the water with less than 30 records, the probability of detection is a fixed external value (i.e. 1 or 1/JNCC correction factor), and there is no estimate of variance associated with these estimates. In these cases when calculating the overall variance of the density and abundance estimates a zero contribution from the calculation of the probability of detection has been used.

We based density estimates upon four different stratifications of the data:

1. A single strata corresponding to, and providing density estimates for, the whole study area (Strata defined by the study area boundary in Figure 1). By multiplying this density estimate by the appropriate area estimate we obtain abundance estimates for each of the three different target areas. When this density estimate is being used to estimate abundance for a smaller area (e.g. the development area or the development area plus a 1 km buffer) the underlying assumption is that within a particular survey the distribution of birds across the study area is largely a random process, and within another survey during the same month a completely different distribution of birds across the study area would have been obtained. Thus, for a particular survey, the density of birds across the whole study area is a less biased predictor of average abundance for the smaller area than the actual density of birds recorded within the smaller area. As the estimate is based upon a larger number of transects, the estimate is also more precise.
2. Two strata, one the area within the development site plus a 1 km buffer, the other strata outside this area but within the whole study area (strata defined by the 1 km buffer and study area boundaries in figure 1). On this basis of this stratification, we use the estimate of density for the development site and buffer to estimate the abundance of birds within the same area, and also for just the development site. As the density estimate used is based upon just two transects it will be very imprecise and is likely to be biased. As only a short length of a single transect passes through the development site itself we do not attempt to estimate abundance for the development site itself on the basis of densities within just that area, as the resulting estimates are likely to be too imprecise and biased to be of any value. Again, when using density estimates from a larger area to estimate density for a smaller area we are assuming that within the larger area birds redistribute between surveys at random, so that density for the larger area is a better predictor of average densities for the smaller area at a particular time of year than the density for the smaller area itself.
3. Three strata, based upon dividing the study area up into three bands, with the divisions between bands running perpendicular to the transects, and dividing the study area up into an area further west along the transects than the development site, an area further east along the transects than the development site, and an area the same distance along the transects as the development site (Figure 2). We use the density of birds in the band at the same distance along the transects as the development site to predict the density of birds in the development site. This assumes that the average density of birds in the development site during the month of the survey is the same as that for other areas in this band. In the original design transects were deliberately orientated so as to be perpendicular to the estimated main direction of the tidal current on 335^0. Thus the current speeds are likely to vary with distance along the transect, as the vessel passes from one side of the current to the other. Furthermore, distance from the Islay coast is clearly related to position along the transects. Thus, if distance from the coast or current speed influences bird numbers, then one might expect the density of birds within the same band as the development site to be a better predictor of the density of birds within the development site than the density of birds across the whole study area. Visual inspection of the distribution maps within the Year 1 and Year 2 draft technical reports suggests that any gradients in bird abundance present do tend to be orientated along the direction of the transects rather than across them (e.g. birds more abundant at the eastern or western ends of individual transects, rather than on the northern or southern transects). This suggests that stratifying the data on the basis of distance along transects, and using the density of birds within the strata which corresponds to the same distance along the transects as the development site should potentially yield

more accurate estimates of density/abundance within the development area than using the average density across the whole study area. Compared to a population estimate based on observations within the development site alone, this estimate should be much more precise and less prone to bias as it is based upon much greater survey effort across 7 transects rather than very limited survey effort on a single transect. Furthermore, if within a survey the distribution of birds within the band is largely random, then the density of birds across the whole band may be a less biased predictor of the average density of birds expected in the development site at the time of the survey than the actual density recorded within the site. Thus, in lieu of estimates from density surface modelling, this would be our preferred stratification upon which to be base design based estimates of density and thus abundance for the development site.

4. Again, three strata, dividing the study area up into three bands, with the divisions between bands running perpendicular to the transects. However in this case, the divisions are located with respect to the development site plus a 1 km buffer (Figure 3), to provide a basis for estimating density for this area. For the same reasons as given above, in lieu of estimates from density surface modelling, this would be our preferred stratification upon which to base design based estimates of density and thus abundance for the development site plus a 1 km buffer.

In summary, for each taxa in each survey we provide a single abundance estimate for the whole study area on the basis of densities across the same area.

For the development area plus a one km buffer for each taxa/survey combination we provide three population estimates:

1. A population estimate based upon the density of birds across the whole study area.
2. A population estimate based upon the density of birds within the appropriate banded strata (Figure 3).
3. A population estimate based upon the density of birds within the area itself (i.e. the development area plus a one km buffer).

For the development site we also provide three abundance estimates for each taxa/survey combination:

1. A population estimate based upon the density of birds across the whole study area.
2. A population estimate based upon the density of birds within the appropriate banded strata (Figure 2).
3. A population estimate based upon the density of birds within the development area plus a one 1 km buffer.

In assessing which species may need to be considered in greater detail, if any, these different abundance estimates complement one another.

Firstly, if the estimated abundance of a species across the whole study area is insignificant in conservation terms, then so will the numbers within the development site or the development site plus a one km buffer.

If applying this first test does not eliminate a species from further consideration, then the next step is try and assess whether the estimated numbers of birds using the area potentially impacted by the development is of conservation importance. This project assumes the area to be impacted will either be the development site, or the development site plus a one km buffer, depending upon the nature of the impact. If within a survey the distribution of birds across the study area is a random process, then the most precise and least biased estimates of the numbers of birds within the potentially impacted area will be that based upon the density across the whole study area. If within a survey, the distribution of birds across the whole study area is not random, but the distribution within the appropriate banded strata is, then the density of birds for these strata will be the most precise and least biased predictor of the density of birds within the potentially impacted area. If the distribution of birds is not random within either the study area or appropriate banded strata, but is fixed, then the density of birds within the development site plus a 1 km buffer could be potentially be the least biased predictor of abundance within this area. However, it should be noted that as this estimate is based upon only two transect it is likely to be very imprecise, and potentially biased. It is not clear which of these scenarios (i.e. random distribution across the study area, random distribution within banded strata, fixed distribution) is closest to the truth, and for different species, different scenarios are likely to hold. Thus, the best approach might be to evaluate potential impacts for a given species on the basis of all three difference kinds of estimate, bearing in mind their precision and potential bias. If any one of the evaluations suggests the species could be significant in the consenting process, then further analyses focussed on this species would be triggered.

However, if the number of birds within the whole study area is not significant in conservation terms, then any development site within the study area also will not hold numbers of significance, and so this more detailed analysis may not be necessary.

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Table 1: Showing which transects were surveyed within which months

Month	Year	Survey within month	Dates	T1	T2	T3	T4	T5	T6	T7	CR	C1	C2	R1	R2
11	2009	1	11/11/2009	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
11	2009	2	28/11/2009	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
12	2009	1	15/12/2009	no	no	no	yes	yes	yes	yes	yes	no	no	no	no
2	2010	1	06/02/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
3	2010	1	09/03/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
4	2010	1	09/04/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
5	2010	1	11/05/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes
6	2010	1	22 & 23/06/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
7	2010	1	20 & 21/07/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
8	2010	1	18 &19/08/2010	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
10	2010	1	13/10/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
12	2010	1	14/12/2010	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
1	2011	1	27/01/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
3	2011	1	03/03/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
3	2011	2	29/03/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
4	2011	1	27 & 28/04/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
6	2011	1	08/06/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no
6	2011	2	28 & 29/06/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
7	2011	1	26 & 27/07/2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
8	2011	1	23/08/2011	yes	yes	yes	yes	yes	yes	yes	yes	no	No	no	no

Table 2: Sample sizes for birds on the water and birds in flight combined
Table 2a: Number of observations (clusters)

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Red-throated diver	1	0	0	0	0	0
Great northern diver	2	2	1	1	1	1
Uncertain Diver sp.	1	0	0	0	0	0
Fulmar	210	81	39	8	19	1
Sooty shearwater	1	0	0	0	0	0
Manx shearwater	277	81	49	20	31	3
Storm petrel	34	7	4	1	2	0
Gannet	283	89	37	8	16	0
Shag	66	40	11	4	6	0
Arctic skua	2	0	0	0	0	0
Great skua	2	0	0	0	0	0
Common gull	4	2	0	0	0	0
Lesser black-backed gull	17	4	2	0	1	0
Herring gull	25	18	8	6	5	0
Great black-backed gull	27	12	8	3	4	0
Kittiwake	189	73	33	13	21	1
Arctic tern	12	2	2	2	1	0
Little tern	1	0	0	0	0	0
Guillemot	1417	580	253	94	125	10
Razorbill	483	134	59	19	20	0
Uncertain Guillemot or razorbill	42	24	13	1	4	0
Puffin	363	60	27	9	16	2
Uncertain Auk sp.	13	3	1	0	0	0
Black guillemot	18	10	2	1	1	0

Table 2b: Number of individual animals

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Red-throated diver	1	0	0	0	0	0
Great northern diver	2	2	1	1	1	1
Uncertain Diver sp.	1	0	0	0	0	0
Fulmar	232	94	48	9	25	1
Sooty shearwater	1	0	0	0	0	0
Manx shearwater	1130	151	95	40	57	5
Storm petrel	36	7	4	1	2	0
Gannet	473	138	59	22	30	0
Shag	71	43	11	4	6	0
Arctic skua	5	0	0	0	0	0
Great skua	2	0	0	0	0	0
Common gull	5	2	0	0	0	0
Lesser black-backed gull	22	5	2	0	1	0
Herring gull	29	19	9	6	5	0
Great black-backed gull	28	12	8	3	4	0
Kittiwake	586	211	56	17	38	1
Arctic tern	28	16	16	16	6	0
Little tern	1	0	0	0	0	0
Guillemot	3996	1175	515	233	200	13
Razorbill	1186	414	234	75	67	0
Uncertain Guillemot or razorbill	238	69	42	20	23	0
Puffin	559	83	34	13	23	3
Uncertain Auk sp.	23	7	1	0	0	0
Black guillemot	21	12	2	1	1	0

Table 3: Sample sizes for birds on the water

Table 3a: Number of observations (clusters)

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Red-throated diver	1	0	0	0	0	0
Fulmar	45	14	5	1	2	0
Sooty shearwater	1	0	0	0	0	0
Manx shearwater	62	7	4	1	3	0
Storm petrel	1	0	0	0	0	0
Gannet	58	14	4	0	3	0
Shag	59	37	10	4	6	0
Great skua	1	0	0	0	0	0
Lesser black-backed gull	2	0	0	0	0	0
Herring gull	6	3	2	1	0	0
Great black-backed gull	15	6	4	2	1	0
Kittiwake	38	3	2	1	2	0
Guillemot	1246	515	227	84	118	8
Razorbill	368	84	33	11	9	0
Uncertain Guillemot or razorbill	19	9	4	1	2	0
Puffin	329	49	22	7	13	2
Uncertain Auk sp.	10	1	1	0	0	0
Black guillemot	17	9	2	1	1	0

Table 3b: Number of individual animals

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Red-throated diver	1	0	0	0	0	0
Fulmar	55	17	8	1	5	0
Sooty shearwater	1	0	0	0	0	0
Manx shearwater	702	19	13	1	12	0
Storm petrel	1	0	0	0	0	0
Gannet	89	16	4	0	3	0
Shag	64	40	10	4	6	0
Great skua	1	0	0	0	0	0
Lesser black-backed gull	4	0	0	0	0	0
Herring gull	10	4	3	1	0	0
Great black-backed gull	15	6	4	2	1	0
Kittiwake	110	7	6	1	6	0
Guillemot	3575	1071	475	210	190	11
Razorbill	905	248	132	52	24	0
Uncertain Guillemot or razorbill	108	37	27	20	21	0
Puffin	500	69	29	11	20	3
Uncertain Auk sp.	14	1	1	0	0	0
Black guillemot	20	11	2	1	1	0

Table 4: Sample sizes for birds in flight

Table 4a: Number of observations (clusters)

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Great northern diver	2	2	1	1	1	1
Uncertain Diver sp.	1	0	0	0	0	0
Fulmar	165	67	34	7	17	1
Manx shearwater	215	74	45	19	28	3
Storm petrel	33	7	4	1	2	0
Gannet	225	75	33	8	13	0
Shag	7	3	1	0	0	0
Arctic skua	2	0	0	0	0	0
Great skua	1	0	0	0	0	0
Common gull	4	2	0	0	0	0
Lesser black-backed gull	15	4	2	0	1	0
Herring gull	19	15	6	5	5	0
Great black-backed gull	12	6	4	1	3	0
Kittiwake	151	70	31	12	19	1
Arctic tern	12	2	2	2	1	0
Little tern	1	0	0	0	0	0
Guillemot	171	65	26	10	7	2
Razorbill	115	50	26	8	11	0
Uncertain Guillemot or razorbill	23	15	9	0	2	0
Puffin	34	11	5	2	3	0
Uncertain Auk sp.	3	2	0	0	0	0
Black guillemot	1	1	0	0	0	0

Table 4b: Number of individual animals

Species	All sightings	Sightings within study area	Sightings within banded strata for 1 km buffer	Sightings within 1 km buffer	Sightings within banded strata for site	Sightings within site
Great northern diver	2	2	1	1	1	1
Uncertain Diver sp.	1	0	0	0	0	0
Fulmar	177	77	40	8	20	1
Manx shearwater	428	132	82	39	45	5
Storm petrel	35	7	4	1	2	0
Gannet	384	122	55	22	27	0
Shag	7	3	1	0	0	0
Arctic skua	5	0	0	0	0	0
Great skua	1	0	0	0	0	0
Common gull	5	2	0	0	0	0
Lesser black-backed gull	18	5	2	0	1	0
Herring gull	19	15	6	5	5	0
Great black-backed gull	13	6	4	1	3	0
Kittiwake	476	204	50	16	32	1
Arctic tern	28	16	16	16	6	0
Little tern	1	0	0	0	0	0
Guillemot	421	104	40	23	10	2
Razorbill	281	166	102	23	43	0
Uncertain Guillemot or razorbill	130	32	15	0	2	0
Puffin	59	14	5	2	3	0
Uncertain Auk sp.	9	6	0	0	0	0
Black guillemot	1	1	0	0	0	0

Table 5: Number of observations available for density surface modelling for each species and each survey. This includes all observations on the core transects T1 to T7, including observations on the outermost transects (T1 and T7) not within the study area.

Table 5a: Birds on the water

Month	Year	Survey within month	Fulmar	Manx shearwater	Gannet	Shag	Lesser black-backed gull	Herring gull	Great black-backed gull	Kittiwake	Guillemot	Razorbill	Guillemot/razorbill	Puffin	auk sp.	Black guillemot
11	2009	1	0	0	0	0	0	0	0	0	12	4	7	0	0	0
11	2009	2	0	0	0	5	0	1	0	1	21	8	1	0	0	0
12	2009	1	0	0	0	0	0	0	0	0	21	0	0	0	0	0
2	2010	1	0	0	0	0	0	0	1	0	99	2	0	0	0	0
3	2010	1	5	0	3	3	0	0	0	1	96	14	1	1	0	2
4	2010	1	0	1	0	3	0	0	0	1	11	3	0	0	0	1
5	2010	1	1	2	0	0	0	0	0	1	2	4	0	20	1	0
6	2010	1	2	1	1	1	1	0	0	0	29	18	0	3	0	4
7	2010	1	2	0	0	1	0	0	0	0	2	2	0	10	0	0
8	2010	1	0	0	1	0	0	0	0	0	0	0	0	6	0	0
10	2010	1	0	0	3	3	0	0	0	0	7	0	0	0	0	0
12	2010	1	0	0	0	6	0	0	1	0	21	1	0	0	0	0
1	2011	1	0	0	0	0	0	3	4	0	97	15	1	0	0	0
3	2011	1	0	0	0	6	0	0	1	0	38	4	0	0	0	1
3	2011	2	0	0	1	4	0	0	0	0	22	8	0	0	0	1
4	2011	1	2	0	0	1	0	0	0	0	5	2	0	12	0	0
6	2011	1	4	2	1	2	0	0	0	0	53	5	0	6	0	0
6	2011	2	3	1	0	1	0	0	0	1	6	4	0	1	0	0
7	2011	1	0	1	0	1	0	0	0	0	9	7	0	4	0	0
8	2011	1	0	2	5	0	0	0	0	0	1	0	0	2	1	0

Table 5b: Birds in flight

Month	Year	Survey within month	Great northern diver	Fulmar	Manx shearwater	Storm petrel	Gannet	Shag	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull	Kittiwake	Arctic tern	Guillemot	Razorbill	Guillemot/razorbill	Puffin	auk sp.	Black guillemot
11	2009	1	1	12	0	0	1	1	0	0	3	0	13	0	3	3	11	0	0	0
11	2009	2	1	3	0	0	0	0	0	0	3	1	12	0	5	10	0	0	0	0
12	2009	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
2	2010	1	0	5	0	0	2	0	0	0	1	1	6	0	9	0	0	0	0	0
3	2010	1	0	3	0	0	2	0	0	0	0	0	3	0	5	0	0	0	0	0
4	2010	1	0	7	3	0	3	0	0	0	0	0	1	0	4	1	2	0	0	0
5	2010	1	0	1	1	0	4	0	0	0	0	0	0	0	1	1	0	3	0	0
6	2010	1	0	3	5	0	7	0	0	0	0	0	3	0	4	4	1	0	0	0
7	2010	1	0	1	5	0	3	0	0	2	0	0	0	0	2	2	0	0	0	1
8	2010	1	0	19	3	4	3	0	0	0	0	0	5	0	0	0	0	3	0	0
10	2010	1	0	1	0	0	4	0	0	0	0	0	12	0	2	3	0	0	0	0
12	2010	1	0	3	0	0	0	0	0	0	4	0	3	0	5	4	0	0	1	0
1	2011	1	0	1	0	0	0	0	1	0	6	2	7	0	15	12	1	0	0	0
3	2011	1	0	3	0	0	1	0	1	0	1	0	2	0	4	3	0	0	0	0
3	2011	2	0	4	0	0	5	1	0	0	0	1	0	0	6	3	0	1	0	0
4	2011	1	0	4	1	0	9	1	0	0	0	1	2	0	0	5	2	4	0	0
6	2011	1	0	4	27	1	7	0	0	1	0	0	0	0	3	3	0	0	0	0
6	2011	2	0	4	13	0	9	0	0	1	0	0	7	2	2	2	0	1	1	0
7	2011	1	0	1	11	1	5	0	0	0	0	0	0	0	1	2	1	1	0	0
8	2011	1	0	0	19	4	16	0	0	0	0	0	2	0	0	0	0	1	0	0

Table 5c: Birds on the water and birds in flight combined

Month	Year	Survey within month	Great northern diver	Fulmar	Manx shearwater	Storm petrel	Gannet	Shag	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull	Kittiwake	Arctic tern	Guillemot	Razorbill	Guillemot/razorbill	Puffin	auk sp.	Black guillemot
11	2009	1	1	12	0	0	1	1	0	0	3	0	13	0	15	7	18	0	0	0
11	2009	2	1	3	0	0	0	5	0	0	4	1	13	0	26	18	1	0	0	0
12	2009	1	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0
2	2010	1	0	5	0	0	2	0	0	0	1	2	6	0	108	2	0	0	0	0
3	2010	1	0	8	0	0	5	3	0	0	0	0	4	0	101	14	1	1	0	2
4	2010	1	0	7	4	0	3	3	0	0	0	0	2	0	15	4	2	0	0	1
5	2010	1	0	2	3	0	4	0	0	0	0	0	1	0	3	5	0	23	1	0
6	2010	1	0	5	6	0	8	1	0	1	0	0	3	0	33	22	1	3	0	4
7	2010	1	0	3	5	0	3	1	0	2	0	0	0	0	4	4	0	10	0	1
8	2010	1	0	19	3	4	4	0	0	0	0	0	5	0	0	0	0	9	0	0
10	2010	1	0	1	0	0	7	3	0	0	0	0	12	0	9	3	0	0	0	0
12	2010	1	0	3	0	0	0	6	0	0	4	1	3	0	26	5	0	0	1	0
1	2011	1	0	1	0	0	0	0	1	0	9	6	7	0	112	27	2	0	0	0
3	2011	1	0	3	0	0	1	6	1	0	1	1	2	0	42	7	0	0	0	1
3	2011	2	0	4	0	0	6	5	0	0	0	1	0	0	28	11	0	1	0	1
4	2011	1	0	6	1	0	9	2	0	0	0	1	2	0	5	7	2	16	0	0
6	2011	1	0	8	29	1	8	2	0	1	0	0	0	0	56	8	0	6	0	0
6	2011	2	0	7	14	0	9	1	0	1	0	0	8	2	8	6	0	2	1	0
7	2011	1	0	1	12	1	5	1	0	0	0	0	0	0	10	9	1	5	0	0
8	2011	1	0	0	21	4	21	0	0	0	0	0	2	0	1	0	0	3	1	0

Table 6: Detection probability estimates for birds on the water

	Data analysed as clusters				Data analysed as individuals				
Species	n	P	SE	cv	n	P	SE	cv	Probability of detection based upon JNCC correction factor
Red-throated Diver	1				1				77%
All divers	1				1				77%
Fulmar	45	67%	18%	26%	55	71%	18%	25%	91%
Sooty shearwater	1				1				77%
Manx shearwater	62	54%	10%	19%	702	79%	6%	7%	77%
Storm Petrel	1				1				67%
Gannet	58	92%	24%	26%	89	98%	20%	21%	100%
Shag	59	57%	13%	23%	64	56%	12%	22%	91%
Great Skua	1				1				77%
LBB Gull	2				4				71%
Herring Gull	6				10				71%
GBB Gull	15				15				71%
Kittiwake	38	56%	15%	27%	110	65%	10%	16%	71%
Guillemot	1246	44%	2%	4%	3575	55%	2%	3%	71%
Razorbill	368	41%	3%	8%	905	50%	3%	6%	67%
Guillemot or razorbill	1633	44%	2%	4%	4588	57%	1%	3%	67%
Puffin	329	45%	4%	8%	500	47%	3%	7%	67%
All auks	1972	44%	1%	3%	5102	56%	1%	2%	67%
Black guillemot	17				20				100%

Figure 1: Location of study area and survey transects for West Islay offshore tidal development. Also shown are the locations of the currently proposed development site, with a 1 km buffer and also the original location proposed for the development.

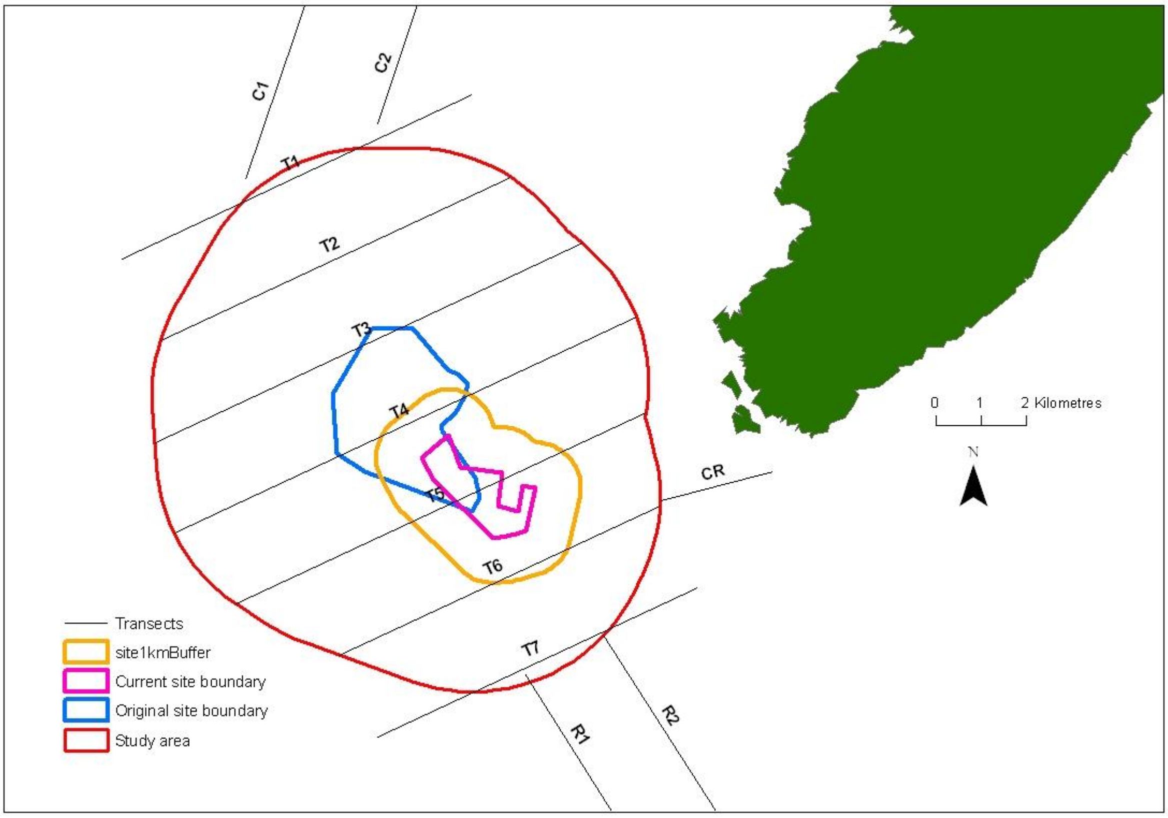


Figure 2: Banded strata used to estimate density of birds within the development site.

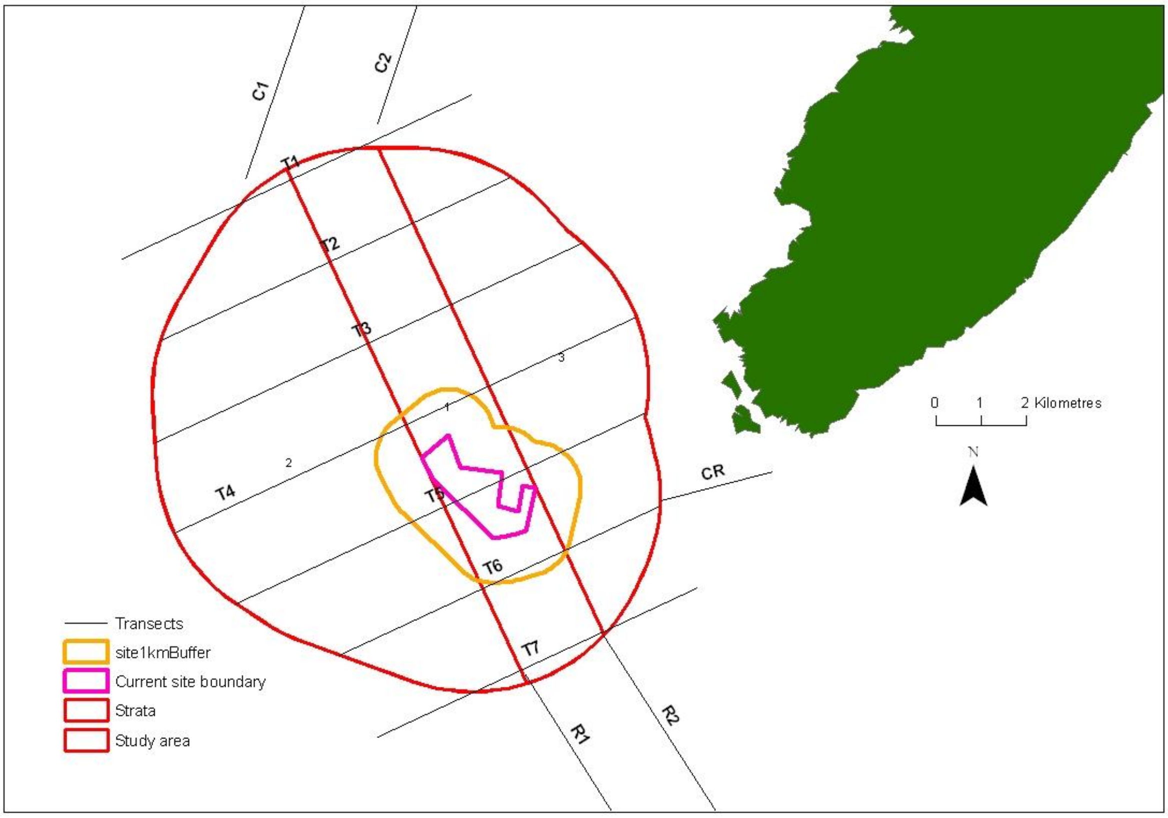


Figure 3: Banded strata used to estimate density of birds within the development site and 1 km buffer

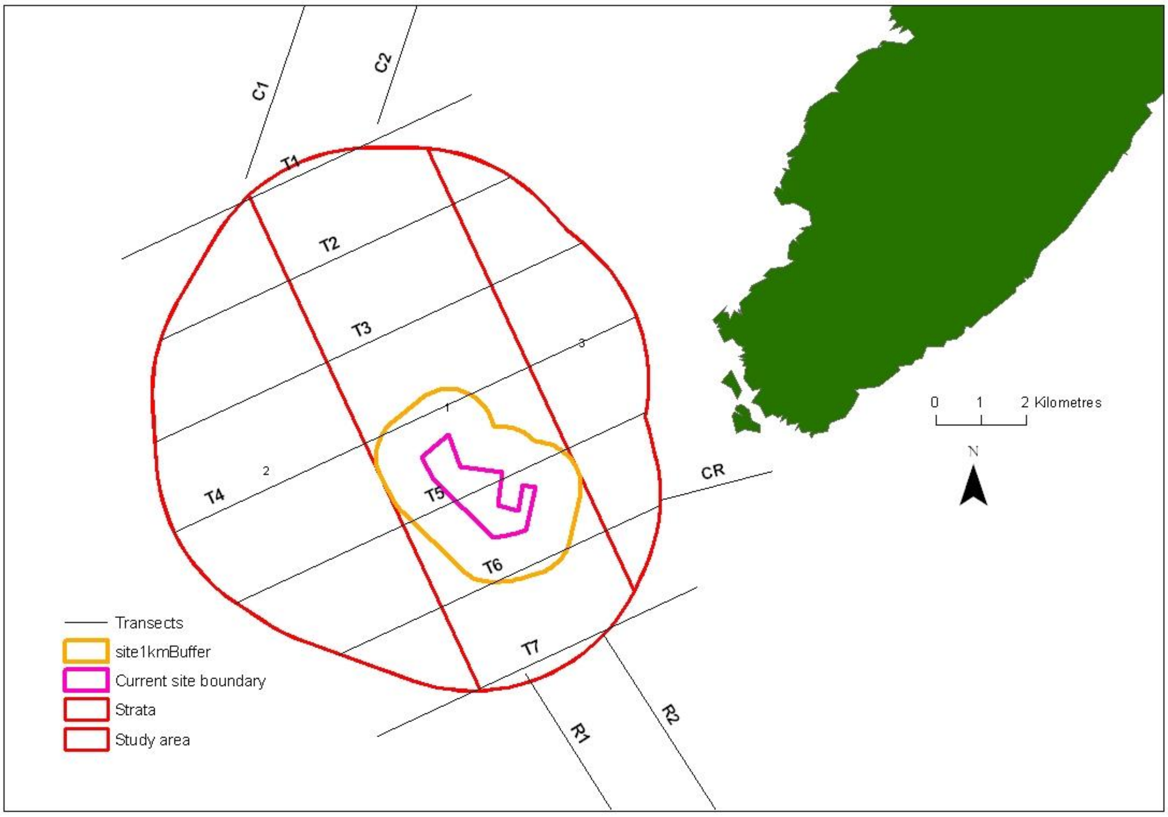


Figure 4: Scaled histograms of detection distances for animals on the water within the 300m transect with fitted detection function based upon a half normal key function.

Figure 4a: Fulmar- data analysed as clusters

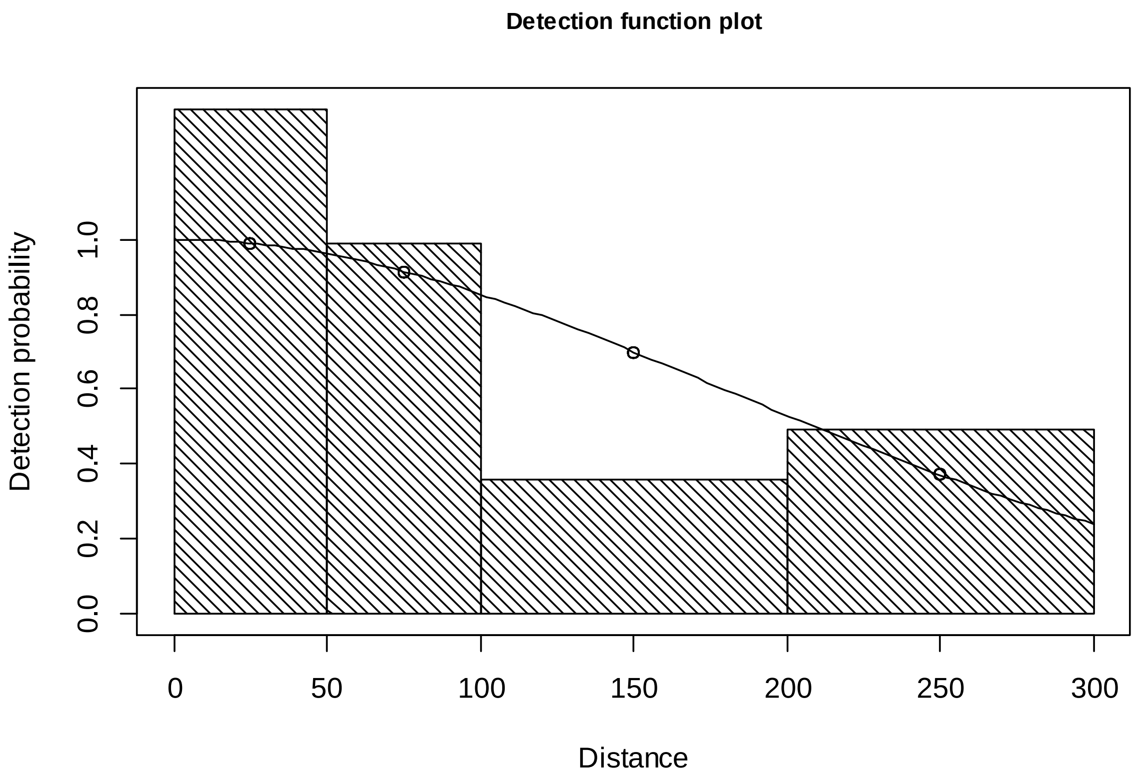


Figure 4b: Fulmar-data analysed as individuals

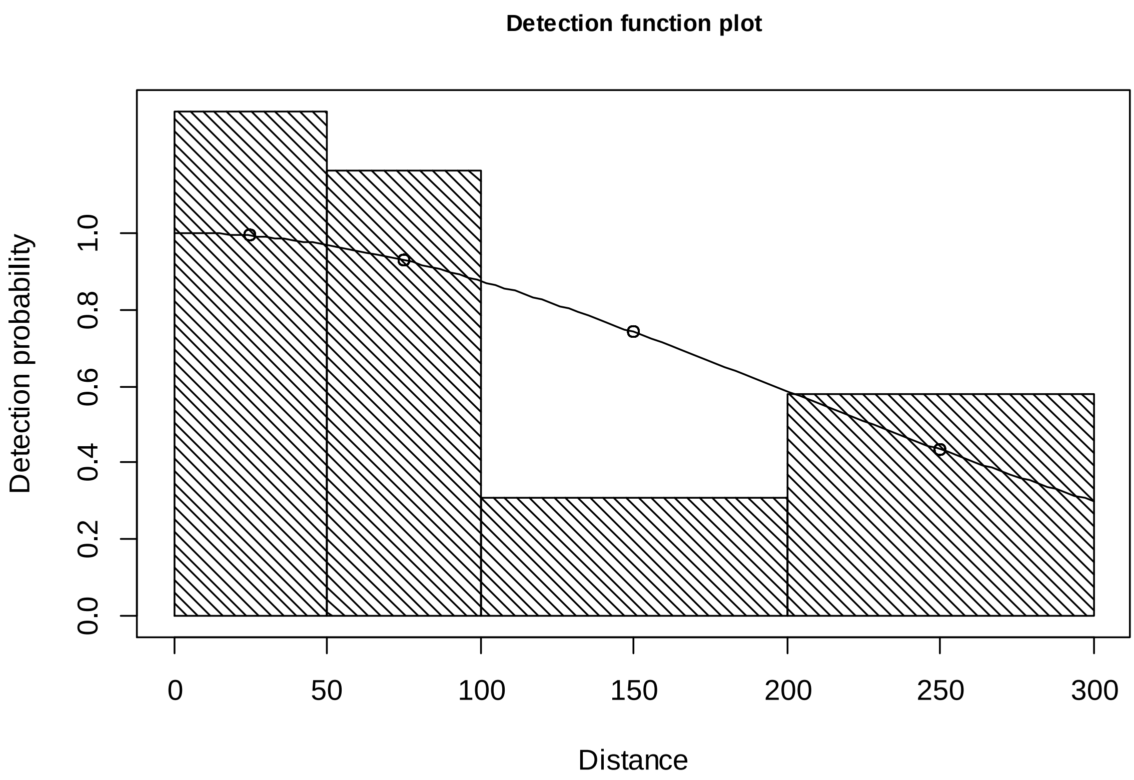


Figure 4c: Manx shearwater - data analysed as clusters

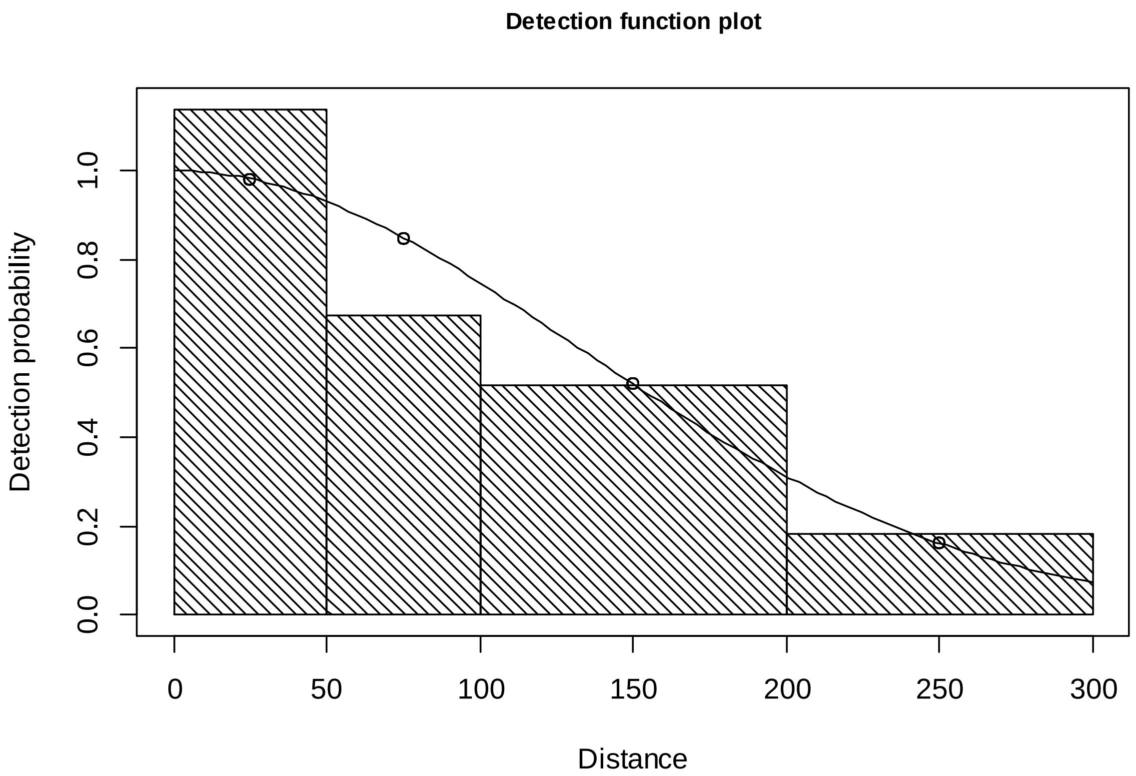


Figure 4d: Manx shearwater - data analysed as individuals

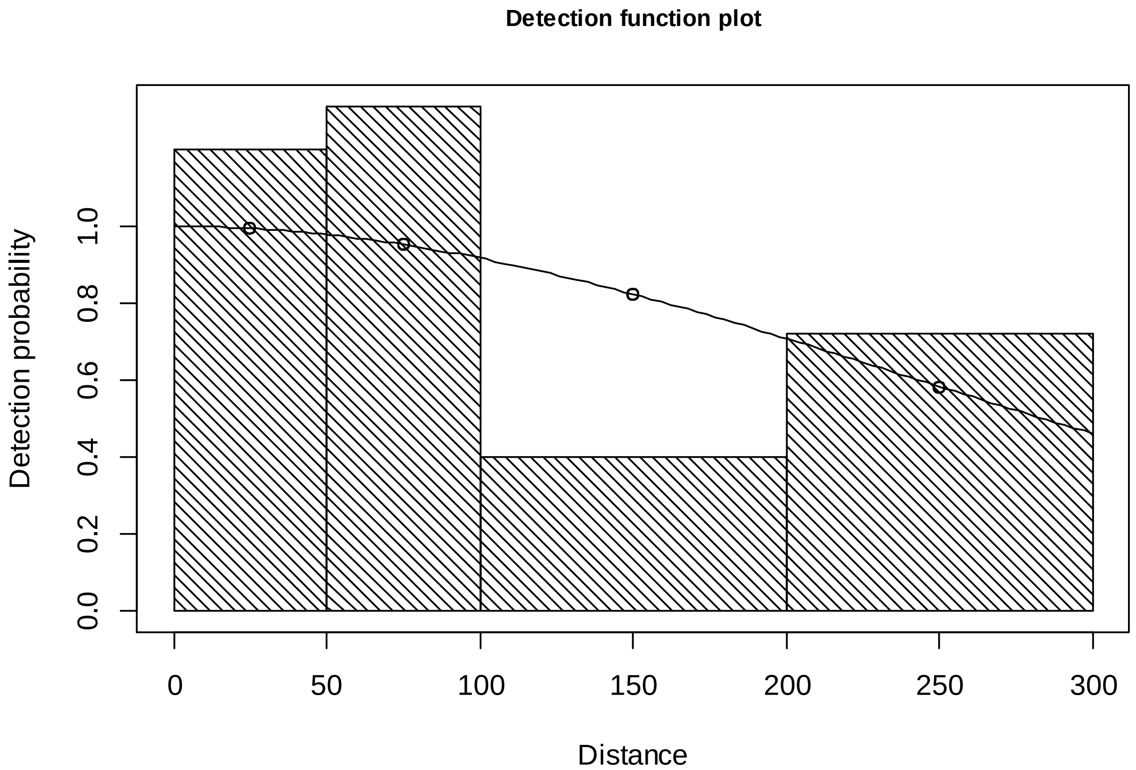


Figure 4e: Gannet - data analysed as clusters

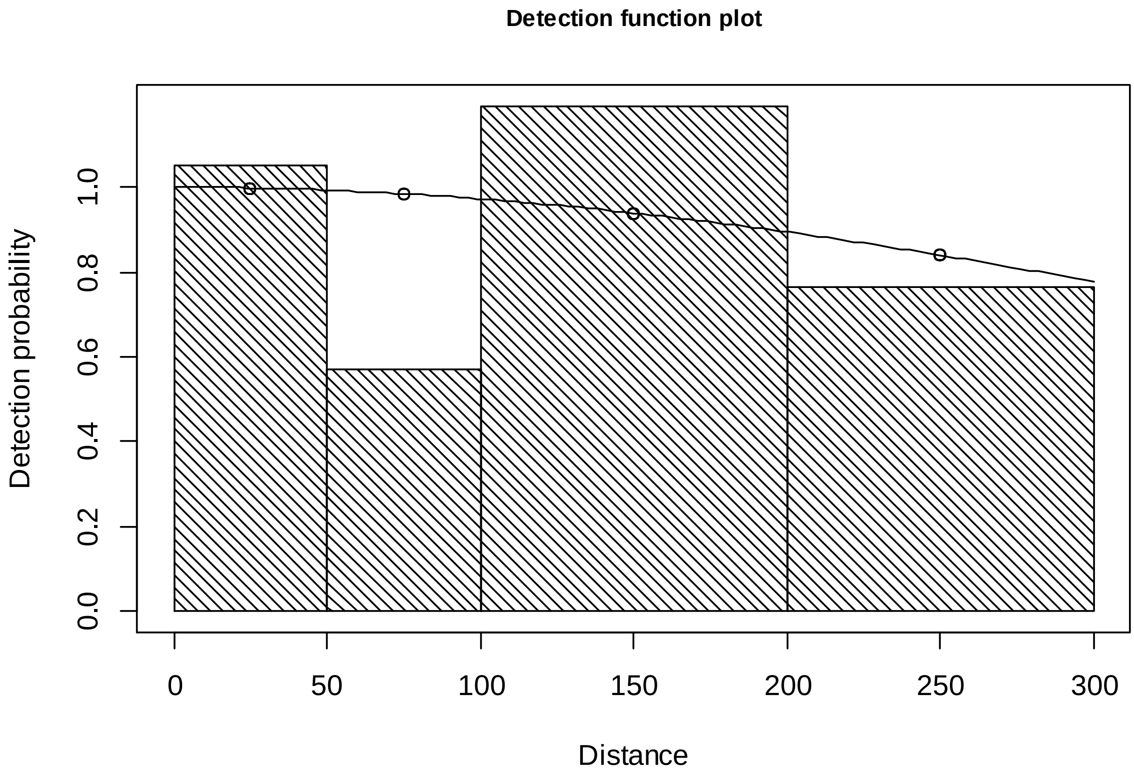


Figure 4f: Gannet - data analysed as individuals

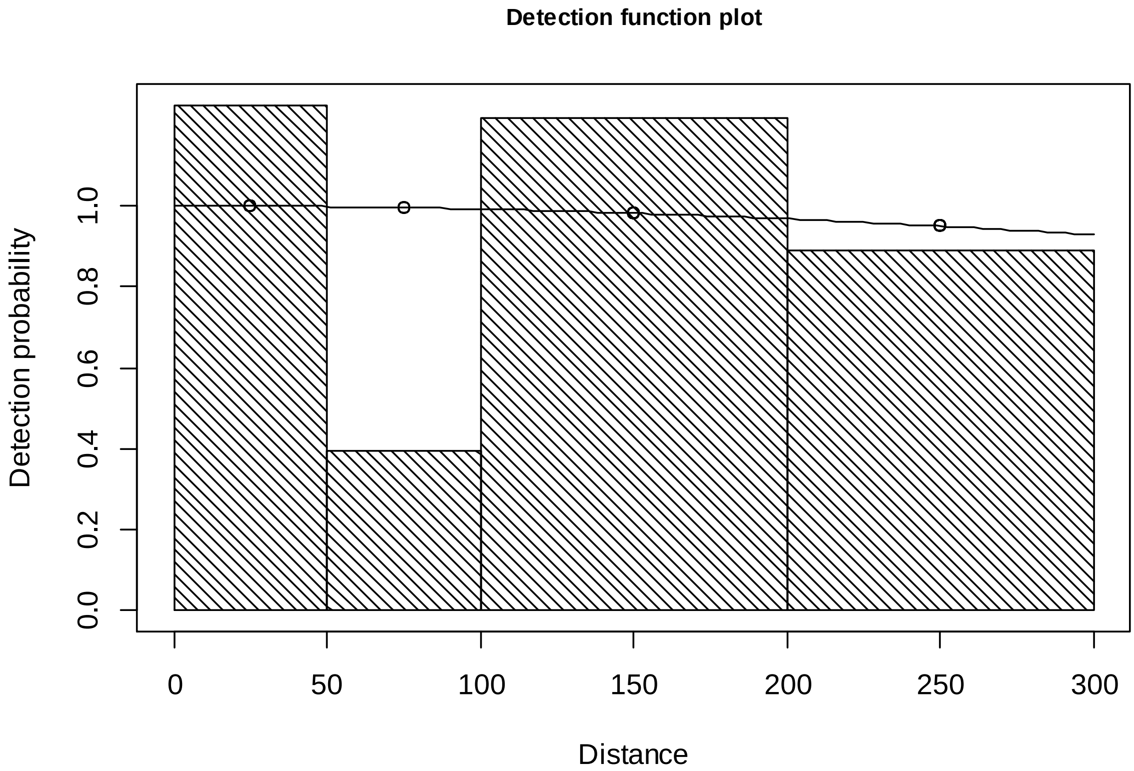


Figure 4g: Shag - data analysed as clusters

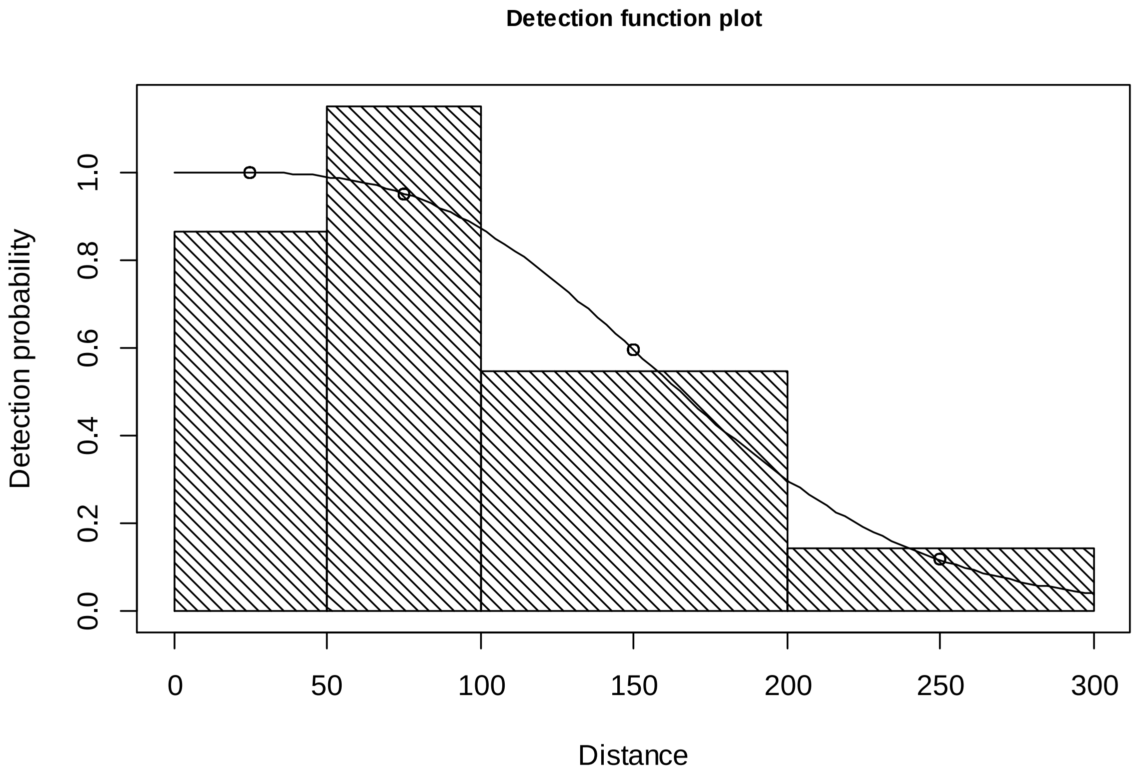


Figure 4h: Shag - data analysed as individuals

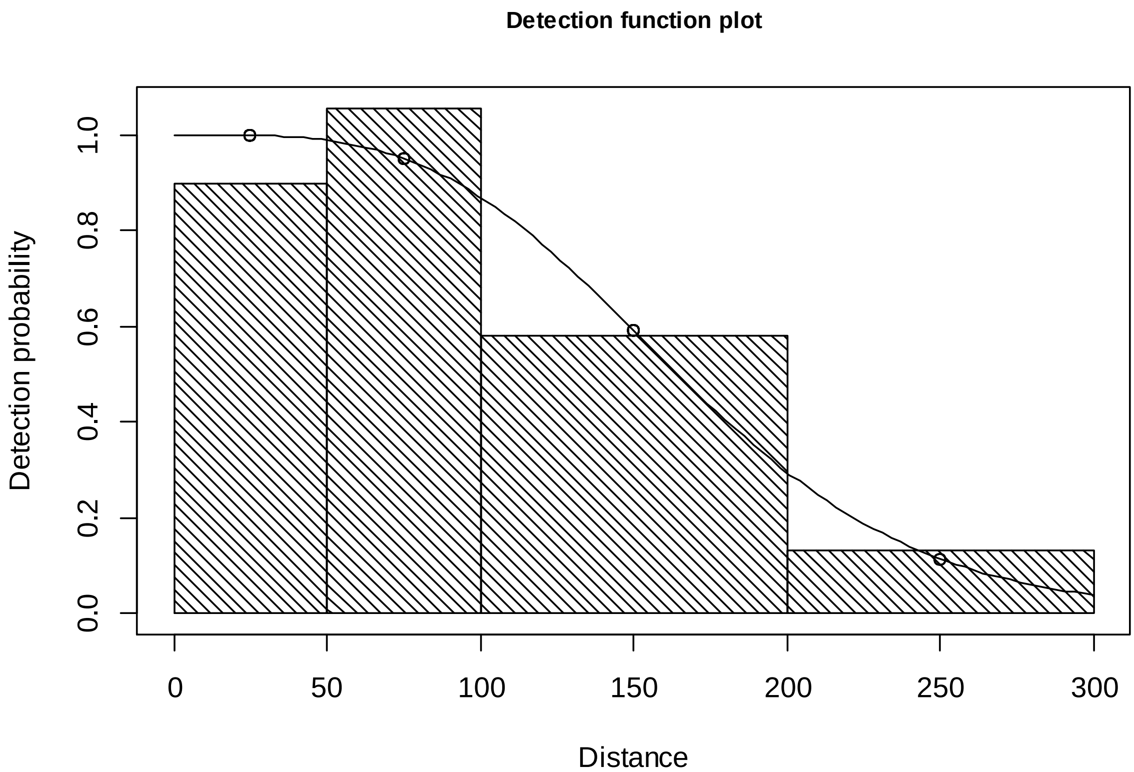


Figure 4i: Kittiwake - data analysed as clusters

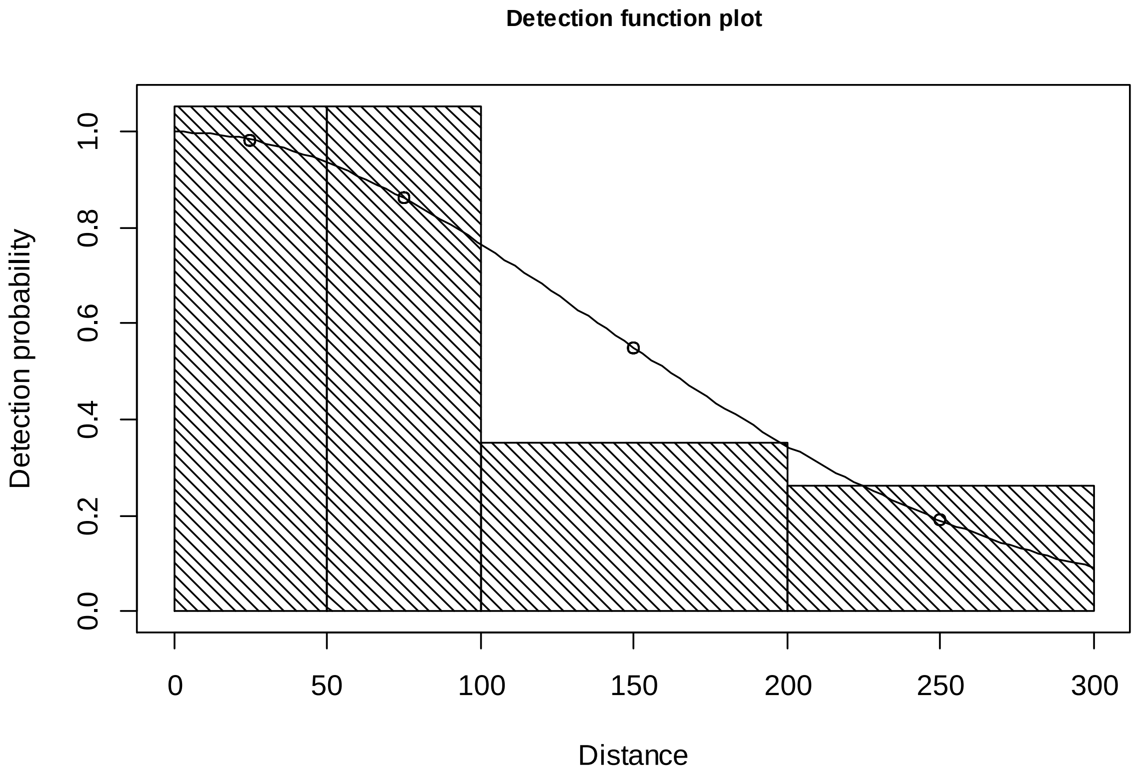


Figure 4j: Kittiwake - data analysed as individuals

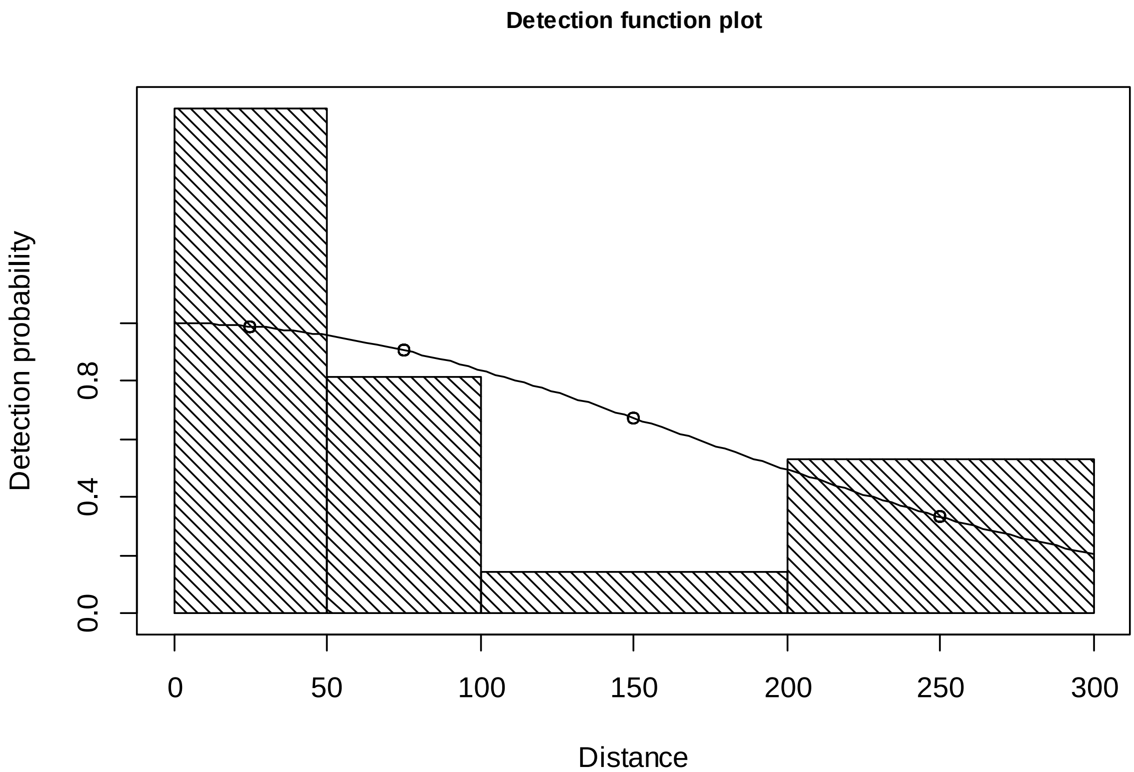


Figure 4k: Guillemot - data analysed as clusters

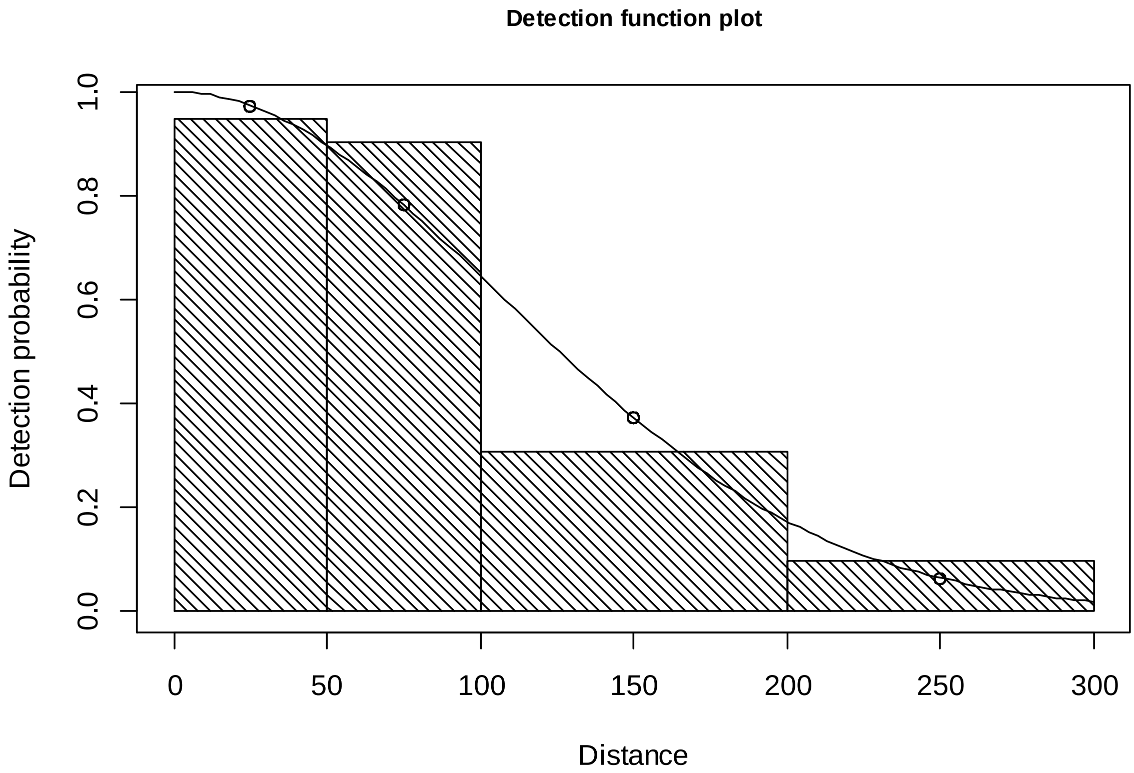


Figure 4l: Guillemot - data analysed as individuals

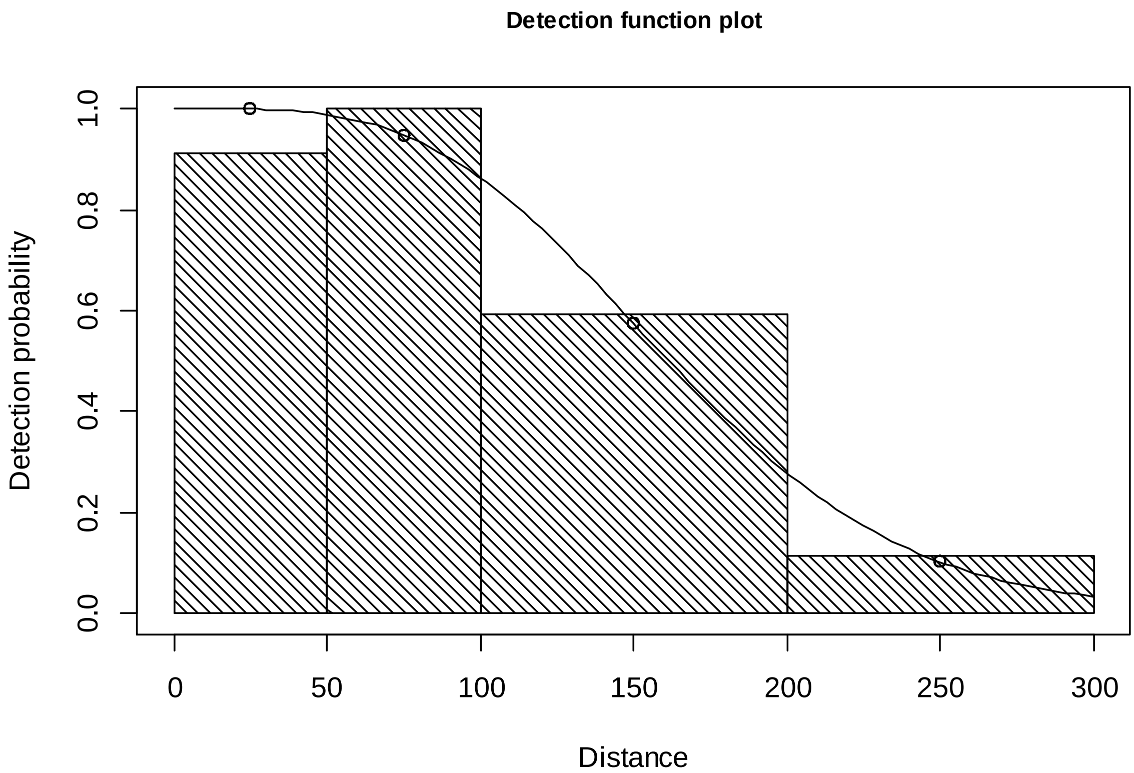


Figure 4m: Razorbill - data analysed as clusters

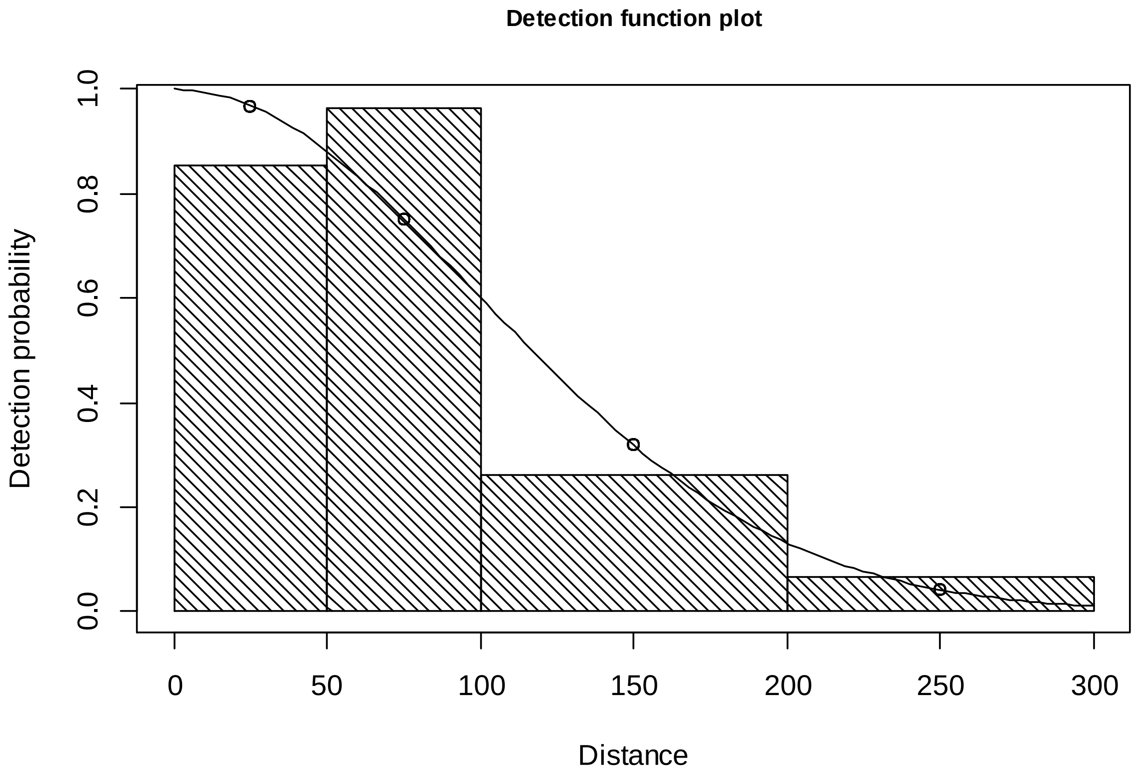


Figure 4n: Razorbill - data analysed as individuals

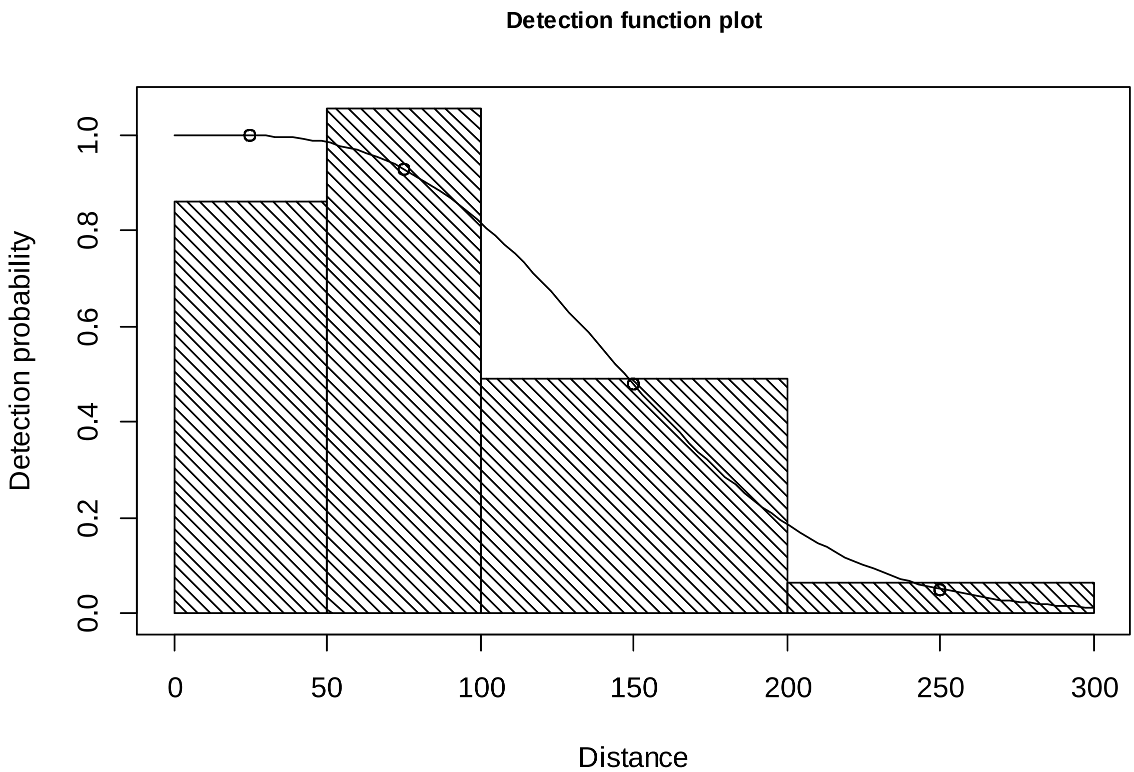


Figure 4o: Puffin - data analysed as clusters

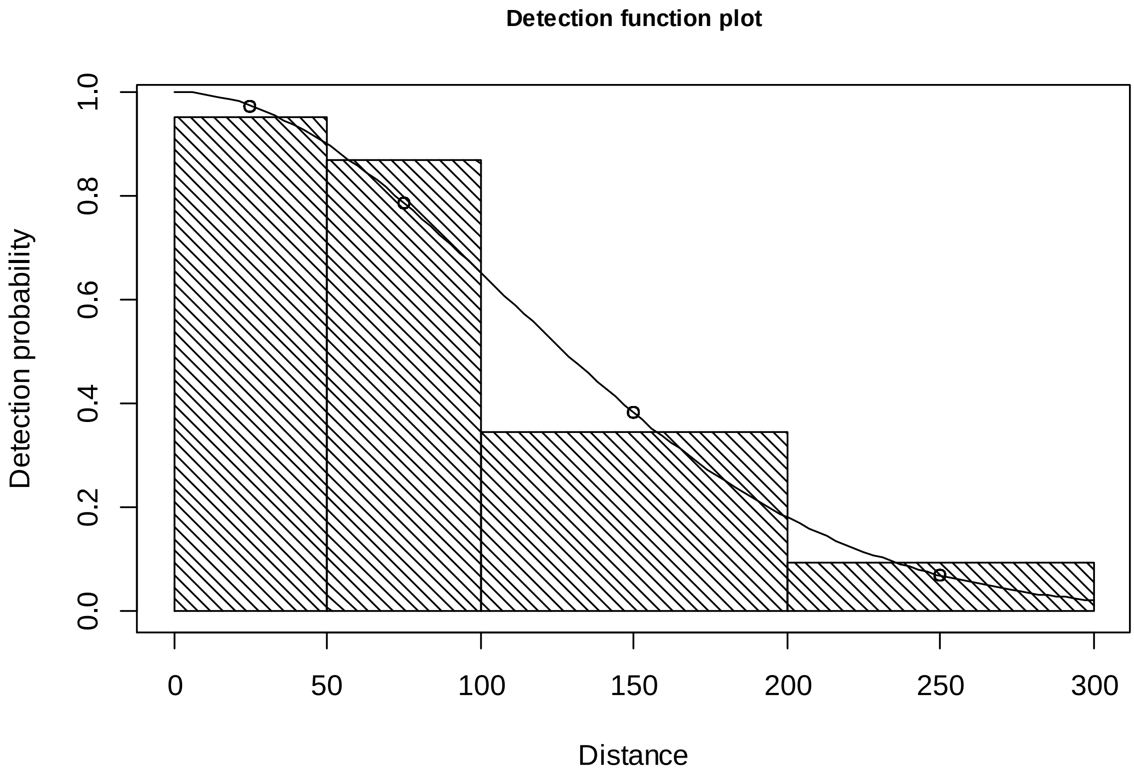


Figure 4p: Puffin - data analysed as individuals

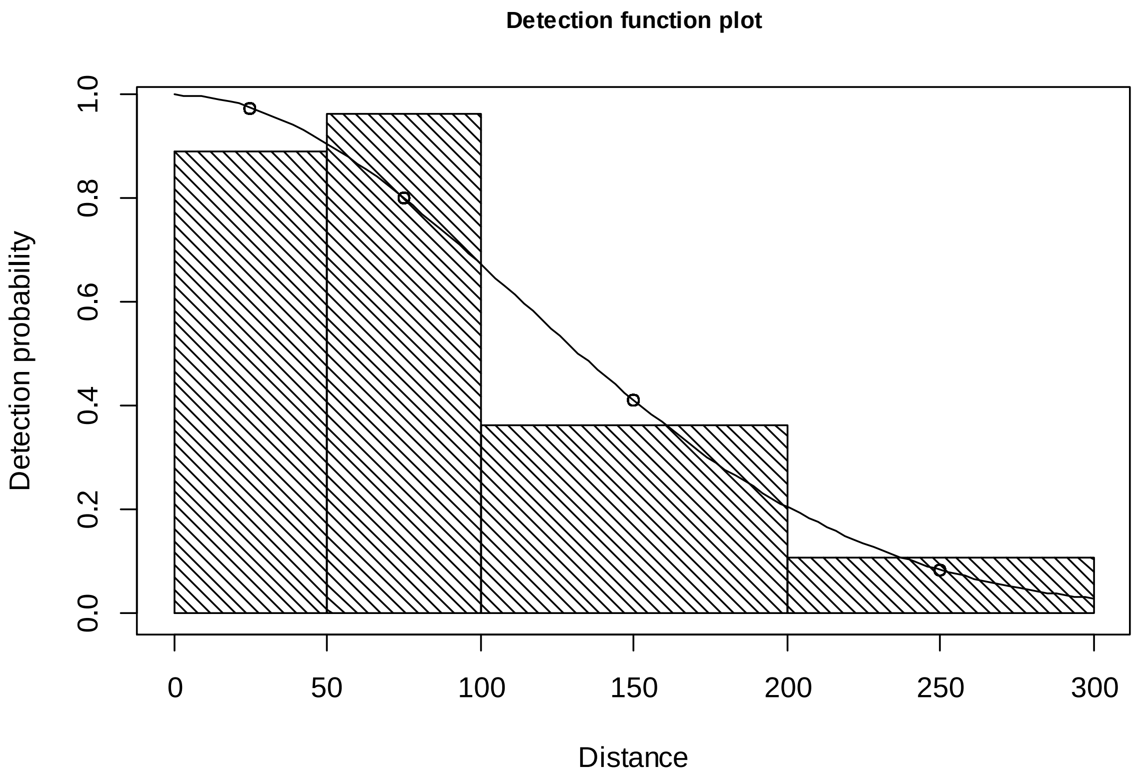


Figure 4q: Guillemot and Razorbill - data analysed as clusters

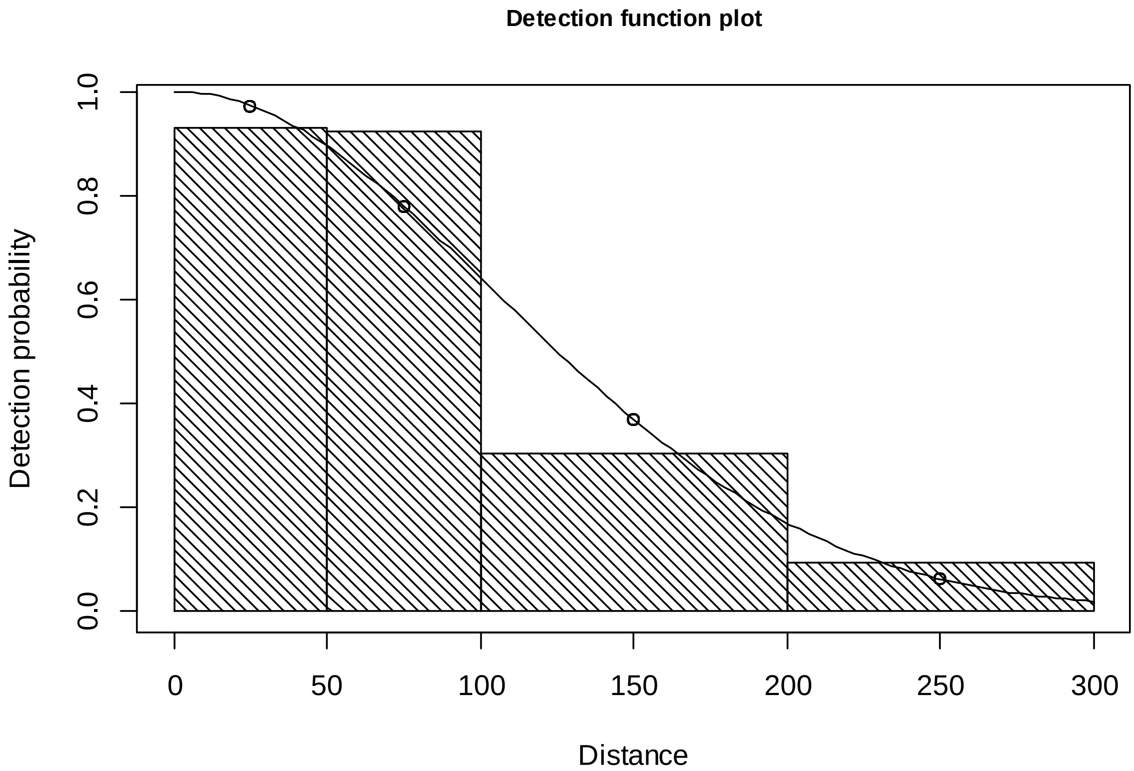


Figure 4r: Guillemot and Razorbill - data analysed as individuals

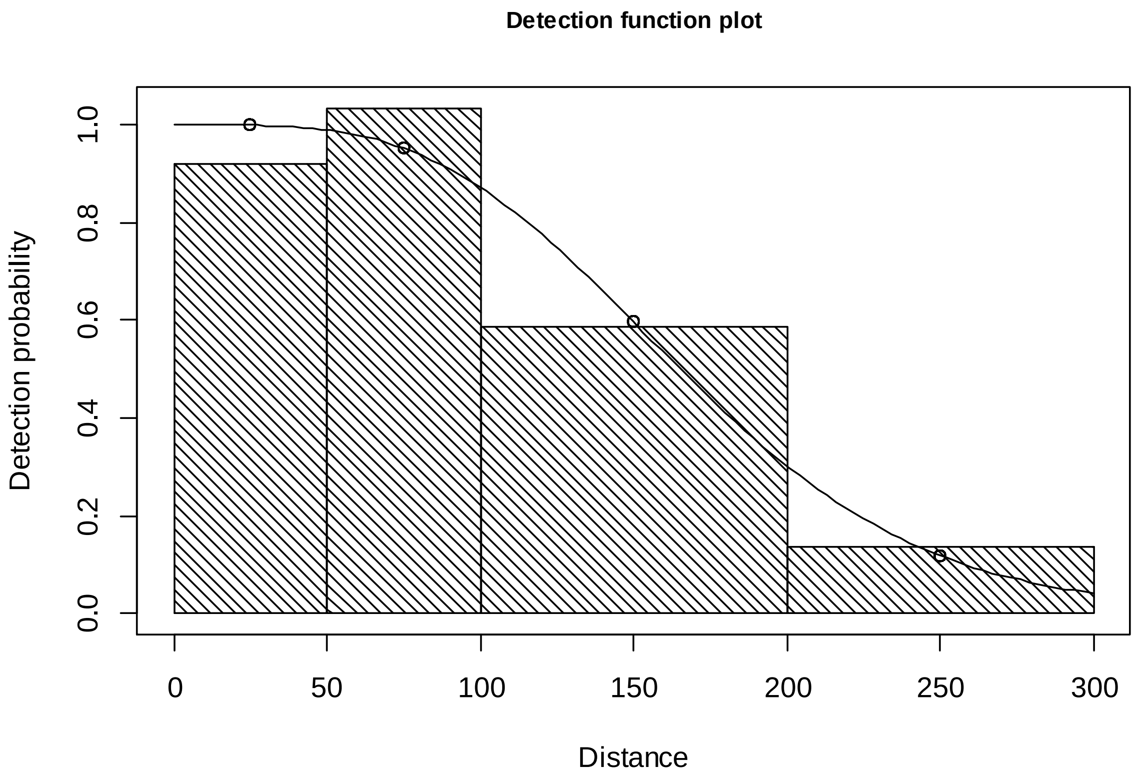


Figure 4s: All auks - data analysed as clusters

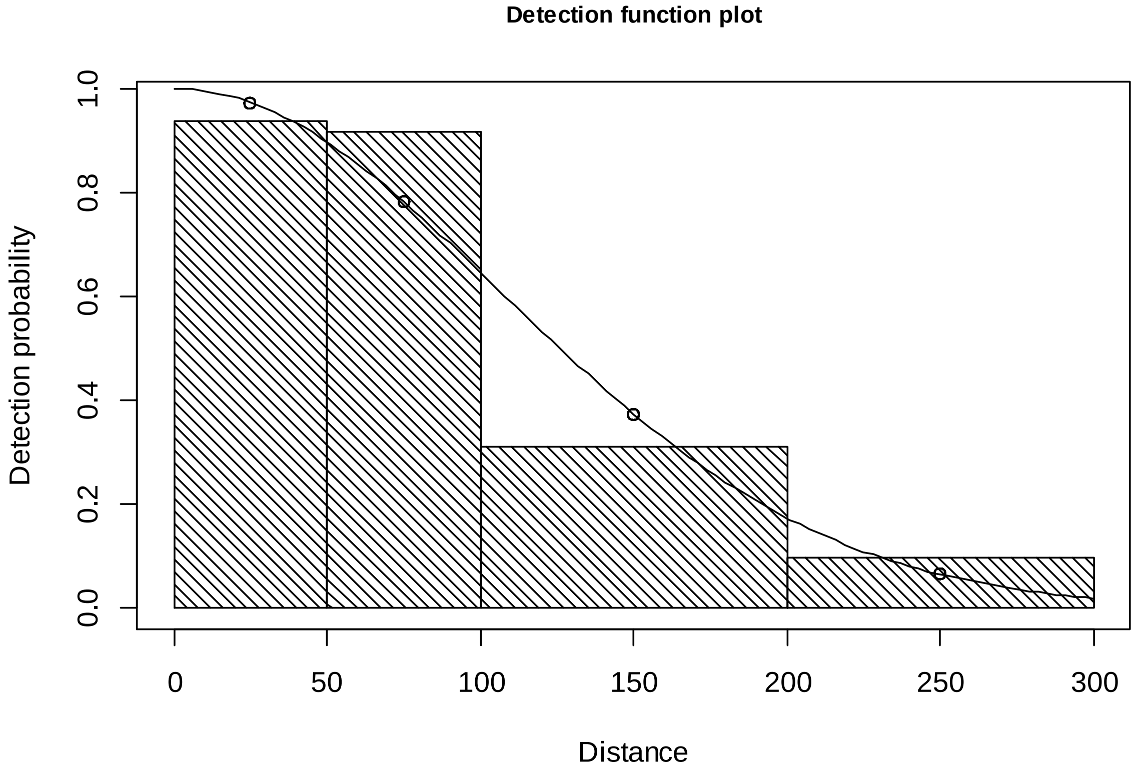
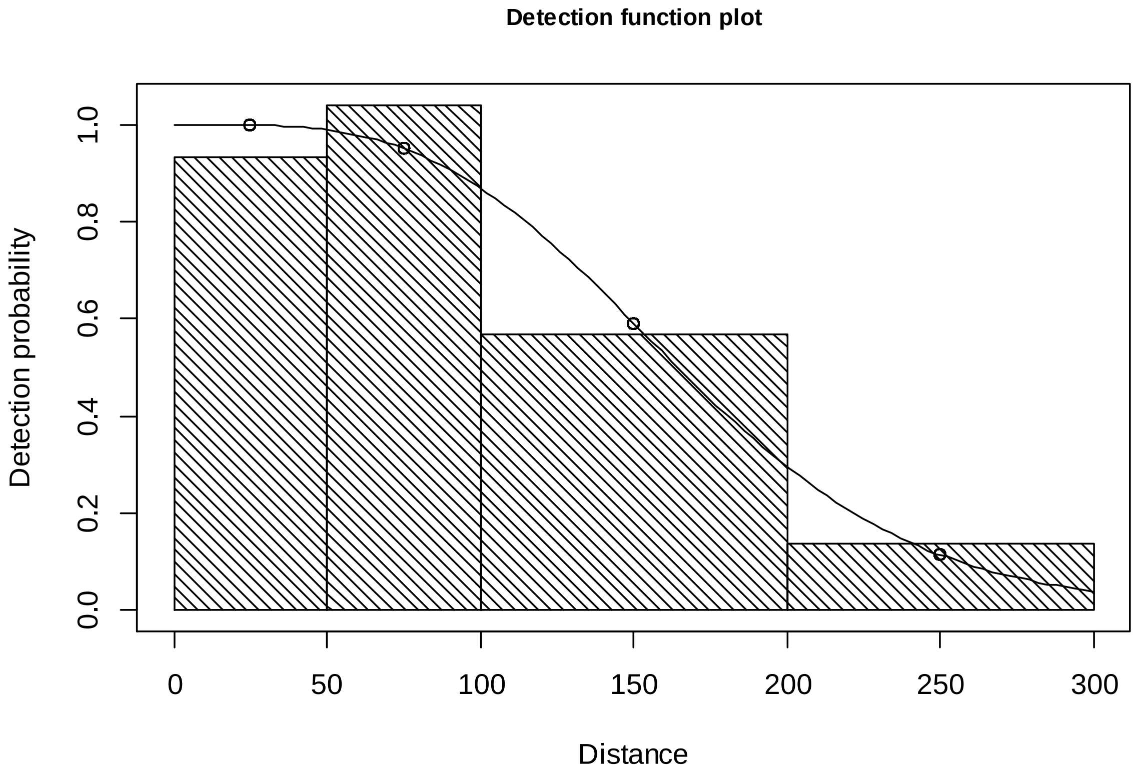


Figure 4t: All auks - data analysed as individuals



Appendix A: Combining density estimates for birds on the water and birds in flight

For data collected under the standard ESAS methodology (Camphuysen *et al.* 2004), as in this study, distance sampling methods can only be applied to birds recorded on the water within transects, as for birds in flight no distance data is available. Thus, for birds in flight we have assumed that all birds within the transect were detected. However, the data for birds in flight was also analysed using the code from Distance, assuming 100% detection within the transect. This provides density estimates for birds in flight along with associated estimates of variance calculated within the same framework/software as the estimates for birds on the water. Whereas the variance estimate for birds in flight only includes components associated with the estimation of encounter rate and mean cluster size, the variance estimate for birds on the water also includes components associated with the estimation of the detection function.

Having obtained $\hat{D}_w$, the estimated density of birds on the water with its associated variance estimate $\mathrm{var}(\hat{D}_w)$ and $\hat{D}_f$, the estimated density of birds in flight with its associated variance estimate $\mathrm{var}(\hat{D}_w)$ from separate Distance analyses, we compute the estimated density of all birds, $\hat{D}_t$ as:

$$\hat{D}_t = \hat{D}_w + \hat{D}_f \tag{1}$$

Assuming $\hat{D}_w$ and $\hat{D}_f$ are uncorrelated random variables (an assumption future work should relax) we estimate the variance of their sum $\hat{D}_t$ as:

$$\mathrm{var}(\hat{D}_t) = \mathrm{var}(\hat{D}_w) + \mathrm{var}(\hat{D}_f) \tag{2}$$

On the basis of these density and variance estimates, we estimated 95% confidence limits using equations 3.72 to 3.74 in Buckland *et al.* (2001:77), which assume that $\hat{D}_t$ is log-normally distributed. However, within these equations we replaced the normal distribution with a t distribution, as does Distance code in its implementation of these equations. For the t distribution we took the degrees of freedom as the number of transects minus 1, which will lead to slightly over-conservative (i.e. wider than they need to be) confidence limits.

Appendix B: Uncertain identifications

For some broader taxonomic groups consisting of similar species, it is not always possible to positively identify sightings to individual species although they can be assigned to the broader taxonomic group. For example, for guillemot and razorbill, although most observations are positively identified to one or other of the two species, in many surveys, including this one, there are a significant proportion of records which can only be classified as one or other of the two species – "guillemot or razorbill". In such scenarios, Maclean *et al.* (2009) recommend that "the relative abundance of each of the species comprising the taxon is calculated from positively identified individuals. Individuals of the generic taxon can then be randomly assigned a species identity using the ratio of relative abundances to determine the total number assigned to each species."

For guillemot and razornill, we calculate "proportional" density/population estimates, based upon the assumption that the proportion of the uncertain identifications consisting of one species was same as that for the positive identifications.

To calculate these population estimates, we first performed distance sampling analyses to obtain density, and variance, estimates for three different taxa:

- $\hat{D}_g$, the density of guillemots from distance sampling analyses including only individuals positively identified as guillemots
- $\hat{D}_r$, the density of razorbills from distance sampling analyses including only individuals positively identified as razorbills.
- $\hat{D}_{rg}$ the density of "guillemots or razorbills" from distance sampling analyses including all individuals identified as guillemots or razorbill; this includes individuals positively identified as guillemots, individuals positively identified as razorbills, and individuals not positively identified, but identified as either guillemot or razorbill.

The "proportional" density estimates were taken as:

$$\frac{\hat{D}_g}{\hat{D}_g + \hat{D}_r}\hat{D}_{rg} \qquad (5)$$

for guillemot, and

$$\frac{\hat{D}_r}{\hat{D}_g + \hat{D}_r}\hat{D}_{rg} \qquad (6)$$

for razorbill.

As a first approximation we ignore the correlation between the three estimation components, and use the Delta method (Seber 1982:7-9) to estimate the variance of derived density estimates. This yields:

$$\left[\frac{\hat{D}_g}{\hat{D}_g + \hat{D}_r}\hat{D}_{rg}\right]^2 \left\{\frac{\mathrm{var}(\hat{D}_g)}{\hat{D}_g^{\,2}} + \frac{\mathrm{var}(\hat{D}_{rg})}{\hat{D}_{rg}^{\,2}} + \frac{\mathrm{var}(\hat{D}_g) + \mathrm{var}(\hat{D}_r)}{(\hat{D}_r + \hat{D}_g)^2}\right\} \qquad (7)$$

as the variance estimate for the “proportional” guillemot density estimate, and

$$\left[\frac{\hat{D}_r}{\hat{D}_g+\hat{D}_r}\hat{D}_{rg}\right]^2\left\{\frac{\text{var}\left(\hat{D}_r\right)}{\hat{D}_r^{\;2}}+\frac{\text{var}\left(\hat{D}_{rg}\right)}{\hat{D}_{rg}^{\;2}}+\frac{\text{var}\left(\hat{D}_g\right)+\text{var}\left(\hat{D}_r\right)}{\left(\hat{D}_r+\hat{D}_g\right)^2}\right\} \quad (8)$$

as the variance estimate for the “proportional” razorbill density estimate.

We derived 95% confidence limits using equations 3.72 to 3.74 in Buckland *et al.* (2001:77), but using a t distribution in place of a normal distribution, and making the conservative assumption that the degrees of freedom was equal to the number of transects minus one. For both species, the approach described above was applied separately to density estimates for birds on the water, birds in flight, and all birds.

For the calculation of “proportional” population estimates, partitioning the combined population estimate including uncertain identifications to individual species on the basis of population sizes estimates for individual species derived from Distance sampling rather than the raw sightings data has the advantage of taking differences in detectability between the two species into account.

ENERGY PARK

volume 4 // appendix 10.2 //
HRA ornithology report

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West Islay Tidal Energy Park:

Birds HRA Report

Wednesday, 10 July 2013

Contents

1. Summary

- The HRA screening presented in this document determines if there is potential for a Likely Significant Effect on any seabird SPA arising from the proposed West Islay Tidal Energy Park project (the Project).
- HRA screening is achieved by consideration of the strength of connectivity between the Project's anticipated impact footprint and each SPA (i.e., how likely is it that the birds using the area originate from a particular SPA), the abundance and behaviour of each species using the anticipated impact footprint and the sensitivity of each species to the potential impacts of tidal arrays.
- An earlier version of this report was sent to SNH, MS, DOENI in February 2013. Following this, a revised version was circulated in April 2013 that took account of comments made by SNH and incorporated new information that had become available. Since then SNH and DOENI have provided further comments and this final version has been further revised, in particular to include additional explanation on the methods used and on the potential for in-combination effects. The various revisions do not affect the original conclusions.
- Consultation with SNH and Marine Scotland in August 2012, before all available information had been analysed, identified that there may be potential LSEs for two SPAs (North Colonsay and Western Cliffs SPA and Rathlin Island SPA).
- The report concludes that there is no potential for a Likely Significant Effect on any qualifying feature at any SPA and therefore detailed HRA (i.e., HRA Step 3 Appropriate Assessment) is not required for the project in respect of bird interests.
- The report's conclusion was endorsed by DOE NI (letter 22nd April 2013) but SNH advised (letter 15th May 2013) that LSE should be concluded for three qualifying species at six SPAs. The difference in the conclusions over the potential for LSEs between this report and SNH advice is recognised and taken up in chapter 10: Birds of the Environmental Statement (ES) ES chapter. However, Step 2 of this report was not changed to be in line with SNH's conclusions because in our opinion the potential for the effects on SPA populations identified are of a magnitude that is not likely to be significant.
- In light of the advice from SNH regarding the potential for LSEs on certain SPAs, and at the request of Marine Scotland on 4th July 2013, the information required for the regulator to undertake Step 3 of HRA (Appropriate Assessment) has also been added to the report, together with a provisional assessment of whether the conservation objectives of these SPA are likely to be compromised and thus potentially affect the integrity of the SPA. In all cases the provisional assessment concludes that the conservation objectives are not likely to be compromised and it therefore follows that the Project is not likely to affect the integrity of any SPA.

2. Abbreviations

- AIF – Anticipated Impact Footprint (this is taken to be either DA or DA+1km depending on the impact being considered)
- DA - Development Area
- DA+1km – Development Area buffered to 1km
- DOE NI – Department of Environment Northern Ireland

- HRA – Habitat Regulations Appraisal
- LSE – Likely Significant Effect
- MMFR – Mean-Maximum Foraging Range
- MS – Marine Scotland
- SNH – Scottish Natural Heritage
- SPA – Special Protection Area
- SSSI - Site of Special Scientific Interest
- WITEP - West Islay Tidal Energy Park (also referred to as the Project)

3. Introduction

The aim of this report is to determine if any Special Protection Area qualifying features could be subject to a potential Likely Significant Effect (LSE) arising from the West Islay Tidal Energy Park (WITEP) (Stage 2 of the Habitats Regulations Appraisal process). If a potential LSE is identified then under the Habitats Regulations, an appropriate assessment is required to assess whether there is a risk to the site integrity of that SPA. This report only considers SPAs designated for breeding seabirds. The LSE is with respect to the cited Conservation Objectives for the SPA in question.

For there to be a potential LSE on a qualifying SPA species three conditions need to be satisfied:

- The species under consideration has to be sensitive to the potential effects of the development;
- There has to be evidence that the qualifying species under consideration (i.e., the population of a species from a particular SPA) is likely to use the AIF (i.e. connectivity).
- The number of individuals of the SPA species population under consideration that are likely to use the AIF must be sufficiently large (in the context of the size of the SPA population) for it to be plausible that a significant effect on the population could arise.

The HRA screening addresses these points with reference to information on the following subjects:

- Species sensitivity to anticipated potential impacts;
- Generic information on species breeding season ranging behaviour;
- Colony specific information on species ranging behaviour;
- The importance of the potential impact footprint for a species based on abundance and behaviour data from the WITEP baseline surveys.
- Colony specific species population counts.
- Generic information on species ecology and habitat selection.

4. Guidance on HRA process

SNH (letter 2 July 2012) advised DP Energy that, through a process of reasoned argument, Natura sites (i.e., SPAs in the case of birds) within the foraging ranges of breeding seabirds are identified and then screened to determine whether the development is likely to have a significant effect on qualifying feature(s), as such which site/features should be taken forward for HRA. In particular they advised that:

> *"Connectivity between qualifying features from SPAs and the proposed Islay Tidal Energy Farm should be judged according to the definitions described in table 1 below and should be informed by the results from the baseline characterisation surveys which will provide insight as to which species are present at the site, their abundance, seasonal patterns of use and behaviour as well as consideration of likely sensitivity from potential impacts. Together, this should then be used to assess whether the proposed Islay Tidal Energy Farm is likely to have a significant effect on the qualifying feature(s) and as such which site/features should be taken forward in the HRA."*

Step 1 of HRA process, as set out in guidance to HRA legislation, is to *'determine whether the proposal is directly connected with or necessary to site management* for conservation'. In the case of the WITEP, the answers to this question is 'no' and therefore the HRA proceeds to Step 2.

Step 2 of the HRA process is to address: *'Is the proposal likely to have a significant effect on the qualifying interests of the SPAs either alone or in combination with other plans or projects?'* To answer this question requires the appropriate information to be examined, and this is the purpose of this part of this report.

SNH has provided the following advice, and this has been followed in the screening process:

> *"This step acts as a screening stage: it removes from the HRA those proposals (plans or projects) which clearly have no connectivity to SPA qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection. When this screening step is undertaken at an early stage in the development process, it usually means that it takes the form of a desk-based appraisal. We advise that this is kept broad so that potentially significant impacts are not missed out, or discounted too early, in any HRA (or EIA).*
>
> *The SPA bird interests being considered in respect of tidal arrays are wide-ranging – many seabirds make long foraging trips, especially during the breeding season. This means that tidal array proposals may be 'connected to' SPAs even at great distances. Although connectivity is thus established the fact that the proposal is located further away from the designated sites means that direct impacts are less likely on qualifying species while they are within the SPA.*
>
> *Expert agreement over species sensitivity should help to identify those SPA qualifying interests for which the conservation objectives are unlikely to be undermined by tidal array development, despite any possible connection (e.g. SPA qualifiers which are recorded within a proposed tidal array site but where their flight behaviour and / or foraging ecology means that the tidal array will not have a likely significant effect).*
>
> *Determination of 'likely significant effect' is not just a record of presence or absence of bird species at a tidal array site, but also involves a judgement as to whether any of the SPA conservation objectives might be undermined. Such judgement is based on a simple consideration of the importance of the area in question for the relevant species. Complex data analysis should not be required at this stage. For example; how many birds have been recorded? What are they using the area for? Is this the only area that they can use for this particular activity? Understanding the behavioural ecology of the species, and the*

characteristics and context of the proposed tidal array site, will help in determining whether there are likely significant effects.

There are three possible conclusions for this step of HRA:

- *The likely impacts are such that there is clear potential for the conservation objectives to be undermined – conclude likely significant effect;*
- *The likely impacts are so minimal (either because the affected area is not of sufficient value for the birds concerned or because the risk to them is so small) that the conservation objectives will not be undermined – conclude no likely significant effect;*
- *There is doubt about the scale of the likely impacts in terms of the conservation objectives – conclude likely significant effect.* "

Step 3 of HRA process, appropriate assessment, as set out in guidance to HRA legislation, is: *"Can it be ascertained that the proposal will not adversely affect the integrity of the SPA, either alone or in combination with other plans or projects?"* This step is the actual undertaking of an appropriate assessment and is the responsibility of the competent authority.

This report is concerned with undertaking Step 2 as described above and providing the information required for Step 3 (Appropriate Assessment) where this is required.

5. SPA Conservation Objectives

The breeding seabird SPAs relevant to the proposed development share the same generic Conservation Objectives (JNCC website).

The conservation objectives for these SPAs are as follows:

a) To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
b) To ensure for the qualifying species that the following are maintained in the long term:
   - Population of the species as a viable component of the site;
   - Distribution of the species within site;
   - Distribution and extent of habitats supporting the species;
   - Structure, function and supporting processes of habitats supporting the species;
   - No significant disturbance of the species.

6. Baseline surveys and abundance measures

The Project developments area (DA) is relatively small (2.3 km^2). Due to the sample size possible at this small scale, it is more difficult to obtain measures of its value to birds using the conventional surveying methods for seabirds at sea. The area covered by the baseline surveys (the Survey Area) included a 4 km buffer around the original development search area, to provide context and a robust baseline for future monitoring. As a result of the 4 km buffer and the relatively large original development search area the final area selected for development covers just 2% of the Survey Area

(125 km^2). The development area thus forms only a very small proportion of the Survey Area and inevitably the great majority of the birds encountered were outside the final development area.

DISTANCE analysis has been undertaken to give a robust designed-based estimate of seabird abundance on each survey visit in whole Survey Area (presented in Annex 1 of Appendix 10.1 of ES). The whole Survey Area is considerably larger than the development AIF and so a measure is also needed of the abundance of a species in subareas of the Surveys Area corresponding to AIF (the DA or the DA+1km depending on the impact under consideration). An approximate indication of a species' abundance can be calculated based on the relative areas of the subarea of interest and the Survey Area. Other methods were also used to estimate numbers in the DA and DA+1km (presented in Appendix 2 of Appendix 10.1 of ES). The statistical analyses have been commented on by MS and SNH and they have advised that for assessment purposes the estimated abundance of a species in the anticipated impact footprint (DA or DA+1km) should be derived from the density figures calculated from the entire Survey Area (letter 12th March 2013). This is also the basis used in this report for estimating the numbers of a species present in the (revised) development area and surrounding 1km buffer.

7. Potential impacts and LSE screening

Potential impacts on birds arising from the WITEP were identified in the Scoping Report. The main potential impacts are disturbance and displacement, direct habitat loss, and, for deep diving species, mortality caused by collision with rotors.

In considering how many birds (or what proportion of an SPA population) might be affected by the development, an anticipated impact footprint (AIF) corresponding to the development area (DA, an area of 2.3 km^2) is considered appropriate for direct habitat loss and collision. An AIF corresponding to the development area buffered to 1 km (DA+1km, an area of 13.1km^2) is considered appropriate for disturbance and displacement. In both cases these AIFs are likely to be highly cautious, i.e. larger than will transpire.

The method described below sets out the three-part process used to determine if there are potential LSE on any SPA qualifying features.

In response to comments from SNH on the original report, it is important to point out that three parts of the screening process were each undertaken separately, i.e., each part of the process examined a full list of species/SPAs as appropriate. However, to keep the report reasonably short and focussed the results are presented sequentially starting with the screening criteria that has greatest effect (sensitivity). The report conclusions are not sensitive to the order in which criteria are presented though the order of presentation does affect the amount of supporting text and tabulated information.

SNH raised a concern about the use of using sensitivity criteria for screening, pointing out that there could be potential for a LSE on SPA qualifying species categorised as having 'low' or 'very low' sensitivity to tidal arrays if that species occurred in large numbers in the development site. This is a valid point in theory. However, in the case of the proposed development all species categorised as either 'low' or 'very low' sensitivity (i.e. those screened out on the basis of sensitivity) occurred in low abundance in the context of the relevant SPA receptor populations. It is also worth pointing out here that, although including sensitivity criteria in the screening leads to additional robustness to the conclusions regarding the potential for LSEs, the same conclusions are reached irrespective of including sensitivity criteria in the screening analyses.

LSE screening Part 1 – sensitivity to tidal arrays

The question of how sensitive seabird species are to the potential impacts caused by tidal arrays has recently been reviewed by Furness *et al*. 2012. As part of this review, species were rated on a number of criteria and the scores combined to give an overall sensitivity score (termed vulnerability score), with a higher score indicating a greater level of sensitivity. These scores were then used as the basis for categorising each species into one of four generic sensitivity (vulnerability) categories ranging from very low to high (Table 1). The criteria used included the potential for collision, response to vessel disturbance and flexibility of foraging behaviour.

The methods used by Furness *et al.* (2012) and their resulting generic vulnerability scores are considered to be entirely appropriate with respect to the WITEP and are therefore adopted. However, it should be noted that these are scores/categories for generic vulnerability to tidal stream devices/arrays; the actual vulnerability of a species at a site will be affected by the numbers using the site. This is why 'sensitivity' is considered to be a preferable descriptor to 'vulnerability' for the Furness *et al*. scores and categories.

For screening purposes it is considered that only species rated as having moderate or high sensitivity (vulnerability) to tidal arrays by Furness *et al*. (2012) could be potentially subject to a LSE (see above).

Only five species that use the AIF are considered to have high or moderate sensitivity to the potential impacts of tidal arrays (Table 1). These are black guillemot, razorbill, shag, common guillemot and puffin. Black guillemot is not a qualifying species at any SPA (http://jncc.defra.gov.uk/page-1419) so is not considered further.

LSE screening Part 2 - theoretical connectivity

Part 2 examines the theoretical strength of the connectivity between a given SPA qualifying species and the AIF of the proposed development. This is achieved by examining metrics of foraging range for each species (Thaxter *et al.* 2012, Birdlife website) and the distance between SPAs and the development site. The results of this are presented in full for 23 SPAs in Appendix 1 (Excel spreadsheet)

The two closest seabird breeding colonies designated as SPAs are Rathlin Island (Northern Ireland) located 43 km (shortest distance) south-east of the development area and the North Colonsay and Western Cliffs SPA on Colonsay, which is located 51 km (shortest distance) to the north-east. These were identified in Scoping Report and in consultation with SNH and MS as the SPAs likely to have the greatest relevance to the development.

Following advice from SNH (letter of 2 July 2012), the likely strength of the connectivity was categorised as high, moderate, low or none (Table 2). When tested against the available foraging metrics, the criteria provided by SNH for categorising connectivity were found to be confusing in parts and gave inappropriate results for some species due to the use of standard deviations of large magnitude in the categorisation process. Therefore, the criteria set out in Table 2 have been modified slightly to those suggested by SNH to remove any ambiguity and in all case provide a biologically reasonable division of a species foraging range.

The results of applying this theoretical connectivity categorisation to all SPA with qualifying breeding seabird species populations are presented in Appendix 1 (Excel spreadsheet).

LSE screening Part 3 - use of AIF

In this third part species are further screened against information on that species' use of the AIF as determined by baseline surveys (summarised in Tables 3 and 4, and presented in full in Appendix 10.1 of ES). Where available, SPA-specific tagging results are also examined for evidence that birds from that SPA forage in the vicinity of the AIF (i.e., information on the actual strength of connectivity). Summary details for SPAs species populations with a theoretical connectivity rated as moderate or high are also presented in Tables 5a-d.

Mere occurrence within the development area (Tables 3 and 4) was not considered sufficient for a species to be considered to be at risk of potential LSE, and that there was risk of the Conservation Objectives being undermined. It is relevant to also consider whether there is evidence that a species actively used the AIF (e.g., for foraging) in at least one season of the year, in reasonable numbers relative to the population size of the SPA. Birds that were flying directly over the survey area showing no evidence of foraging or searching for prey were not considered to be using the site. In practice this was only applied to auk species as other species forage on the wing and so were potentially searching for food and using the site when they were flying. For practical purposes the threshold for 'reasonable numbers' was cautiously set at 0.1% of the population estimated to be present on average i.e., it was assumed there was potential for LSE only if the estimated average number using the AIF exceeded 0.1% of the SPA population. The purpose of applying this abundance criterion was to prevent scarce occurrences of individuals from large populations triggering the conclusion that there was potential for LSE, when it is apparent that it is not ecologically plausible for a population to be affected.

The average breeding season abundance of each species in the development area (DA), and the development area buffered to 1 km (DA+1km), was derived from the two years of baseline survey data (Appendix 10.1 of ES) (Table 3). The breeding season corresponds to the period when adults are attending colonies. For most the breeding season was defined as April to August but for guillemot and razorbill, species that leave their colonies in July, it was defined as April to July. For fulmar, gannet and Manx shearwater the breeding season extends into September, however there were no survey data for this month.

These abundance estimates are expressed as a proportion of a SPA receptor population sizes to give a measure of the value of the development area to each receptor population were it to be assumed that all the birds present were from that population (Tables 5a-b, Appendix 1). The high likelihood of birds originating from multiple colonies means that this assumption although highly cautious is not realistic for most species (see below). This assumption is also cautious as it makes no allowance for non-breeding birds; for many seabird species non-breeding individuals (mostly immature birds) form a substantial proportion of a population. Furthermore, for several species (e.g., Manx shearwater, fulmar, kittiwake, gannet, lesser black-backed gull) it was not possible to take into account the fact that a high proportion of individuals recorded were likely to have been merely transiting through the area and not actually making use of it, were this to be taken into account the apparent value of the area to a population would be reduced further.

The most cautious interpretation of the abundance information would be to assume that all the birds present in the development area were from the SPA population under consideration. However, this is not a realistic assumption where there are a number of alternative colonies (designated or not) located within the foraging-range-distance of the development site. Where this is the case, it is likely that the birds present in the development area originate from multiple colonies. This is most likely to be so for species that have large foraging ranges and a relatively large number of colonies, for example, fulmar, Manx shearwater, lesser black-backed gull and puffin.

No species has (or even nearly has) a mean breeding season abundance within the 2.3 km^2 development area (DA) that exceeds 0.1% of any SPA species qualifying population that has a theoretical connectivity categorised as high or moderate (Appendix 1). Two SPA qualifying species (Copeland Islands Manx shearwater and Rathlin Island puffin) have a mean abundance within the development area buffered to 1 km (DA+1km, 13.1 km^2) that slightly exceeds 0.1% of the assumed qualifying species' population size. However, for the reason explained below, in both these cases it is likely that a high proportion of the birds occurring in the vicinity of the development site are from other breeding colonies and therefore that the 0.1% threshold is not exceeded.

In the case of Manx shearwater we assessed what we considered to be a worst case scenario in which all birds are displaced from the DA+1km. Under this scenario an average of 13 Manx shearwaters would be displaced. Judging by this species' observed limited at-sea response to human activities and infrastructure (in particular vessels and navigation markers), a displacement response of this magnitude is highly unlikely to occur, and therefore for assessment purposes this scenario is highly cautious. Furthermore, non-breeding immatures are likely to form a substantial minority of the population but these were not been taken into consideration, which also makes the assessment method cautious. On the basis of the strength of theoretical connectivity (as presented in Appendix 1) four SPA Manx shearwater colonies could be potentially affected, Rum SPA and Copeland Islands SPA, St Kilda SPA and Aberdaron Coast and Bardsey Island SPA.

If all the Manx shearwaters using the anticipated impact footprint were from Rum then this would be 13 out of an assumed SPA population of 240,000 breeding adults (Mitchell *et al.* 2004), which is <0.01% of the SPA population. This is well below the magnitude what could plausibly cause a significant effect.

If all Manx shearwaters using the DA+1km anticipated impact footprint were from the Copeland Islands, 23 out of an assumed population of 9,600 adults would be 0.13%, i.e. approximately 1 in 800. Whereas this is very low it is above the 0.1% threshold we use as a criterion in the HRA screening. However, it is not likely that all the birds are from Copeland Islands population, as the much larger Rum colony is approximately the same distance away and there are other non-SPA colonies even closer (e.g., Treshnish Islands and Sanday). Thus, a further assessment was undertaken for the more realistic scenario that the birds using the impact footprint originate from all colonies that have a have high or moderate theoretical connectivity with the development area and in proportion to colony size. There are 294,000 breeding adults in this wider population (Mitchell *et al.* 2004), of which the Copeland Islands birds make up around 7%. Therefore, under the second scenario, it is assumed that only 7% of the 13 birds on average present in the assumed displacement impact footprint (DA+1km) are from the Copeland Islands SPA. This translates to just 0.9 birds which is <0.01% of the SPA population or 1 bird in approximately 11,000. The second scenario is considered to be likely to be closer to the true situation. On this basis, it was not considered plausible that the magnitude the displacement effect on Copeland Islands Manx shearwater could be sufficient to conclude there was potential for a LSE. Using the same method, the same conclusion was reached for Manx Shearwater breeding at St Kilda SPA and Aberdaron Coast and Bardsey SPA.

If all puffins using the DA were from Rathlin Island, 0.06% of this SPA population would potentially be at risk of a collision impact (average of 1.9 birds out of an assumed Rathlin Island population of

3,220 adults, equivalent to 1 bird in 1700). This is below the magnitude considered plausible to cause a significant impact. If all puffins using the DA+1km were breeding birds from Rathlin Island, 0.33% of the SPA population would be potentially at risk of a displacement impact (average of 10.7 birds out of an assumed Rathlin Island population of 3,220 adults, equivalent to 1 bird in 300). Whereas this is very low it is above the 0.1% threshold we use as a criterion in the HRA screening. However, it is unlikely that all the puffins using the DA+1km are breeding birds from the Rathlin Island SPA population because there are several other puffin colonies close enough to the Project to be within foraging range. In total there are approximately 11,200 breeding puffins that are close enough to have theoretical connectivity rated as high or moderate (based in results in Mitchell *et al*. 2004). In addition, these colonies are likely to have substantial numbers of non-breeding birds, totalling several thousand birds. It is considered likely that the birds present in the DA+1km comprise a mix of birds from these colonies and include non-breeding individuals. Under this more likely scenario the average number of puffins in the DA+1km whose origin might be reasonably attributed to the Rathlin Island SPA breeding population is slightly below the 0.1% of this SPA's population. Given that the default AIF used for displacement of DA+1km is extremely cautious for puffin (a species that shows on a weak disturbance response to vessels) it was considered not plausible that displacement effect on this species could lead to a potential LSE on the Rathlin Island SPA population.

SPA-specific information on connectivity are available for North Colonsay and Western Cliffs SPA for kittiwake, common guillemot and razorbill (the latter is a not a qualifying feature at this SPA), obtained as a result of GPS tagging studies undertaken in 2010 and 2011 (FAME website). SPA-specific tagging results are available also for Rathlin Island for guillemot (two birds) and kittiwake (5 birds) from a Queen's University MSc study undertaken in 2009 (Curry, 2010).

The Colonsay tagging results show no evidence that common guillemots or razorbill breeding on Colonsay forage in the vicinity of the development area (i.e., off south-west Islay) and suggest that there was no connectivity between the development area and North Colonsay and Western Cliffs SPA during the breeding season.

The tagging results for Colonsay kittiwakes show that this species forages over a wider area of sea, with some individuals travelling over 100 km to areas south of the Outer Hebrides. In 2011, a minority of the tagged the kittiwakes studied foraged or transited through the general vicinity of the development area. On the basis of this empirical evidence (abundance and tagging), it is concluded that there is a low level of connectivity between the Colonsay and the development AIF.

The tagged guillemots and kittiwakes from Rathlin Island did not forage in the immediate vicinity of the development (Curry 2010). Although, both species commonly headed in the general direction of Islay to forage, in all cases they did not reach as far as SW Islay; it is approximately 45 km to the development area. The maximum distance travelled by the tagged birds from Rathlin Island was 37.9 km for guillemot (n=20 foraging trips) and 32.6 km for kittiwakes (n=528 foraging trips). The Rathlin Island tagging results suggest that the actual level of connectivity between this SPA and the development area for kittiwake and guillemot is low.

8. LSEs identified

The results of the screening are summarised in Tables 5a-d for all SPA qualifying species population that have moderate or high theoretical connectivity with the development area. Appendix 1 gives more detailed information on connectivity and abundance for all SPA qualifying species populations categorised as having low, moderate or high theoretical connectivity to the development area.

To conclude that there is potential for a LSE on a SPA qualifying feature, and thereby trigger the need for AA, the qualifying feature had to satisfy three conditions, as examined in Parts 1, 2, 3 of the screening exercise above. These are:

- Evidence for high or moderate connectivity between the SPA under consideration and the development AIF concerned;
- Be a species that is considered to have either high or moderate sensitivity to the effects of tidal arrays; and,
- Be a species that uses the development AIF in at least reasonable numbers in the context of the SPA population (taken to be <0.1% of the population).

As SNH pointed out in their comments on earlier version of this report, there is also a theoretical possibility of a potential LSE on a SPA species population with low or very low sensitivity to tidal arrays should the development area have a high importance to sustaining that population. However, as has been shown, the development area has no more than low importance for all SPA species populations so this possibility can be ruled out.

No SPA qualifying feature satisfied all three conditions and therefore no potential LSEs were identified. Furthermore, in no case was it considered that lack of available information resulted in appreciable uncertainty in determining the answers to the three screening questions. Irrespective of the screening on the basis of connectivity and sensitivity, all SPA qualifying species populations were screened out by the abundance-within-the-development-area criterion alone.

9. Potential for LSE from in-combination effects

This section on the in-combination effects has been added following the receipt of the letter from SNH (14 May 2013) advising that they conclude that the Project has the potential to cause LSEs on guillemot, razorbill and puffin qualifying features at several SPAs. For the purpose of examining the potential for LSEs to arise from the effects of the Project acting cumulatively with those from other developments, SNH's conclusions about the potential for LSE to arise from Project acting alone are taken as the starting point.

Following advice given by SNH, projects that are operational, consented, or that are otherwise reasonably foreseeable are considered in the in-combination effects assessment. SNH have indicated that the proposed tidal array at Kyle Rhea should not be included in assessment of in-combination effects as it is too distant (it lies approximately 190 km to the north) for it to be likely there to be sufficient connectivity to give any concerns.

For all SPA qualifying species that occur in the development area apart from common guillemot, razorbill and puffin, the combination of low or very low sensitivity to tidal arrays (Furness *et al*. 2012) and low or very low abundance in the anticipated impact footprint (as shown by the two-year baseline survey programme) means that there is likely to be either no impact arising or that any impacts will at most be of very small magnitude. It is not plausible that such small impacts could act in-combination with impacts from other developments to make a material difference to the overall impact on a SPA population. Therefore, in-combination effects on these species are not considered further.

In the case of the SPA populations of the three auk species for which a potential for LSE has been concluded by SNH (letter 14 May 2013), it is plausible that there could be an in-combination effects arising that is shown to be of sufficient magnitude to cause a significant impact on a SPA receptor population, even though the contributions from individual projects are judged not significant. Therefore, the potential for the impacts from other developments and from the Project to cause in-combination effects on these three species is examined below and summarised in in Table 6.

Sound of Islay Demonstration Project

The environmental statement for the consented Sound of Islay Demonstration Project shows that in the spring and summer months razorbill occur in the development area at a similar density to that recorded in the Project survey area (approximately 0.7 birds km^2 in the spring and summer). By far the most likely origin of the razorbill seen in the Sound of Islay is the colonies on Colonsay (approximately 30 km away) where this species is not a qualifying feature of the North Colonsay and Western Cliffs SPA. On the basis of foraging range meta-data the strength of theoretical connectivity between the Sound of Islay and Rathlin Island (approximately 70 km away) is rated as low. It is concluded that impacts on Rathlin SPA razorbill caused by the Sound of Islay Demonstration Project are unlikely to cause LSE in isolation, but could marginally increase the potential for LSE when added to LSE already identified arising from the Project.

Common guillemots and puffin were scarce in the Sound of Islay baseline studies with breeding season densities averaging approximately 0.2 birds/km^2 and <0.1 birds/km^2 respectively. These densities are approximately an order of magnitude lower than recorded in the Project survey area and are so low that any impacts from Sound of Islay project would be extremely small in magnitude for all SPA populations that have theoretical connectivity with this site.

Offshore Wind farms

Common guillemots, razorbills and puffins that use the vicinity of the two proposed offshore windfarms, (the Islay Offshore Wind Farm and the Argyll Array Offshore Windfarm) in the region would potentially be from the same SPA populations for which LSE arising from the Project have been identified by SNH. The impacts of these windfarm on these species are likely to be limited to relatively small-scale displacement effects which in isolation are likely to be rated as no more than negligible magnitude for any SPA population considered. These auk species habitually fly low above the sea (typically well below wind turbine rotor height) and therefore the collision risk posed to flying auks by these wind farms is likely to be very small and at most rated as negligible in magnitude. It is considered likely that the displacement impact on auks arising from these wind farm projects has the potential to act in-combination with the potential LSE identified from the Project in isolation and thereby add to the overall magnitude of adverse impacts on these SPA populations. Nevertheless, it is also considered likely than the magnitude of the in-combination effect is likely to be negligible in all cases.

Small scale projects

A 35 kW prototype tidal stream device is currently proposed in Sanda Sound off the South Kintyre coast. Impacts from this development are anticipated to be of a very low level and would not contribute to an in-combination effect with the Project. Also proposed, but unconsented, is the 3MW Argyll Tidal project off the western coast of the Mull of Kintyre, and similarly, due to the small scale of potential effects and the distance to the Project, no risk of an in-combination effect is identified.

Torr Head and Fair Head proposals

Two exclusivity leases have been granted for the development of tidal energy off Northern Ireland in the Rathlin Island and Torr Head Strategic Area; Fair Head (DP Marine Energy / DBE) and Torr Head (Tidal Ventures). Based on a superficial consideration of the proposed scale of these projects 100MW each) and their relatively close proximity to Rathlin Island SPA, it would appear likely that both these projects will conclude there is potential for LSE on the Rathlin Island SPA populations of common guillemot, razorbill and puffin. However, these projects have not yet reached the scoping phase and insufficient information exists to undertake a proper assessment of the potential for in-combination effects.

In-combination effects conclusion

It is concluded that when other projects are considered alongside the Project, no new potential LSEs on SPA populations are identified. However, it does shows that some other proposed developments appear to also have potential to cause LSE in isolation on the same SPA qualifying populations for which the potential for LSE have been shown from the Project.

10. Step 3. Appropriate Assessment Information

In light of the advice from SNH that they conclude there is potential for LSE on three auk species that are qualifying features at various SPAs, information for these is presented below to enable the regulator to undertake AA. Information is also presented on kittiwake as the birds of this species breeding at North Colonsay and Western Cliffs SPA and at Rathlin Island SPA were initially identified during scoping and consultation as potentially being of concern also.

A provisional assessment is also undertaken using the information presented to examine the likelihood of the Project compromising the conservation objectives of the SPAs and thus to potentially affect the integrity of these SPAs.

Inevitably this section repeats some of the information presented earlier at the screening stage. Where relevant it also examines in greater detail the information on connectivity, and the proportion of birds using the anticipated impact footprint (AIF) that might be from the SPA population under consideration. The origins of birds using the AIF during the winter period is also considered and whether or not it is likely that birds from the SPA populations are present at this time of year.

The abundance estimates of birds using the AIF are expressed as a proportion of a SPA receptor population sizes to give a measure of the value of the AIF. The three auk species considered do not breed until they are approximately five years old and this means that there is likely to be a relatively high ratio of immature (i.e. those <5 years old) to adult (i.e. those at least 5 years old) birds in a population, as many as 1 immature to every 2 adults would not be unreasonable. With rare exceptions, immature birds of these species are indistinguishable from breeding adults during breeding season surveys. It is also likely a moderate to high proportion (depending on species) of the immature birds in the SPA populations considered over-summer in the breeding area (razorbill are perhaps an exception to this, see below). For these reasons, it is highly likely that the auks recorded using the AIF during the breeding season include immature birds. No allowance for non-breeding birds has been made in the assessments below, and this is likely to mean that the estimated value of the AIF to a particular auk SPA population is biased high, perhaps by as much as a factor of 1.5.

In considering what proportion of an SPA population might be affected by the project, an AIF corresponding to the development area (DA, an area of 2.3 km^2) is considered appropriate collision impacts. An AIF corresponding to the development area buffered to 1 km (DA+1km, an area of 13.1km^2) is considered appropriate for disturbance and displacement. In both cases these AIFs are likely to be highly cautious, i.e. larger than will transpire.

Two estimates of the value of the AIF to an SPA qualifying feature are presented. The first is the more cautious but in most cases probably unrealistic scenario of assuming that all birds present in the AIF are from the SPA population under consideration. This is the mean number using the AIF as a percentage of the assumed population size (Tables 7a to 7c). A more realistic scenario would be to assume that birds using the AIF are from multiple colonies. For this scenario the portion present that might reasonably attributed to the SPA under consideration was calculated from the average number present as a proportion of the wider population that might reasonably be expected to usethe AIF on the basis of the theoretical foraging range from colonies (Tables 7a to 7c). For simplicity the wider population is defined as the sum of all other breeding colonies that have the same or greater theoretical connectivity as the SPA population under consideration. For example, for an SPA population rated as having moderate theoretical connectivity, the wider population is the sum of birds in colonies (based on colony size data in Mitchel *et al*. 2004). The breeding seabird SPAs relevant to the proposed development share the same generic conservation objectives (JNCC website).

The conservation objectives for these SPAs are as follows:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a) Population of the species as a viable component of the site;
    b) Distribution of the species within site;
    c) Distribution and extent of habitats supporting the species;
    d) Structure, function and supporting processes of habitats supporting the species;
    e) No significant disturbance of the species.

Conservation objectives 1 and 2b only concern the area within a SPA boundary. In no case do the potential impacts of the project extend to inside an SPA boundary, therefore the project will not affect these conservation objectives.

In order for the viability of an SPA population (conservation objective 2a) to be significantly affected would require the project to cause change to the population's productivity or mortality. Typically these parameters would need to change by at least 1% of their baseline rate for the change to be considered significant. For this project, the only realistic way for causing such changes is through the theoretical potential for underwater collision risk with diving birds to cause additional mortality. Quantitative assessment of collision risk to diving birds is hampered by a lack of empirical information on how birds respond to TECs and whether or not collision results in injury or death. There is currently no approved method, or an adequate understanding on collision avoidance or the consequences for birds of collision events (e.g., injury rate when a bird comes into contact with a rotor). The combination of the relatively small size of the rotor swept area of devices (up to 380m^2 per rotor) and the relatively wide spacing distance between rotors (see ES chapter for details) mean that only a very small proportion (well below 1%) of dive paths of auks feeding in the development area would be likely to pass through the rotor swept area of a device. It is also clear that only a minority (approximately 20%, estimated using Band model, Band *et al*. (2007), depending on TEC design and rotation period) of birds that swim through a TEC rotor swept area would be struck even if they showed no avoidance. It is also likely that a high proportion of birds (e.g., in line the proportion assumed likely for seals by Davies and Thompson (2011)) will make effective avoidance manoeuvres and that many collisions will not cause any injury (e.g., those that occur when rotors are turning at slow speed or make contact near the hub). During periods of low current speed (<1m/s) and TEC maintenance there will be no collision risk as rotors will not be rotating; rotors are estimated to be inoperative for approximately 25%-30%. Given all the above, it is clear that injurious collisions will at most be rare events and that for sufficient deaths to occur to have a significant effect on a SPA population mortality rate there would need to be relatively high densities of birds regularly using the site.

Conservation objectives 2c, 2d and 2e, all relate to the importance of areas outside the SPA boundary to sustaining the SPA population. In the case of their relevance to this project, these conservation objectives effectively relate to the importance to the SPA population of the AIF as a foraging site. The project could potentially deprive an SPA population of foraging resources within the AIF through a combination of direct habitat loss, displacement and disturbance. The estimates percentage of birds from an SPA population on average present in the AIF during baseline surveys is taken as an indication of how important it is for providing foraging to a species. Although there is no agreed definition, it is common practice in ornithological assessment work to use 1% as the threshold for establishing the significance of importance, i.e. an area that provides less than 1% of a population's foraging requirements might be considered to have only negligible importance. This threshold is probably appropriate for the assessing if a tidal energy project could potentially have a significant effect on an SPA population's foraging resources and thereby possibly compromise conservation objectives 2c, 2d and 2e. However, in the absence of guidance, the regulator may consider that a more cautious threshold is appropriate. Therefore, a much more (ten times more) cautious threshold of 0.1% of the population is also considered for the assessment of the Project (right hand most columns in Tables 7a to 7c).

Common guillemot

Common guillemot is considered to have a high sensitivity to the effects of tidal arrays (Furness *et al.*, 2012) on account of it showing only moderate tolerance to human activities, vessels and infrastructure, and in particular, because they regularly dive to the depths of rotors and therefore may be at risk of collision impacts. The estimated adult baseline mortality rate of common guillemot is 11.5% (del Hoyo, Elliot and Sargatal, 1996).

The average number using (i.e., on the sea) the DA only (the suggested AIF appropriates for assessing collision impacts) was approximately 4 birds in the breeding season and approximately 24 birds in the autumn/winter (Tables 3 and 4). Similarly, the average number in the in the DA+1km (the suggested AIF for displacement impacts) was approximately 21 birds in the breeding season and approximately 140 birds in the autumn/winter (Tables 3 and 4).

Examination of the distribution maps (Figs 1 and2) shows that use by guillemots of the DA and DA+1km is less than expected compared to the overall study area. Therefore, the above estimates based on data for the whole survey area are likely to be biased high and thus are inherently cautious for assessment purposes.

The most likely origin of common guillemots using the AIFs in the breeding season is the small colonies on the west coast of Islay, these non-SPA colonies are within the mean foraging distance (37.8km) of the AIF, and therefore on theoretical grounds would be expected to have high connectivity. The results of the SPA 'corridor' surveys provide evidence of low connectivity between the two closest SPA colonies for this species (Colonsay and Rathlin Island) (ES Appendix 10.1).

Although somewhat larger numbers of guillemot are present in the AIF in winter (average of 24 in DA), only a small proportion, if any, of these birds are likely to be from regional SPA populations. Ringing recoveries show that common guillemots breeding in Scotland disperse widely outside the breeding season. They typically overwinter several hundred kilometres from their breeding site but there is considerable individual variation with some individuals moving only short distances (Wernham *et al.* 2002). In mid-winter (December and January) ringing recoveries of British adult guillemot have on average a difference of approximately three degrees of latitude (approximately 330 km) compared to their breeding site, and about one quarter are up to six degrees (approximately 660 km) from their breeding colony. Most birds head south (especially to the Bay of Biscay) or south east (to the southern North Sea), but others go north (e.g., to the Faeroese waters) or east (to the northern North Sea). Recoveries also show that some birds breeding overseas, in particular those from the Faeroes and Norway, overwinter around Scotland. There is clearly considerable mixing of birds from different breeding areas occurring in winter, with the birds wintering in any one area comprising a mixture of birds from a wide geographic spread of breeding areas. Faeroese birds potentially make up a large proportion of birds overwintering in west Scotland as they number in the region of half a million individuals, roughly the same as the number breeding in west Scotland.

It is concluded that the guillemots present in the development AIF in winter are likely to originate from a wide range of breeding sites, mostly likely are sites in across western Scotland, Ireland and the Faeroes. Although it is likely that some birds present in winter are from UK SPA colonies (e.g. Handa Island and Rathlin Island) the proportion from any one SPA is likely to be low because of the large individual variation in the size and direction of winter movements leads to a mixing of breeding populations in winter.

North Colonsay and Western Cliffs SPA

SNH concluded there was potential for LSE on the common guillemot population breeding on North Colonsay and Western Cliffs SPA.

Breeding common guillemot is a qualifying feature at North Colonsay and Western Cliffs SPA as a component of an 'Internationally Important Bird Assemblage'.

The shortest distance between the AIF and this SPA (51 km) is comfortably within the Mean Maximum Foraging Range of guillemot (84 km, Thaxter *et al.* 2012) and therefore on theoretical grounds it is concluded that there might be moderately strong breeding season connectivity between this SPA and DA. However, the recent FAME results for guillemots tagged on Colonsay show no indication that the sea to the south-west of Islay is used for foraging (FAME website). The FAME results provide strong empirical evidence that the actual breeding season connectivity between this SPA and the AIF is either low or zero.

If all the birds using the AIF were from the Colonsay SPA population (which is unlikely) the average number present during the breeding season in the AIF (taken to be either the DA or DA+1km) would be a negligible proportion (below 0.1%) of the population of approximately 34,124 adults (26,249 birds counted in Seabird 2000 colony count, which converts to 17,062 pairs after correcting for colony attendance using x0.67 correction factor, Mitchell *et al*. 2004) (Table 7a). It is more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.002% in DA and 0.015% in DA+1km (Table 7a).

Assuming a 11.5% baseline annual mortality rate (del Hoyo, Elliot and Sargatal, 1996), it is estimated that approximately 3,924 adult common guillemot in the Colonsay SPA population die annually and that for collision mortality to merit classification as an effect of greater than negligible magnitude (i.e., causing a greater than 1% increase in baseline mortality rate) there would need to be at least 39 collision deaths of breeding adults from this population per year.

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding common guillemot qualifying feature of the North Colonsay and Western Cliffs SPA.

Rathlin Island SPA

SNH concluded there was potential for LSE on the common guillemot population breeding on Rathlin Island.

Breeding common guillemot is a qualifying feature at Rathlin Island SPA as an 'Important Migratory Population of a non-Annex 1 species'.

The shortest distance between the development site and this SPA (43 km) is comfortably within this species MMFR of guillemot (84 km, Thaxter *et al.* 2012) and therefore on theoretical grounds it is concluded that there might be moderately strong breeding season connectivity between this SPA and the AIF. The 2009 tagging data for Rathlin Island kittiwakes showed that none of the tagged birds foraged more than 38 km from their nest and therefore did not travel as far as the development area, a result that suggests the actual level of connectivity perhaps low, though it should be borne in mind that only two birds were tagged (Curry 2010). The results of the SPA 'corridor' surveys provide further evidence of low connectivity to this SPA (ES Appendix 10.1). Guillemots using the vicinity of the development area in the breeding season are perhaps most likely to originate from the much closer small colonies on the west coast of Islay.

If all the birds in the AIFs were from the Rathlin SPA population (which is unlikely) the average number present during the breeding season in the AIF (either the DA or DA+1km) would be a negligible proportion (well below 0.1%) of the SPA population of approximately 127,456 birds (95,117 birds counted in Seabird 2000 colony count, which converts to 63,728 pairs after correcting for colony attendance using x0.67 correction factor, Mitchell *et al*. 2004) (Table 7a). It is more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.002% in DA and 0.015% in DA+1km (Table 7a).

Although somewhat larger numbers of guillemot are present in the AIF in winter (approximate average of 24 in DA), for the reason already explained, only a small proportion, if any, of these birds are likely to be from Rathlin Island SPA population.

Assuming a 11.5% baseline annual mortality rate (del Hoyo, Elliot and Sargatal, 1996), it is estimated that approximately 14,657 adult common guillemot in the Rathlin SPA population die annually and that for collision mortality to merit classification as an effect of greater than negligible magnitude (i.e., causing a greater than 1% increase in baseline mortality rate) there would need to be at least 146 collision deaths of breeding adults from this population per year.

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding common guillemot qualifying feature of the Rathlin Island SPA.

Canna and Sanday SPA

SNH concluded there was potential for LSE on the common guillemot population breeding on Canna and Sanday SPA.

Breeding common guillemot is a qualifying feature at Canna and Sanday SPA as an 'Internationally Important Bird Assemblage component only'.

The shortest distance between the AIF and this SPA (151 km) this exceeds the maximum foraging distance for common guillemot (135 km, Thaxter *et al.* 2012) and therefore on theoretical grounds it there is unlikely to be any connectivity between this SPA and DA. It is not clear why SNH classed the SPA as having low theoretical connectivity, it may be because they measured a direct route compared to the distance by sea.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the DA would be a negligible proportion (below 0.1%) of the SPA population of approximately 7,772 birds (Table 7a). Similarly, the average number present in the DA+1km would represent approximately 0.3% of the population (Table 7a). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.001% in DA and 0.011% in DA+1km (Table 7a).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding common guillemot qualifying feature of the Canna and Sanday SPA.

Mingulay and Berneray SPA

SNH concluded there was potential for LSE on the common guillemot population breeding on Mingulay and Berneray SPA.

Breeding common guillemot is a qualifying feature at Mingulay and Berneray SPA as an 'Internationally Important Bird Assemblage component only'.

The shortest distance between the AIF and this SPA (137 km) this exceeds the maximum foraging distance for common guillemot (135 km, Thaxter *et al.* 2012). However it does so by a very small margin and, therefore, it is nevertheless concluded that there might be low connectivity between this SPA and the DA.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the AIFs (both the DA and the DA+1km) would be a negligible proportion (well below 0.1%) of the SPA population of approximately of approximately 41,406 birds (Table 7a). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent just 0.001% in DA and 0.011% in DA+1km (Table 7a).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding common guillemot qualifying feature of the Mingulay and Berneray SPA.

Rum SPA

SNH concluded there was potential for LSE on the common guillemot population breeding on Rum SPA.

Breeding common guillemot is a qualifying feature at Rum SPA as an 'Internationally Important Bird Assemblage component only'.

The shortest distance between the AIF and this SPA (143 km) this exceeds the maximum foraging distance for common guillemot (135 km, Thaxter *et al.* 2012) and therefore on theoretical grounds it there is unlikely to be any connectivity between this SPA and DA. It is not clear why SNH classed the

SPA as having low theoretical connectivity, it may be because they measured a direct route compared to the distance by sea.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the DA would be a negligible proportion (below 0.1%) of the SPA population of approximately 5,360 birds (Table 7a). Similarly, the average number present in the DA+1km would represent approximately 0.4% of the population (Table 7a). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.001% in DA and 0.011% in DA+1km (Table 7a).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding common guillemot qualifying feature of the Rum SPA.

Razorbill

For the same reasons stated earlier for common guillemot, razorbill is considered to have a high sensitivity to the effects of tidal arrays (Furness *et al*. 2012). The estimated adult baseline mortality rate of common guillemot is 9.5% (del Hoyo, Elliot and Sargatal, 1996).

The average number of razorbill using (i.e., on the sea) the DA only (the suggested AIF for collision impacts) was approximately 2 birds in the breeding season and approximately 6 birds in the autumn/winter (Tables 3 and 4). Similarly, the average number in the in the DA+1km (the suggested AIF for displacement impacts) was approximately 9 birds in the breeding season and approximately 32 birds in the autumn/winter (Tables 3 and 4).

Examination of the distribution maps (Figures 3 and 4) shows that use by razorbills of the DA and DA+1km is less than expected compared to the overall study area. Therefore, the above estimates based on data for the whole survey area are likely to be biased high and thus are inherently cautious for assessment purposes.

The most likely origin of razorbills using the AIFs in the breeding season is the small colonies on the west coast of Islay, these non-SPA colonies are within the mean foraging distance (23.7 km) of the AIF, and therefore on theoretical grounds would be expected to have high connectivity. The results of the SPA 'corridor' surveys provide evidence of low connectivity only between the two closest SPAs for this species (Colonsay and Rathlin Island) (ES Appendix 10.1).

The razorbills using the AIFs in summer are likely to comprise a mix of Scottish breeding birds from colonies up to approximately 50 km away and immatures (of non-breeding age) from more northerly breeding grounds (especially Iceland). The ratio of birds from these two origins is unknown, but locally breeding birds probably form the majority. Although there is a lack of direct evidence for the presence of immature Icelandic birds in summer, this can nevertheless reasonably be inferred from the recoveries of immature razorbill ringed as chicks in British colonies. These show that many immature British birds spend the summer hundreds of kilometres south or east of their natal area, i.e., in approximately the same areas as where they occur in winter (Wernham *et al.* 2002). It is likely that immature Icelandic birds behave in a similar way, which would mean that many are likely to over summer in Scottish waters.

Recoveries of adult razorbill ringed at breeding sites in western Scotland show that they typically overwinter several hundred kilometres away in areas to the south and east, such as the North Sea and western Norway (Wernham *et al* 2002). Indeed, the median distance for winter recoveries of British adults is nearly 700 km from the breeding site, and nearly a 1000 km for immature birds (Wernham *et al* 2002). Recoveries also show razorbills from breeding sites in Iceland and Scandinavia overwinter in the seas around the UK including western Scotland (Wernham *et al.* 2002). On the basis of measurements of dead birds washed ashore, it is also inferred that large numbers of birds of the nominate '*torda'* race of this species overwinter in western Britain most likely from breeding sites in Greenland (birds breeding in Britain are of the '*islandica'* race). Thus it is concluded that the birds present in the AIF in winter are likely to mostly or entirely originate from overseas breeding areas. They probably comprise a mix of birds from Greenland, Iceland, Scandinavia and perhaps the Faeroes also. Icelandic birds in particular are likely to account for a high proportion because Iceland has a very large breeding population, approaching a million individuals (i.e., about three times the number that breed in the Great Britain and Ireland).

Rathlin SPA

SNH concluded there was potential for LSE on the razorbill population breeding on Rathlin Island.

Breeding razorbill is a qualifying feature at Rathlin Island SPA as an 'Important Migratory Population of a non-Annex 1 species'.

The shortest distance between the development site and this SPA (43 km) is below the MMFR of razorbill (48.5 km, Thaxter *et al.* 2012) and therefore on theoretical grounds the strength of breeding season connectivity between this SPA and the AIF is categorised as moderate. Unfortunately there are no tagging results from Rathlin Island to provide empirical evidence on the actual strength of connectivity, but the scarcity of birds seen in baseline surveys suggest that at most it is low. The results of the SPA 'corridor' surveys provide further evidence of low connectivity to this SPA (ES Appendix 10.1). Furthermore, there are small non-SPA razorbill colonies on the west coast of Islay that are within the mean foraging range (23.7 km) from the AIF, and therefore these are the most likely origin of the birds present in the breeding season.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the AIF (either the DA or DA+1km) would be a negligible proportion (0.006% in DA, 0.03% in DA+1km) of the SPA population of approximately 31,134 birds (20,860 birds counted in Seabird 2000 colony count, which converts to 31,134 birds after correcting for colony attendance by dividing by 0.67 correction factor, Mitchell *et al*. 2004) (Table 7b). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.004% in DA and 0.028% in DA+1km (Table 7b).

Assuming a 9.5% baseline annual mortality rate (del Hoyo, Elliot and Sargatal, 1996), it is estimated that approximately 2,957 adult razorbills in the Rathlin Island SPA population die annually and that for collision mortality to merit classification as an effect of greater than negligible magnitude (i.e., causing a greater than 1% increase in baseline mortality rate) there would need to be at least 30 collision deaths of breeding adults from this population per year.

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding razorbill qualifying feature of the Rathlin Island SPA.

Puffin

Puffin is considered to have a moderate sensitivity to the effects of tidal arrays (Furness *et al*. 2012) largely on account of its feeding strategy of diving to the depths occupied by rotors and therefore it may be at risk of collision impacts. However this species' very extensive foraging range potentially gives it a very wide choice of potential feeding areas. The estimated adult baseline mortality rate of puffin is 7.6% (Harris *et al.* 1997).

The average number of puffins using (i.e., on the sea) the DA only (the suggested AIF for collision impacts) was approximately 2 birds in the breeding season and approximately 0.2 birds in the autumn/winter (Tables 3 and 4). Similarly, the average number using the DA+1km (the suggested AIF for displacement impacts) was approximately 11 birds in the breeding season and approximately 1 bird in the autumn/winter (Tables 3 and 4).

Examination of the distribution maps (Figures 5 and 6) shows that use by puffins of the DA and DA+1km is approximately the same as the overall study area. Therefore, the above estimates based on data for the whole survey area are likely to be unbiased.

The most likely origin of puffins using the AIFs in the breeding season is Rathlin Island, the closest colony, however this species regularly forages long distances to forage (over 100 km) and the AIF is well within the typical foraging distance (Thaxter *et al*. 2012) of several other colonies. The results of the SPA 'corridor' surveys provide evidence of low connectivity between the AIFs and Rathlin Island (ES Appendix 10.1).

Rathlin SPA

SNH concluded there was potential for LSE on the puffin population breeding on Rathlin Island SPA.

Breeding puffin is a qualifying feature at Rathlin Island SPA as a component of an 'Internationally Important Bird Assemblage'.

The shortest distance between the development site and this SPA (43 km) is below the MMFR of razorbill (105 km, Thaxter *et al.* 2012) and therefore on theoretical grounds the strength of breeding season connectivity between this SPA and the AIF is categorised as moderate. Unfortunately there are no tagging results from Rathlin Island to provide empirical evidence on the actual strength of connectivity, but the scarcity of birds seen in baseline surveys suggest that at most it is low. The results of the SPA 'corridor' surveys provide further evidence of low connectivity to this SPA (ES Appendix 10.1).

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the DA would be a negligible proportion (below 0.1%) of the SPA population of approximately 3,854 birds (Table 7c). Similarly, the average number present in the DA+1km would represent approximately 0.3% of the population (Table 7c). It is more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.015% in DA and 0.086% in DA+1km (Table 7c).

Assuming a 7.6% baseline annual mortality rate Harris *et al.* 1997, it is estimated that approximately 293 adult puffins in the Rathlin Island SPA population die annually and that for collision mortality to merit classification as an effect of greater than negligible magnitude (i.e., causing a greater than 1% increase in baseline mortality rate) there would need to be at least 3 collision deaths of breeding adults from this population per year.

From the information presented above, it is concluded that it is not likely that the project would have any significant effect on the conservation objectives for the breeding puffin qualifying feature of the Rathlin Island SPA.

Canna and Sanday SPA

SNH concluded there was potential for LSE on the puffin population breeding on Canna and Sanday SPA.

Breeding puffin is a qualifying feature at Canna and Sanday SPA as a component of an 'Internationally Important Bird Assemblage.

The shortest distance between the development site and this SPA (151 km) is below the maximum foraging of puffin (200 km, Thaxter *et al.* 2012) and therefore on theoretical grounds the strength of breeding season connectivity between this SPA and the AIF is categorised as low.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the DA would be a negligible proportion (0.08%) of the SPA population of approximately 2,400 birds (Table 7c). Similarly, the average number present in the DA+1km would represent approximately 0.45% of the population (Table 7c). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.008% in DA and 0.047% in DA+1km (Table 7c).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding puffin qualifying feature of the Canna and Sanday SPA.

Mingulay and Berneray SPA

SNH concluded there was potential for LSE on the puffin population breeding on Mingulay and Berneray SPA.

Breeding puffin is a qualifying feature at Mingulay and Berneray SPA as a component of an 'Internationally Important Bird Assemblage.

The shortest distance between the development site and this SPA (137 km) is below the maximum foraging of puffin (200 km, Thaxter *et al.* 2012) and therefore on theoretical grounds the strength of breeding season connectivity between this SPA and the AIF is categorised as low.

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present during the breeding season in the DA would be a negligible proportion (0.02%) of the SPA population of approximately 8000 birds (Table 7c). Similarly, the average number present in the DA+1km would represent approximately 0.13% of the population (Table 7c). It is much more likely that the birds using the AIFs would be from multiple colonies; using the allocation method described earlier, the share of average number of birds attributable to this SPA would represent a negligible proportion of the SPA population, just 0.008% in DA and 0.047% in DA+1km (Table 7c).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding puffin qualifying feature of the Mingulay and Berneray SPA.

Kittiwake

Although it has been concluded that there is no potential for the Project to cause a LSE on kittiwake SPA populations, the potential relevance of the Rathlin Island and Colonsay SPA populations to the Project were identified during scoping and consultation process. In light of this and the fact that the wider kittiwake population is declining (SNH 2012), additional information is presented below to give added confidence that the Project has no potential to compromise the conservation objectives for the kittiwake populations of these two SPAs.

Kittiwake is considered to have a low sensitivity to the effects of tidal arrays (Furness *et al*., 2012), on account of it showing a very high tolerance to human activities, vessels and infrastructure, having a foraging strategy that seeks food over wide areas and the fact that they do not dive to depths of rotors.

The closest kittiwake colonies to the development area are the small colony on the west coast of Islay, and birds from this colony are perhaps the most likely birds to use the AIF in the breeding season.

In the decade or so since the Seabird 2000 census counts, kittiwake numbers have declined in Scotland, on average by approximately -44% (derived from SNH 2012 and Mitchell *et al.* 2004). The current size of SPA populations in the regional is unknown. This species has been in overall decline in Britain and Ireland since the mid 1980s but the size of population change varies between regions. Indeed, between the last two national censuses (Seabird Colony Register Census 1985-88 and the Seabird 2000 1998-2002) the numbers of kittiwake breeding in the region (Argyll & Bute and County Antrim) increased by 21%, which sharply contrasts to the overall decline of -23% for the Britain and Ireland as a whole over the same period (Mitchell *et al.* 2004).

Kittiwake was shown by the baseline surveys to be relatively uncommon in the survey area at all times of year, especially in the breeding season. The average estimated number in the DA+1km was approximately 5 birds in the breeding season and approximately 9 birds in the autumn/winter (Tables 3 and 4).

The distribution of kittiwakes seen in baseline surveys is shown in Figures 7 and 8.

North Colonsay and Western Cliffs SPA

Breeding kittiwake is a qualifying feature at the North Colonsay and Western Cliffs SPA as a component of an 'Internationally Important Bird Assemblage'.

The shortest distance between the AIF and this SPA (51 km) is comfortably within the MMFR of kittiwake (60 km, Thaxter *et al*. 2012) and the recent FAME tagging results for kittiwakes tagged on Colonsay show that in one of the two study years a minority of the tagged the kittiwakes foraged or transited through the general vicinity of the development area. On the basis of this evidence (abundance and tagging), it is concluded that there is a low level of connectivity between the Colonsay and the development AIF. The results of the SPA 'corridor' surveys provide further evidence of low connectivity to this SPA (ES Appendix 10.1).

If all the birds using the AIF were from the SPA population (which is unlikely) the average number present in the AIF (taken to be DA+1km) would be a negligible proportion (0.04%) of the SPA population of 12,970 adult birds (6,485 pairs, Seabird 2000 count).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding kittiwake qualifying feature of the North Colonsay and Western Cliffs SPA.

Rathlin Island SPA

Breeding kittiwake is a qualifying feature at Rathlin Island SPA as a component of an 'Internationally Important Bird Assemblage'.

The shortest distance between the AIF and this SPA (43 km) is comfortably within the MMFR of kittiwake (60 km, Thaxter *et al*. 2012), suggesting there is potential for moderately strong connectivity. The 2009 tagging data for Rathlin Island kittiwakes showed that none of the tagged birds foraged more than 33 km from their nest and therefore did not travel as far as the development area, a result that suggests the actual level of connectivity is low, though it should be borne in mind that only six birds were tagged (Curry 2010). The results of the SPA 'corridor' surveys provide further evidence of low connectivity to this SPA (ES Appendix 10.1).

If all the birds using the AIF were from this SPA population (which is unlikely) the average number present in the AIF (taken to be DA+1km) would be a negligible proportion (0.05%) of the SPA population of 9,917 pairs (Seabird 2000 count).

From the information presented above, it is concluded that it is not likely that the project would have any significant effects on the conservation objectives for the breeding kittiwake qualifying feature of the Rathlin Island SPA.

11. Conclusions

On the basis of the results of the screening process presented in Step 2, no potential LSEs arising from the proposed Project were identified for any SPA qualifying features.

However, SNH has advised that there is potential for LSE on three species at various SPAs and therefore it is necessary to undertake Step 3 of the HRA process (Appropriate Assessment) for these SPAs as set out in the Habitats Regulations, i.e., to undertake a detail examination of identified potential LSEs to ascertain that the proposal will not adversely affect the integrity of SPAs.

On the basis of the information presented in Step 3 and the provisional assessment undertaken, it is concluded that that none of the conservation objectives of the SPAs examined are likely to be compromised and it therefore follows that the Project is not likely to adversely affect the integrity of these SPAs.

12. References

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Tables

Table 1. Species generic vulnerability to tidal arrays ordered by vulnerability score. From Furness *et al*. 2012.

Species	Generic vulnerability score	Generic vulnerability category
Black guillemot	9.9	High
Razorbill	9.6	High
Shag	9.6	High
Common guillemot	9.0	High
Cormorant	7.0	High
Puffin	3.8	Moderate
Arctic Tern	1.9	Low
Gannet	1.4	Low
Great black-backed gull	1.0	Very low
Kittiwake	0.9	Very low
Herring gull	0.8	Very low
Common gull	0.7	Very low
Lesser black-backed gull	0.7	Very low
Fulmar	0.5	Very low
Storm petrel	0.5	Very low

Table 2. Criteria used to categorise theoretical connectivity between an SPA qualifying feature and the development site (adapted from SNH letter of 2 July 2012).

Theoretical connectivity	Definition
High	Site within Mean Foraging Range
Moderate	Site within Mean Maximum Foraging Range +10%, or Site within 95% of Cumulative Foraging Distance (use whichever is more ecologically appropriate)
Low	Site within Maximum Foraging Range
None	Site further than the Maximum Foraging Range
Unknown	Insufficient data available.

Table 3. Baseline survey breeding season population estimates. Based on five surveys in 2010 and five surveys in 2011.

Species	**Study Area** (106.7 km^2) (DISTANCE analysis)		**Dev. Area+1km** (13.1km^2) (apportionment by area)		**Dev. Area** (2.3 km^2) (apportionment by area)	
	Mean	Max	**Mean**	Max	**Mean**	Max
Fulmar	**38.8**	111	**4.8**	16.9	**0.8**	4.4
Storm petrel	**4.6**	20	**0.4**	5.7	**0.1**	1.0
Manx shearwater	**102.2**	332	**12.6**	108.6	**2.2**	18.8
Gannet	**76.1**	177	**9.4**	74.3	**1.6**	12.9
Shag	**13.4**	35	**1.7**	10.1	**0.3**	1.8
Lesser b-b. gull	**3.3**	20	**0.3**	2.4	**0.05**	0.6
Great b-b. gull	**0.7**	7	**0.1**	5.7	**0.01**	1.0
Herring gull	**0**	0	**0**	0	**0**	0
Kittiwake	**36.8**	266	**4.5**	48.4	**0.8**	12.5
Arctic tern	**10.5**	105	**1.3**	91.4	**0.2**	15.9
Guillemot (on sea)	**169.0**	515	**20.8**	89.4	**3.6**	19.5
Guillemot (fly)	**27.7**	116	**3.4**	62.9	**0.6**	10.9
Razorbill (on sea)	**75.1**	257	**9.2**	44.1	**1.6**	7.6
Razorbill (fly)	**38.7**	111	**4.8**	40.0	**0.8**	7.2
Puffin (on sea)	**87.0**	267	**10.7**	73.5	**1.9**	12.7
Puffin (fly)	**8.5**	39	**1.0**	5.7	**0.2**	1.0
Black guillemot (all)	**4.6**	33	**0.5**	5.7	**0.1**	1.0

Table 4. Baseline survey autumn/winter (October to March) population estimates. Based on five surveys in 2009/2010 and five surveys in 2010/2011. (Table updated following further statistical analyses, see NRP report: Islay Tidal Energy Project Bird Survey Population Estimates, March 2013).

Species	**Study Area** (106.7 km^2) (DISTANCE analysis)		**Dev. Area+1km** (13.1km^2) (apportionment by area)		**Dev. Area** (2.3 km^2) (apportionment by area)	
	Mean	Max	**Mean**	Max	**Mean**	Max
Fulmar	**27.3**	111	3.4	13.7	0.6	2.4
Gannet	**14.4**	46	1.8	8.5	0.3	1.5
Shag	**35.0**	81	2.9	12.0	0.5	2.1
Great b-b. gull	**8.8**	50	1.1	16.0	0.2	2.8
Herring gull	**13.5**	76	1.7	13.7	0.3	2.4
Kittiwake	**69.3**	570	8.5	70.2	1.5	12.2
Guillemot (on sea)	**1140**	3504	140.3	1415.9	24.3	245.7
Guillemot (fly)	**56.9**	139	7.0	28.6	1.2	5.0
Razorbill (on sea)	**261.7**	1163	32.2	519.0	5.6	90.1
Razorbill (fly)	**92.7**	326	11.4	43.9	2.0	7.6
Puffin (all)	**10.5**	98	1.3	12.1	0.2	2.1
Black guillemot (all)	**3.3**	20	0.4	2.4	0.1	0.4

Table 5a. Summary of screening results for fulmar. Details for other SPAs with low theoretical connectivity to the development area are presented in Appendix 1.

Species	SPA	Popltn. size (pairs =AOS)	Sensitivity to tidal arrays	Theoretical connectivity	Mean in DA	% in DA	>0.1% of SPA pop. in DA	Mean in DA+1km	% in DA+1	>0.1% of SPA pop. in DA+1km	Potential for LSE
Fulmar	Rathlin Island	2414	Very low	High	0.8	0.02%	No	4.8	0.10%	No	No
Fulmar	Mingulay & Berneray	10450	Very low	Moderate	1.2	0.01%	No	4.8	0.02%	No	No
Fulmar	The Shiant Isles	6820	Very low	Moderate	1.2	0.01%	No	4.8	0.04%	No	No
Fulmar	St Kilda	62800	Very low	Moderate	1.2	0.00%	No	4.8	0.00%	No	No
Fulmar	Flannan Isles	4730	Very low	Moderate	1.2	0.01%	No	4.8	0.05%	No	No
Fulmar	Handa Island	3500	Very low	Moderate	1.2	0.02%	No	4.8	0.07%	No	No
Fulmar	Cape Wrath	2300	Very low	Moderate	1.2	0.03%	No	4.8	0.10%	No	No
Fulmar	North Rona and Sula Sgeir	9000	Very low	Low/Moderate	1.2	0.01%	No	4.8	0.03%	No	No
Fulmar	North Caithness Cliffs	14700	Very low	Low/Moderate	1.2	0.00%	No	4.8	0.02%	No	No

Table 5b. Summary of screening results for storm petrel, Manx shearwater, gannet and shag. Details for other SPAs with low theoretical connectivity to the development area are presented in Appendix 1.

Species	SPA	Popltn. size (pairs=AOS)	Sensitivity to tidal arrays	Theoretical connectivity	Mean in DA	% in DA	>0.1% of SPA pop. in DA	Mean in DA+1km	% in DA+1	>0.1% of SPA pop. in DA+1km	Potential for LSE
Storm petrel	Treshnish Isles	5040	Very low	Low/Moderate	0.1	0.00%	No	0.5	0.00%	No	No
Manx shearwater	Copeland Islands	4800	Very low	High	2.2	0.02%	No	12.6	0.13%	No	No
	Rum	120000	Very low	High	2.2	0.00%	No	12.6	0.01%	No	No
	St Kilda	4803	Very low	Moderate	2.2	0.02%	No	12.6	0.13%	No (see text)	No
	Aberdaron Coast and Bardsey Island	16183	Very low	Moderate	4	0.01%	No	12.6	0.04%	No	No
Gannet	Ailsa Craig	35825	Very low	Moderate	1.6	0.00%	No	9.4	0.01%	No	No
	St Kilda	60400	Very low	Low/Moderate	1.6	0.00%	No	9.4	0.01%	No	No
Shag	All SPAs		High	None	0.3		No	1.7		No	No

Table 5c. Summary of screening results for gull species. Details for other SPAs with low theoretical connectivity to the development area are presented in Appendix 1.

Species	SPA	SPA population (pairs = AOS)	Sensitivity to tidal arrays	Theoretical connectivity	Mean in DA	% in DA	>0.1% of SPA pop. in DA	Mean in DA+1km	% in DA+1	>0.1% of SPA pop. in DA+1km	Potential for LSE
Kittiwake	Rathlin Island	9917	Very low	Moderate	0.8	0.00%	No	4.5	0.02%	No	No
	Colonsay	6485		Moderate	0.8	0.01%	No	4.5	0.03%	No	No
Herring gull	Rathlin Island	19	Very low	Low/Moderate	0	0.00%	No	0	0.00%	No	No
Lesser black-backed gull	Rathlin Island	139	Very low	High	0.05	0.02%	No	0.3	0.11%	No	No
	Ailsa Craig	1800	Very low	Low/Moderate	0.05	0.00%	No	0.3	0.01%	No	No
	Lough Neagh and Lough Beg	475	Very low	Low/Moderate	0.05	0.01%	No	0.3	0.03%	No	No
Great black-backed gull	All SPAs		Very low	None	0.01		No	0.1		No	No
Arctic Tern	All SPAs		Low	None	0.2		No	1.3		No	No

Table 5d. Summary of screening results for auk species. Details for other SPAs with low theoretical connectivity to the development area are presented in Appendix 1.

Species	SPA	SPA population	Sensitivity to tidal arrays	Theoretical connectivity	Mean in DA	% in DA	>0.1% of SPA pop. in DA	Mean in DA+1km	% in DA+1	>0.1% of SPA pop. in DA+1km	Potential for LSE
Common guillemot	Rathlin Island	95117 birds	High	Moderate	3.6	0.00%	No	20.8	0.02%	No	No
	Colonsay	26249 birds	High	Moderate	3.6	0.01%	No	20.8	0.08%	No	No
Razorbill	Rathlin Island	20860 birds	High	Low/Moderate	1.6	0.01%	No	9.2	0.04%	No	No
Puffin	Rathlin Island	1927 AOB (=pairs)	Moderate	Moderate	1.9	0.05%	No	10.7	0.28%	No (see text)	No

Table 6. The potential for impacts from other projects in the region to act in-combination with impacts from West Islay Tidal Energy Park on SPA populations of common guillemot, razorbill and puffin.

Project name (development type)	Potential to impacts on SPA common guillemot, razorbill and puffin populations.	Potential for in-combination effects with WITE project
Sound of Islay Tidal Demonstration Project (tide)	Razorbill, small potential for collision and displacement but birds there are most likely to be from Colonsay colony, where this species is not a qualifying feature of the SPA. Guillemot and puffin occur at very low density in Sound of Islay, so negligible potential to cause any impacts on SPA populations.	Negligible potential for all impacts for all three species.
Islay Offshore Wind Farm (wind)	Unlikely to be any mortality impact as these species typically fly too low to be at significant risk of collision with wind rotors. Likely to be a small scale displacement impacts potentially affecting auks from the same SPAs identified for WITEP	Negligible potential for collision impacts. Minor potential for displacement impacts to act cumulatively for all three species.
Argyll Array Offshore Wind Farm		
Argyll Tidal project (3MW)	These projects are very small scale and therefore it is very unlikely that they would pose a significant collision or displacement risk to these species.	Negligible potential for all impacts for all three species. Although there is no assessment information, these projects are small in scale and not close to breeding colonies so any impacts are likely to be of negligible magnitude.
Sanda Sound (35 kW tidal demonstration project)		
Fair Head proposal (tidal)	These projects have not yet reached the scoping phase and insufficient information exists to undertake a proper assessment of the potential for in-combination impacts. However, based on a superficial consideration of the proposed scales of these projects (100MW each) and their relatively close proximity to Rathlin Island SPA, it would appear likely that both these projects will conclude there is potential for LSE on the Rathlin Island SPA populations of common guillemot, razorbill and puffin, and possibly other SPA populations also.	
Torr Head proposal (tidal)		

Table 7a. The estimated proportion of guillemot SPA populations using the anticipated impact footprint (either DA scenarios: 1) all birds are from the SPA under consideration, 2) birds are from all colonies with the same or greate details in text.

Guillemot	Closest distance (km)	Theoretical connectivity	SPA population count (census count - birds)	SPA population size corrected (breeding adults)	% of SPA popltn. in DA if all from SPA	% of SPA popltn. in DA+1km if from SPA
Ailsa Craig	104	Low	9415	12616	0.029%	0.165%
Canna and Sanday	151	None*	5800	7772	0.046%	0.268%
Mingulay and Berneray	137	Low	30900	41406	0.009%	0.050%
North Colonsay and Western Cliffs	51	Moderate	26249	35174	0.010%	0.059%
Rathlin Island	43	Moderate	95117	127457	0.003%	0.016%
Rum	143	None*	4000	5360	0.067%	0.388%

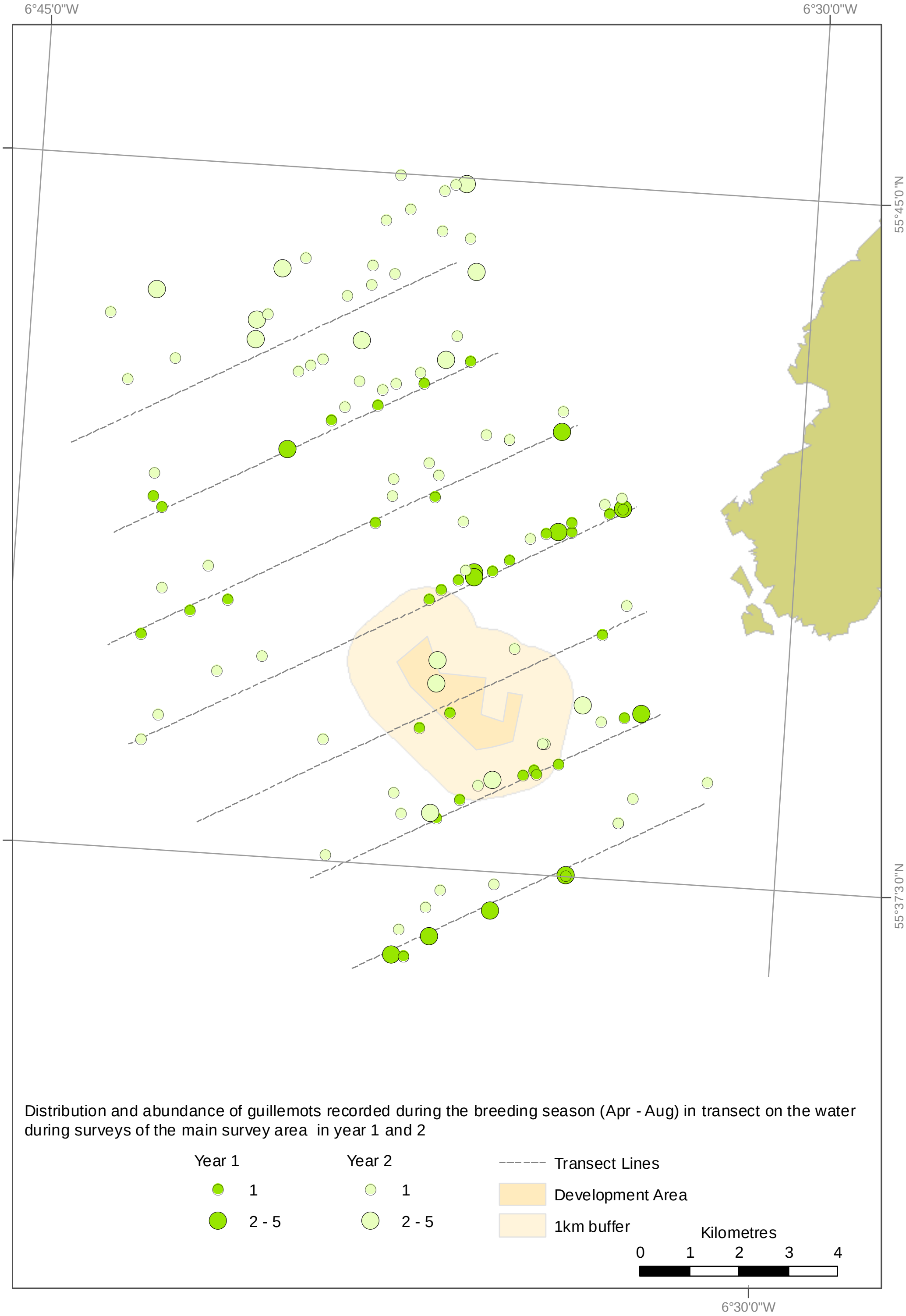
* SNH concluded that there was low theoretical connectivity to these SPAs. This appears to be an error as theses SPAs are further of guillemot.

Table 7b. The estimated proportion of Rathlin Island SPA razorbill population using the anticipated impact footprir two scenarios: 1) all birds are from Rathlin Island, 2) birds are from all colonies with the same or greater level of c						
Razorbill	**Closest distance (km)**	**Theoretical connectivity**	**SPA population count (census count - birds)**	**SPA population size corrected (breeding adults)**	**% of SPA popltn. in DA if all from SPA**	**% of SPA popltn. ir DA+1km if from SPA**
Rathlin Island	43	Moderate	20860	27952	0.006%	0.033%

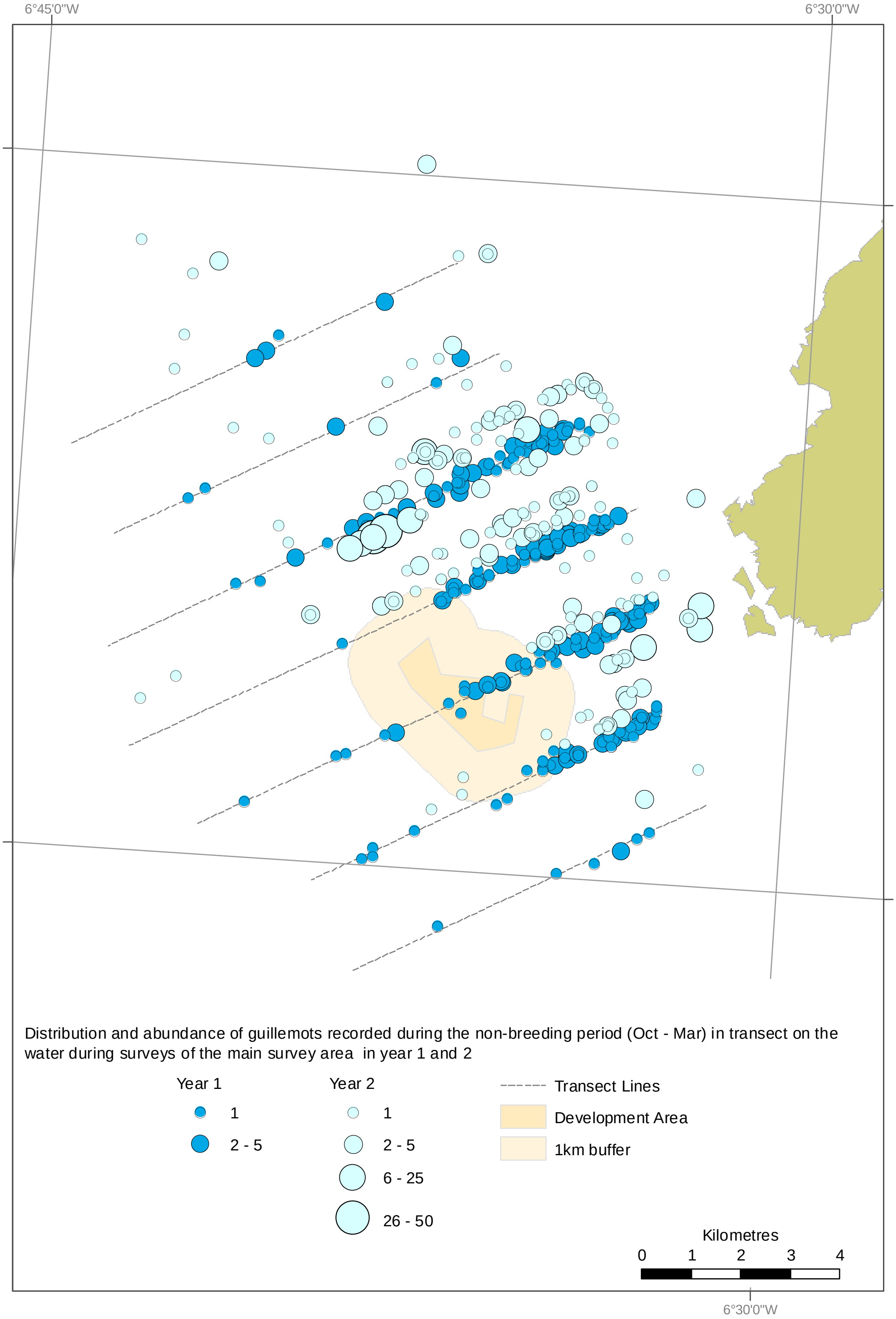
Table 7c. The estimated proportion of puffin SPA populations using the anticipated impact footprint (either DA or D all birds are from the SPA under consideration, 2) birds are from all colonies with the same or greater level of conn						
Puffin	**Closest distance (km)**	**Theoretical connectivity**	**SPA population count (census count -AOBs)**	**SPA population size corrected (breeding adults)**	**% of SPA popltn. in DA if all from SPA**	**% of SPA popltn. ir DA+1km if from SPA**
Rathlin Island	43	Moderate	1927	3854	0.049%	0.278%
Canna and Sanday	151	Low	1200	2400	0.079%	0.446%
Mingulay and Berneray	137	Low	4000	8000	0.024%	0.134%

Figures

1 Common guillemot breeding season (Apr – Aug)

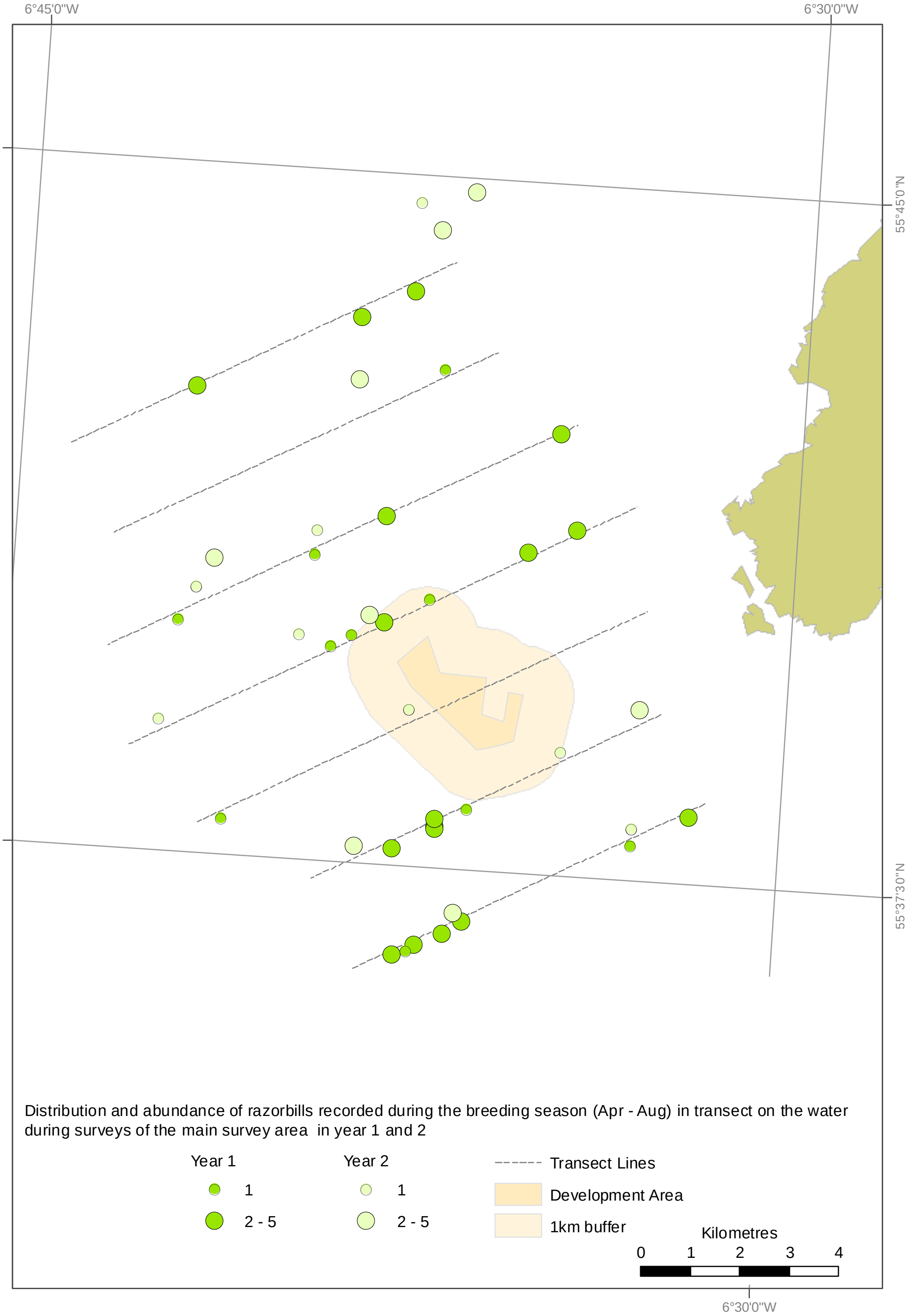


***2** Common guillemot non-breeding period (Oct – Mar)*

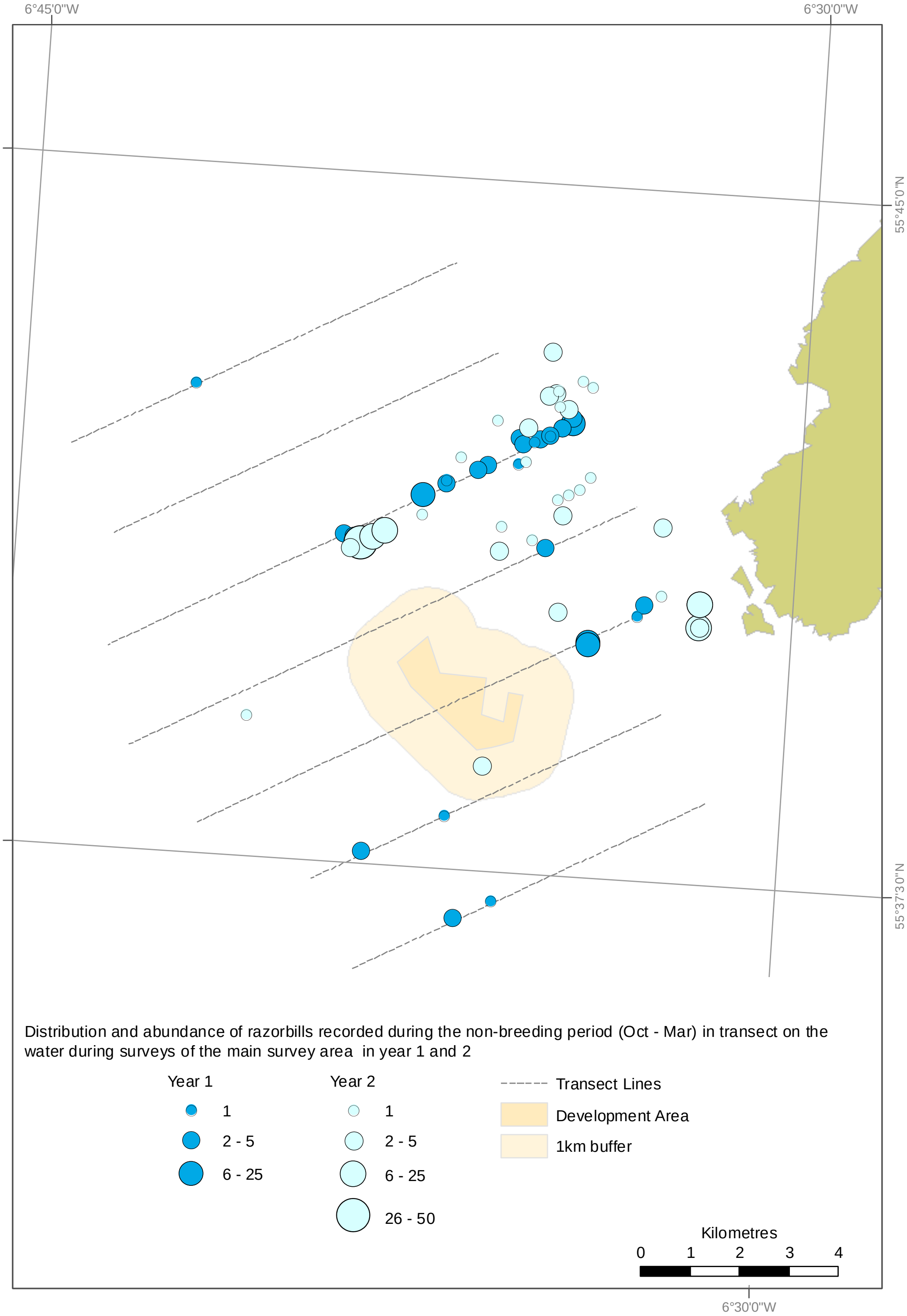


Distribution and abundance of guillemots recorded during the non-breeding period (Oct - Mar) in transect on the water during surveys of the main survey area in year 1 and 2

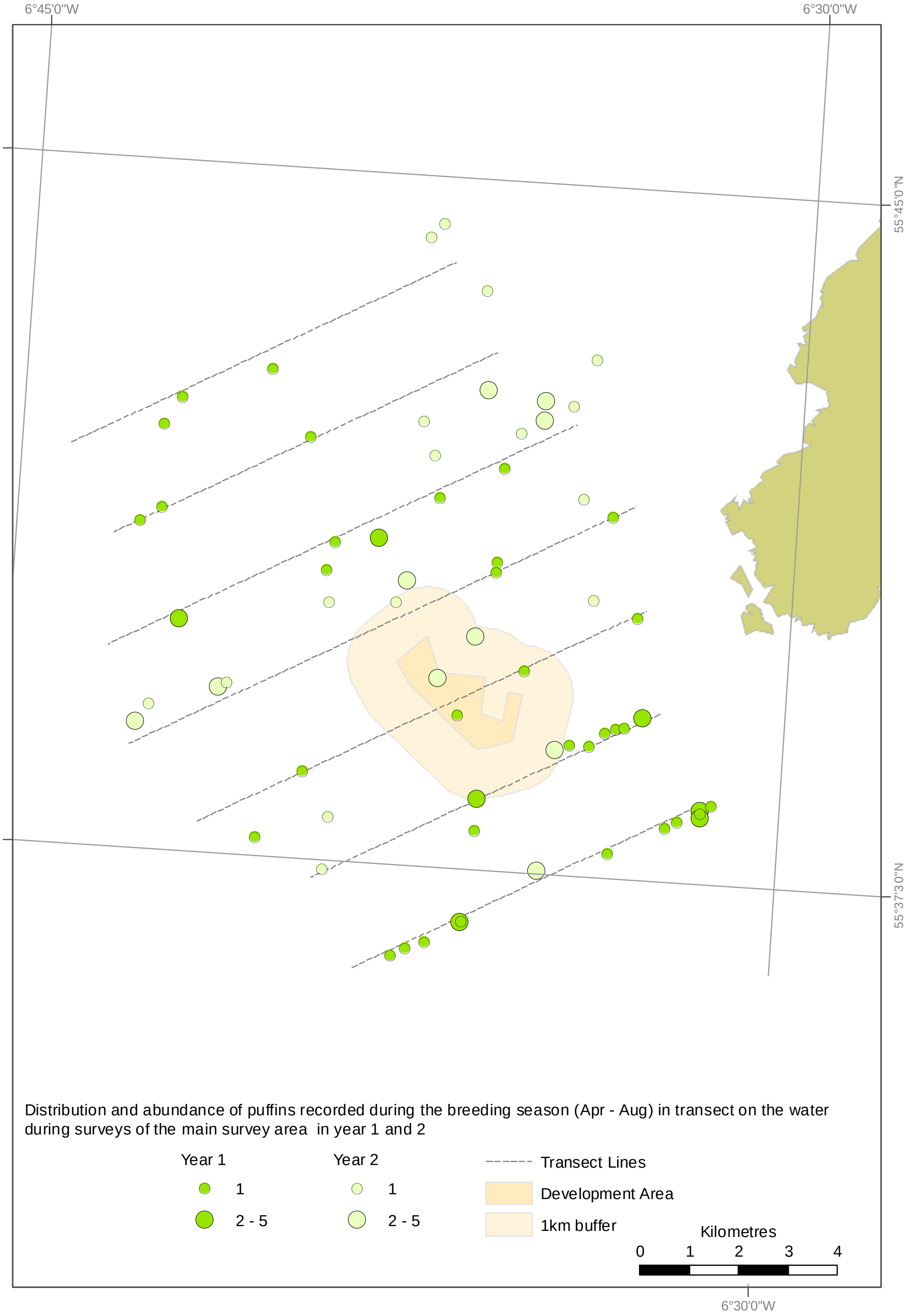
3 Razorbill breeding season (Apr – Aug)



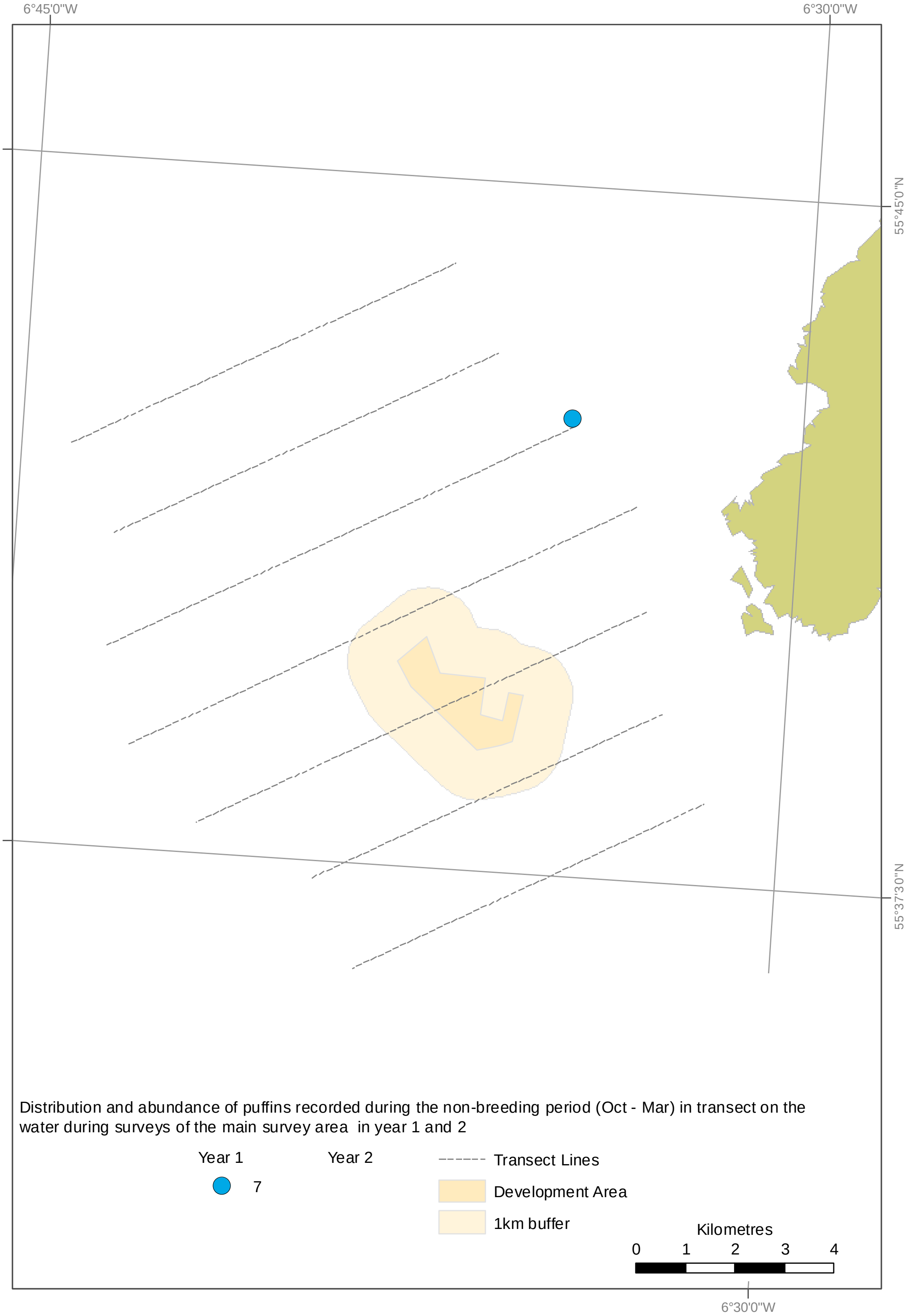
4 Razorbill non-breeding period (Oct – Mar)



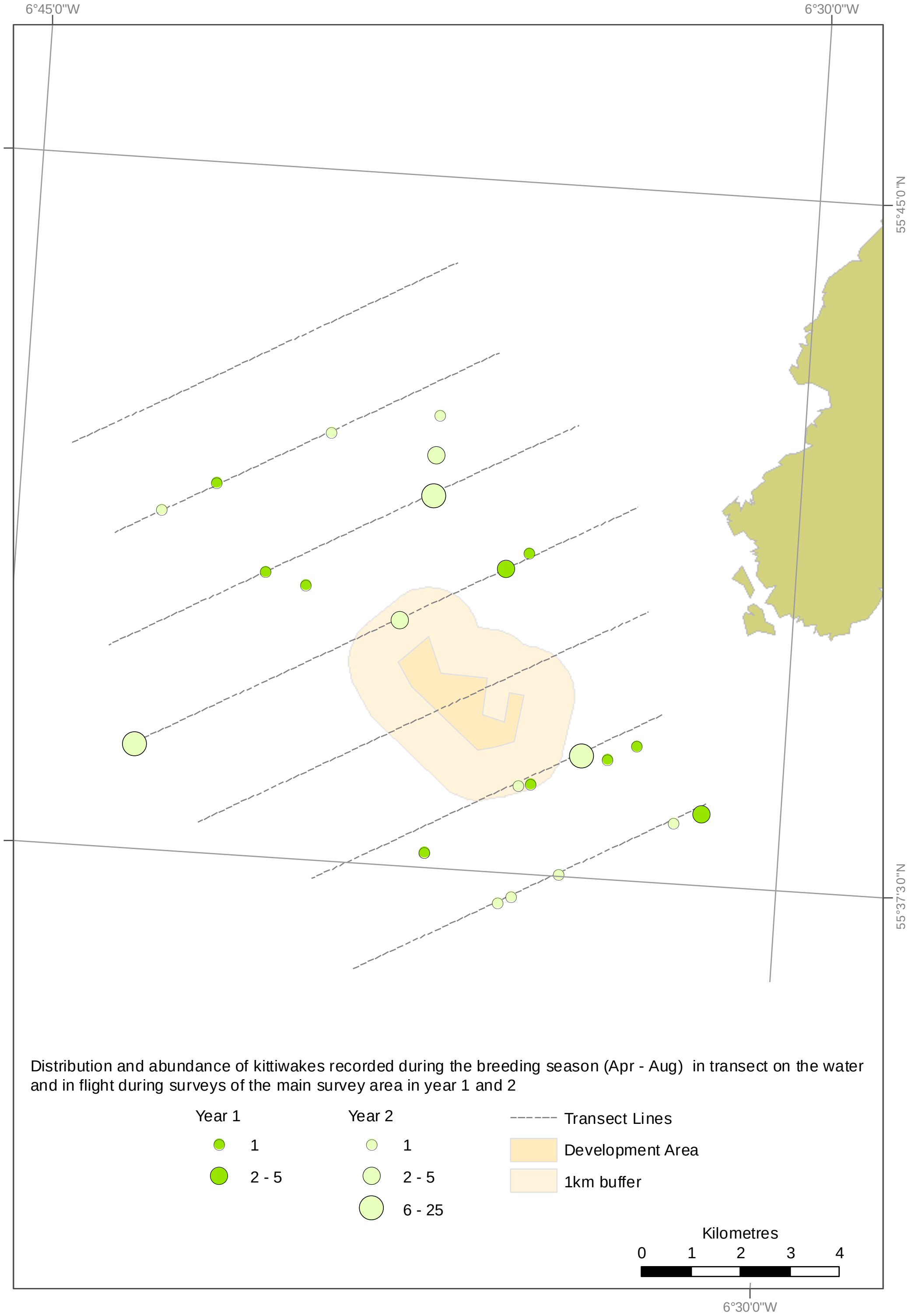
5 *Puffin breeding season (Apr – Aug)*



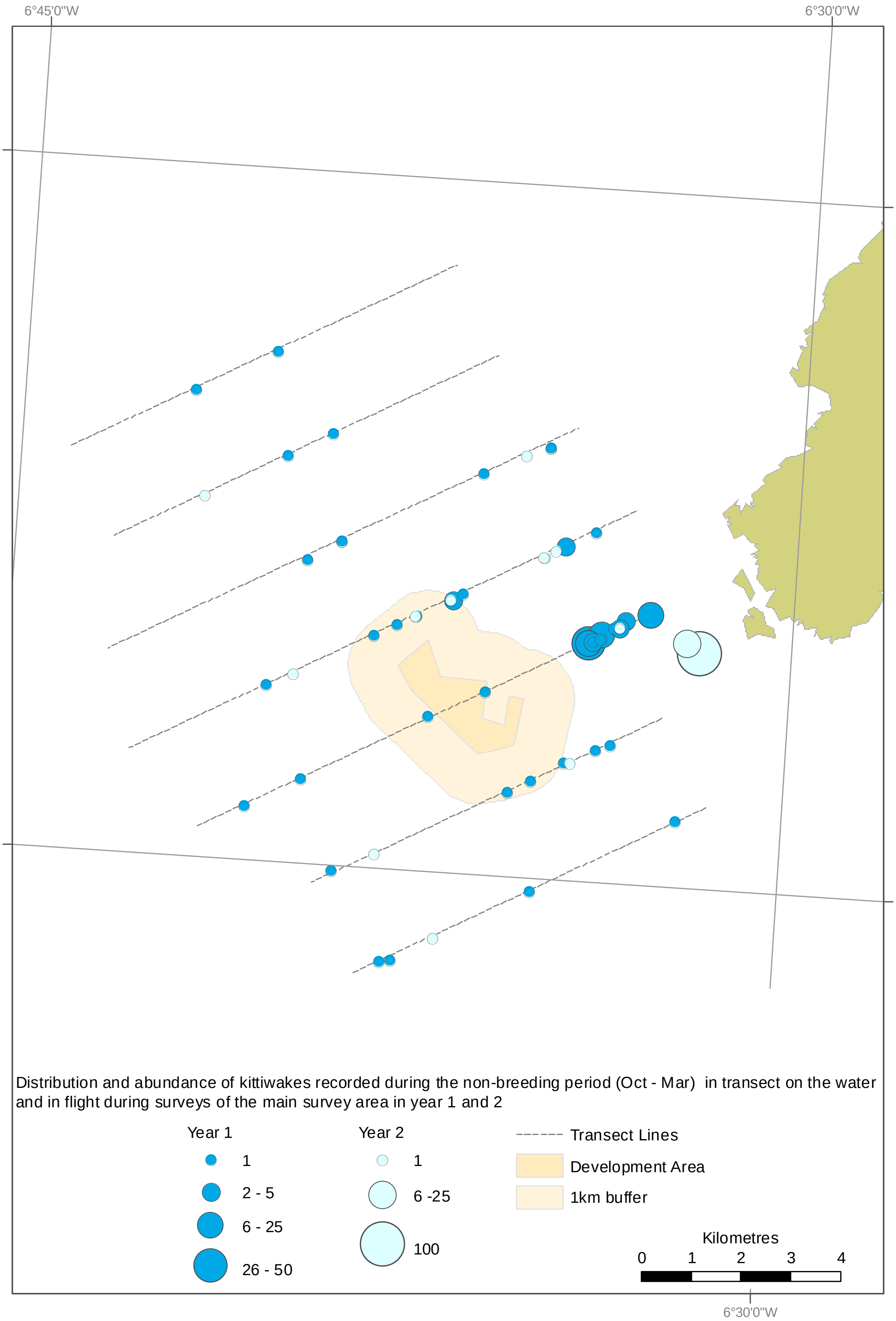
6 *Puffin non-breeding period (Oct – Mar)*



7 Kittiwake breeding season (Apr – Aug)



8 Kittiwake non-breeding period (Oct- Mar)



Distribution and abundance of kittiwakes recorded during the non-breeding period (Oct - Mar) in transect on the water and in flight during surveys of the main survey area in year 1 and 2

ENERGY PARK

volume 4 // appendix 11.1 //
DPE natural fish baseline report

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01	First Issue	25/10/12
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Table of Contents

1 INTRODUCTION

1.1 Project Background

1.1.1 DP Marine Energy Ltd (DPME) are in the process of developing a tidal energy project west of Islay, called West Islay Tidal Project'. The Islay project site for the 30MW is an area of approximately 2.2km^2 located west of the Rhinns of Islay. An associated cable route runs from the site, across Islay, and then onto Kintyre on the main land.

1.1.2 The proposed project will consist of up to twenty seven tidal stream turbines which will be installed in an area of up to 2.2 km^2 and operated as phase 1 of a substantially larger development. DPME has already secured an Agreement for Lease (AfL) from The Crown Estate for a 30MW Saltire Prize lease which is effective for 25 years.

1.1.3 DPME have contracted SAMS Research Services Ltd (SRSL) to undertake an assessment of fisheries aspects (natural and commercial) and to provide resultant baseline and environmental impact assessments.

1.2 Document Purpose

1.2.1 The purpose of this document is to provide a baseline for natural fish resources in and adjacent to the proposed tidal site and associated cable route. The baseline draws together information from the literature review and additional beam trawls undertaken along the cable route.

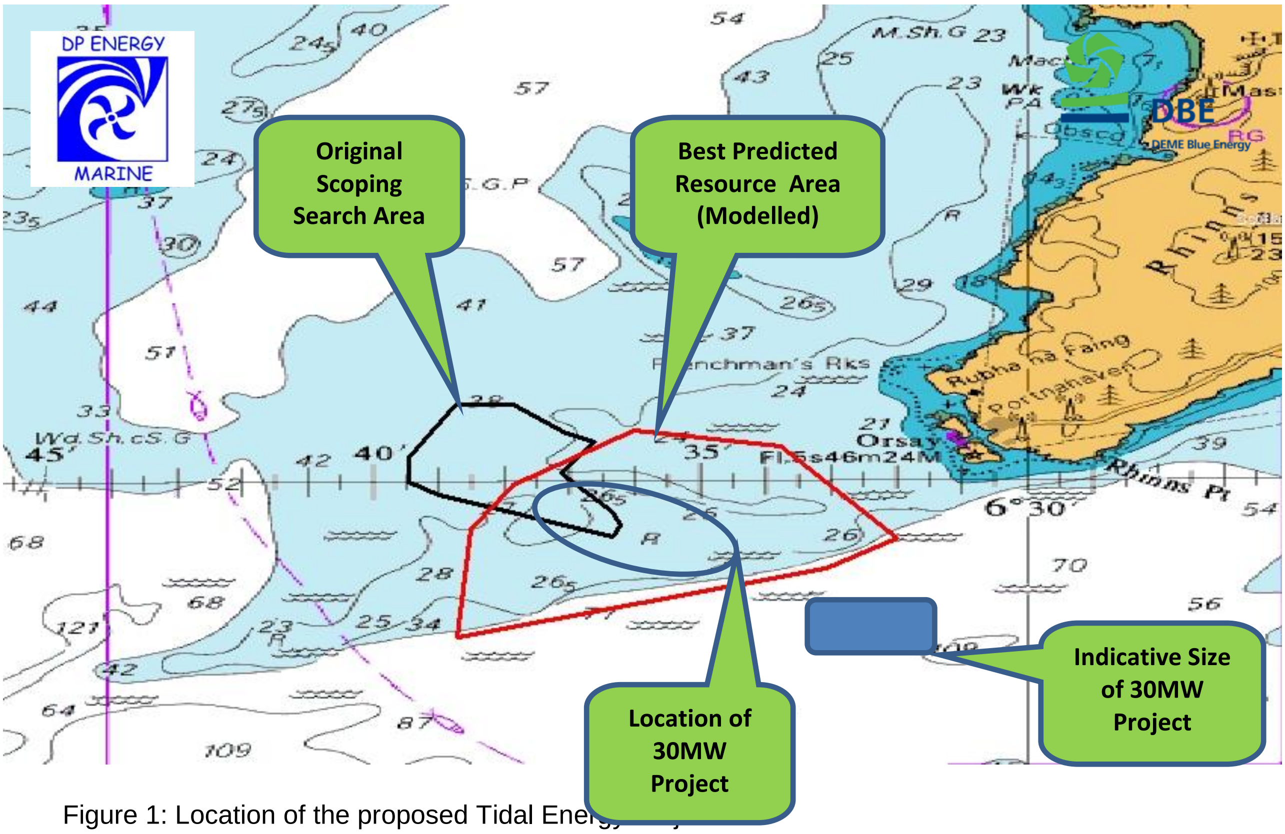

Figure 1: Location of the proposed Tidal Ener

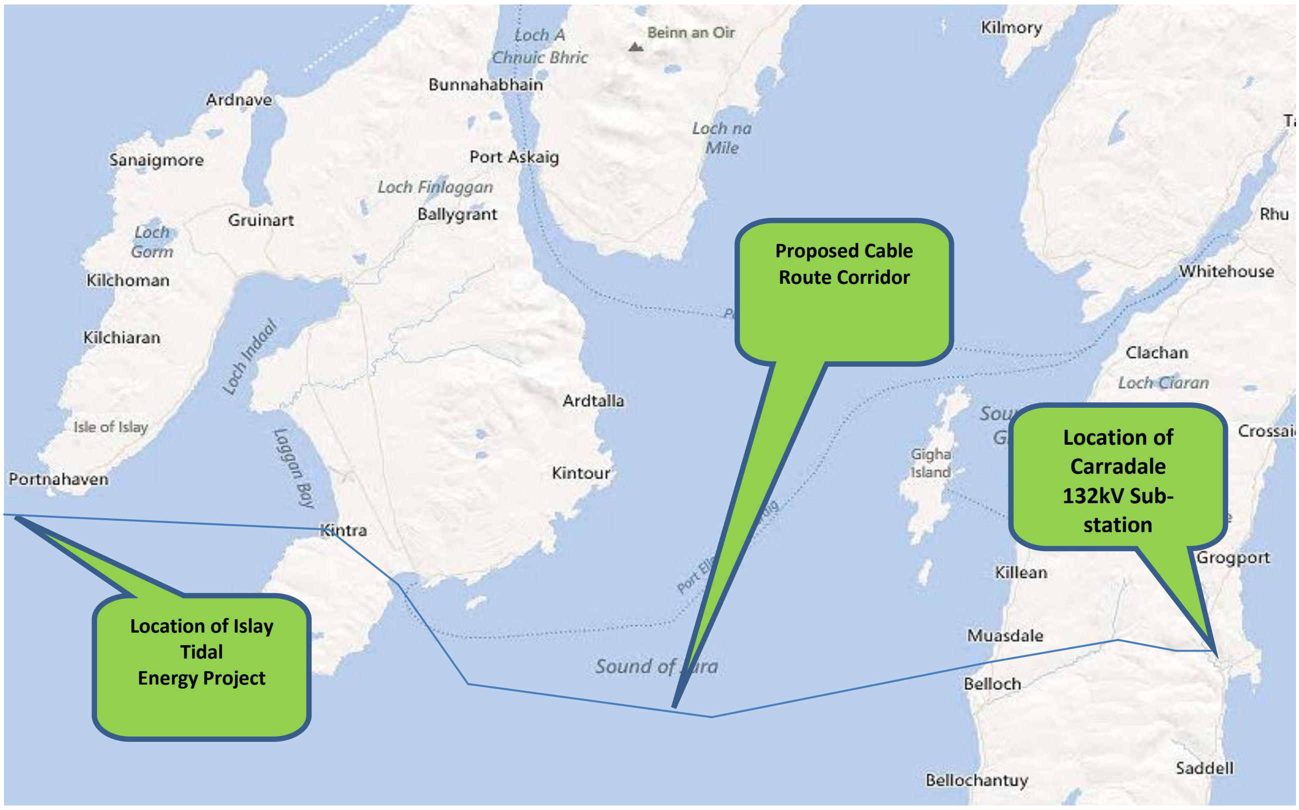

Figure 2: Location of the proposed cable route

2 CONTRIBUTING INFORMATION

2.1 Introduction

2.1.1 Information to create the baseline for the tidal site and cable route has been gathered from a number of sources:

- Literature review of available and published information for the site
- Beam trawls undertaken along the cable route
- Video surveys undertaken at both the tidal site and cable route

2.2 Literature Review

2.2.1 Literature relevant to the development site and cable route was sourced using internet searches (Google scholar, Marine Scotland website and Web of Science) and from reports and papers held by the principal author and the SAMS library. Because of the relative paucity of literature reports directly relevant to the site and cable route, additional data was downloaded from the Scottish west coast trawl surveys conducted by Marine Scotland and lodged with ICES. Data were processed to reveal the range of species caught in the vicinity of the proposed development and temporal patterns in dominant and species of conservation concern.

2.2.2 Full details and results of the analysis are provided in Annex A.

2.3 Beam trawl survey

2.3.1 DPME commissioned beam trawl sampling along the cable route corridor. Trawling was undertaken on the 14th and 15th of August 2012 during daylight hours using a 2 m beam trawl fitted with an iron tickler chain and 24 mm mesh net (Fig. 3). A total of 8 tows were undertaken lasting from 5 to 13 minutes in length, at a speed over ground of between 2 and 3 knots. Total swept areas thus ranged from 802m^2 to 1845m^2. One tow failed due to a ripped net resulting in a total of seven valid hauls.

2.3.2 Full details and results of the survey are provided in Annex B.

Figure 3: 2 m beam trawl used for the cable route survey

2.4 Video Surveys

2.4.1 DPME have commissioned a number of video surveys across the tidal site and cable route. Surveys were undertaken with a drop down video frame, with tows lasting from 2-5 minutes. The video survey was conducted during July and August 2012.

2.4.2 Video survey details are provided within the Islay Benthic Video Survey report (Envision Mapping, Sept 2012). Any fish which could be identified from the video were also noted.

3 TIDAL SITE

3.1 Introduction

3.1.1 The tidal site is where the energy generating devices will be located. The site occupies an area of approximately 20 km^2 and lies around 8 km off the south-western tip of Islay. The site is characterised by water depths of between 35 and 50 m and high tidal flow.

3.1.2 The Islay Benthic Video Survey Report (Envision Mapping Ltd, Sept 2012), describes the physical habitat (Fig. 4) as follows;

"The Tidal Array search area habitat was tide-swept bedrock, bedrock and boulders or boulders with very little finer sediment. A marked drop-off (from approximately 30 m to 90 m) lay along the south eastern boundary of the search area and the substratum was of rugged bedrock. The bedrock extended north of the drop-off but with an increasing proportion of boulders. The northern and north-western areas were extensive level areas of boulders with very little bedrock."

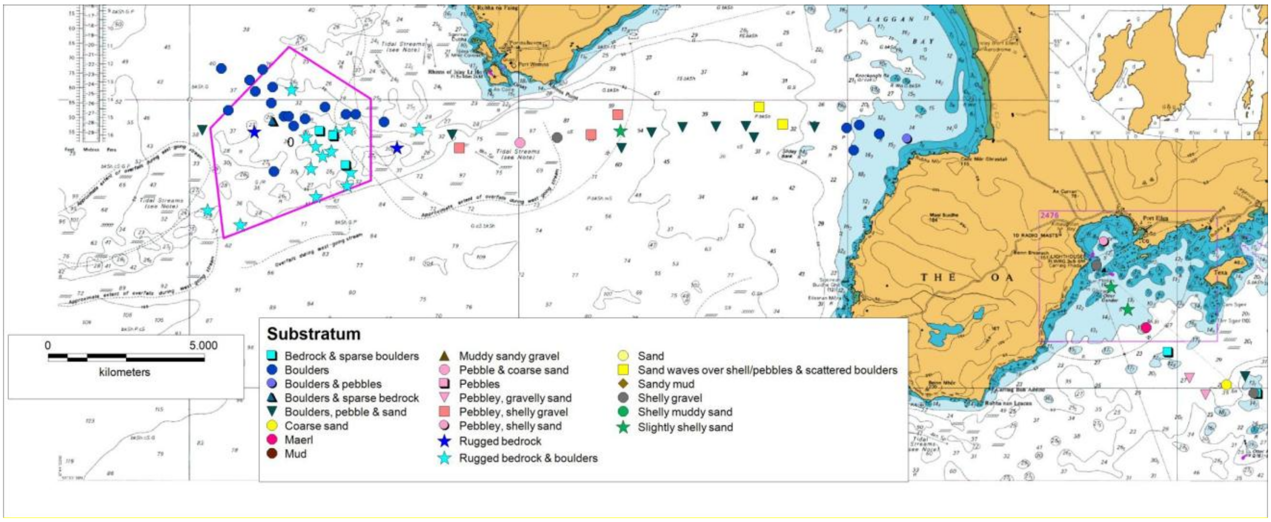

Figure 4: Classification of substratum at the tidal site and along cable route – tidal site to Laggan Bay (Envision Mapping Ltd, Sept 2012)

3.2 Importance of the Tidal Site for Fish Species

3.2.1 The top ten species caught in the Scottish groundfish surveys adjacent to the tidal site (in terms of numbers per hour) were whiting; grey gurnard; sprat; Norway pout; dab; poor cod; haddock; herring; plaice and common squid. All these species are rather common to the west of Scotland. Rays (spotted, blonde, cuckoo, roker and common) were caught in relatively low abundances but note that some species (cuckoo and spotted) were caught on more than one third of the hauls (Annex A, Figs 8 and 9). Spurdog were caught in relatively low abundance although average catch increased since 2010 and spurdog were present on more than one third of the hauls. Changes in average annual catch (numbers per hour) over time are plotted for the top ten species and for the skates, rays and spurdog in Annex A, Figs. 8 and 9.

3.2.2 There is considerable variability in average catches by year across the time-series (Annex A, Figs. 8 and 9) which is to be expected when data from a limited number of hauls per year (1-

3) are averaged. However, some trends are apparent e.g. catches of poor cod appear to have increased in recent years. Other species have fluctuated without any obvious pattern. Several species have had single year peaks which dominate the overall average catches e.g. haddock and common squid. Whiting were particularly abundant between 1998 and 2005 but since then have been caught at much lower levels.

3.2.3 Inter-annual changes in abundance can also be the result of changes in the spatial coverage of the survey over time. For example, the stations adjacent to the cable route have only been sampled in a few years but if particular species are very abundant on those stations, this will affect the result in those years.

3.2.4 The Islay Benthic Video Survey Report (Envision Mapping Ltd, Sept 2012) recorded only a few fish at the tidal site. These included butterfish (*Pholis gunnellus*) and Ballan wrasse (*Labrus bergylta*). Again these species are rather common around rocky habitats at shallow to moderate depth.

3.3 Importance of the Tidal Site for Shellfish Species

3.3.1 Analysis of video footage taken at the tidal site shows the presence of hermit crabs and scallops (Islay Benthic Video Survey Report, Envision Mapping Ltd, Sept 2012).

3.3.2 Discussions with local fishermen during fisheries liaison meetings noted that crayfish (European Spiny Lobsters) are present in and around the tidal site (DP Energy, Fisheries Liaison, Kintyre Information Day Notes, 05/10/12).

3.4 Distribution of Substrates Suitable for Sandeel

3.4.1 According to Holland et al. (2005) sandeel prefer sediments containing a high proportion of medium to coarse (0.25 – 2 mm) sand. Furthermore, increased levels of silt (> 4% where silt was defined as particle sizes 0.1 to 63 µm) were associated with reduced abundance of sandeels since silt interferes with sandeel respiration when in the sediment (Holland et al., 2005). Although Corbin's sandeel were recorded on around 3% of hauls conducted adjacent to the site by the West Scotland Groundfish Surveys, there does not seem to be any habitat suitable for sand-eel within the tidal site (Figure 4, section 3.1.2).

3.5 Migration Routes

3.5.1 Malcolm et al. (2010) summarised the current state of knowledge on migration pathways for salmon, sea trout and eel as follows: "Broad scale patterns of migration are identified for adult Atlantic salmon, although the resolution of available data is unlikely to be sufficient to inform site specific risk assessment. Less extensive information is available on juvenile migratory routes and no information is available on juvenile migration from important east coast rivers. The limited information available on sea trout migration suggests predominantly inshore and local use of the marine environment, although wider ranging migrations have been observed from some rivers. No specific migratory routes can be discerned for either juvenile or adult sea trout. European eels in Scotland are part of a single European population for which there is considerable uncertainty regarding migratory routes. The limited evidence which is available suggests that eels from a number of European countries may migrate through Scottish waters. For all the species considered, there is only very limited information on behaviour and swimming depths. Most of this information has been generated outwith Scotland and it is uncertain whether it can be reliably transferred to the Scottish context given differences in the life stages observed and local geography."

3.5.2 According to the Argyll Fisheries Trust (AFT) (http://www.argyllfisheriestrust.co.uk), Islay has historically supported fisheries for salmon and sea trout. In line with the decline in salmonid species elsewhere these fisheries are now not as productive as they once were. The AFT has undertaken a limited sampling programme on two river catchments on the Island. Little is currently known of the status of fish populations in most of the other rivers on the island.

3.5.3 The Isle of Jura supports limited fisheries for salmon and sea trout and in line with the decline in salmonid species elsewhere, these fisheries are not now as productive as they once were. AFT has undertaken a limited sampling programme on one river catchment. Little is currently known of the status of fish populations in most of the other rivers on the island.

3.5.4 Internet searches revealed no information on the migration routes of salmon or trout from these rivers.

3.6 Spawning Areas

3.6.1 The closest spawning ground for whiting to the development site is in the North Channel of the Irish Sea. Given prevailing south to north current flow, whiting eggs and larvae might be transported to the west of Islay. A spawning ground for plaice is noted to the west of Islay. Nephrops and sprat are also reported to spawn to the west of Islay (Annex A, Table 6).

3.6.2 For species known to occur in the waters adjacent to the proposed development site (based on analysis of IBTS data in this report or other published sources), Ellis et al. (2010) suggests that spurdog, common skate, spotted ray, herring, cod, whiting, blue whiting, ling, hake, anglerfish, sandeels and mackerel may use the area as nurseries. The abundance of juveniles of these species to the west of Islay was however classified as low intensity, except for spurdog, whiting and blue whiting, where it was classified as high intensity.

3.6.3 For species known to occur in the waters adjacent to the proposed development site (based on analysis of IBTS data in this report or other published sources), Ellis et al. (2010) also identified specific data gaps (i.e. high uncertainty in the data) for spawning sites for common skate and basking shark and for spawning and nursery grounds for spotted ray.

3.7 Elasmobranchs

3.7.1 Basking sharks are known to occur in the area and are of conservation interest. Most observations have come from surface records during summer although satellite and data storage tags have also been deployed on a limited number of animals. Satellite tracking has shown that basking sharks can undergo extensive migrations, probably following seasonal changes in thermal fronts and plankton production (Priede, 1984; Sims et al., 2003; Southall et al. 2006). Visual sighting records indicate fewer sharks were recorded to the west of Islay compared with areas slightly further north, particularly around Tiree, Coll and Mull. This probably reflects the spatial locations of plankton enhancing oceanographic fronts in the region, but may also be partly a result of differential observation effort (Southall et al. 2005; Sharrock et al. 2006; Solandt and Ricks, 2009). Since around 2000 there has also been a strong increase in the number of reported sightings in the area although this appears to have declined somewhat since 2006. Again this may reflect genuine changes in shark abundance or distribution, but could also be related to public greater awareness and an increase in wildlife boat trips in the area.

3.7.2 2012 spot data can be viewed at the weblink below, noting that there were no basking sharks sighted within a 50km radius of the tidal site (see Figure 5 below). http://maps.google.co.uk/maps/ms?hl=en&vpsrc=1&ctz=0&ie=UTF8&msa=0&msid=215020002835086271927.00048e2bfbc054548df7b&t=h&ll=56.378488,-27.134435&spn=25.288327,84.49847&source=embed

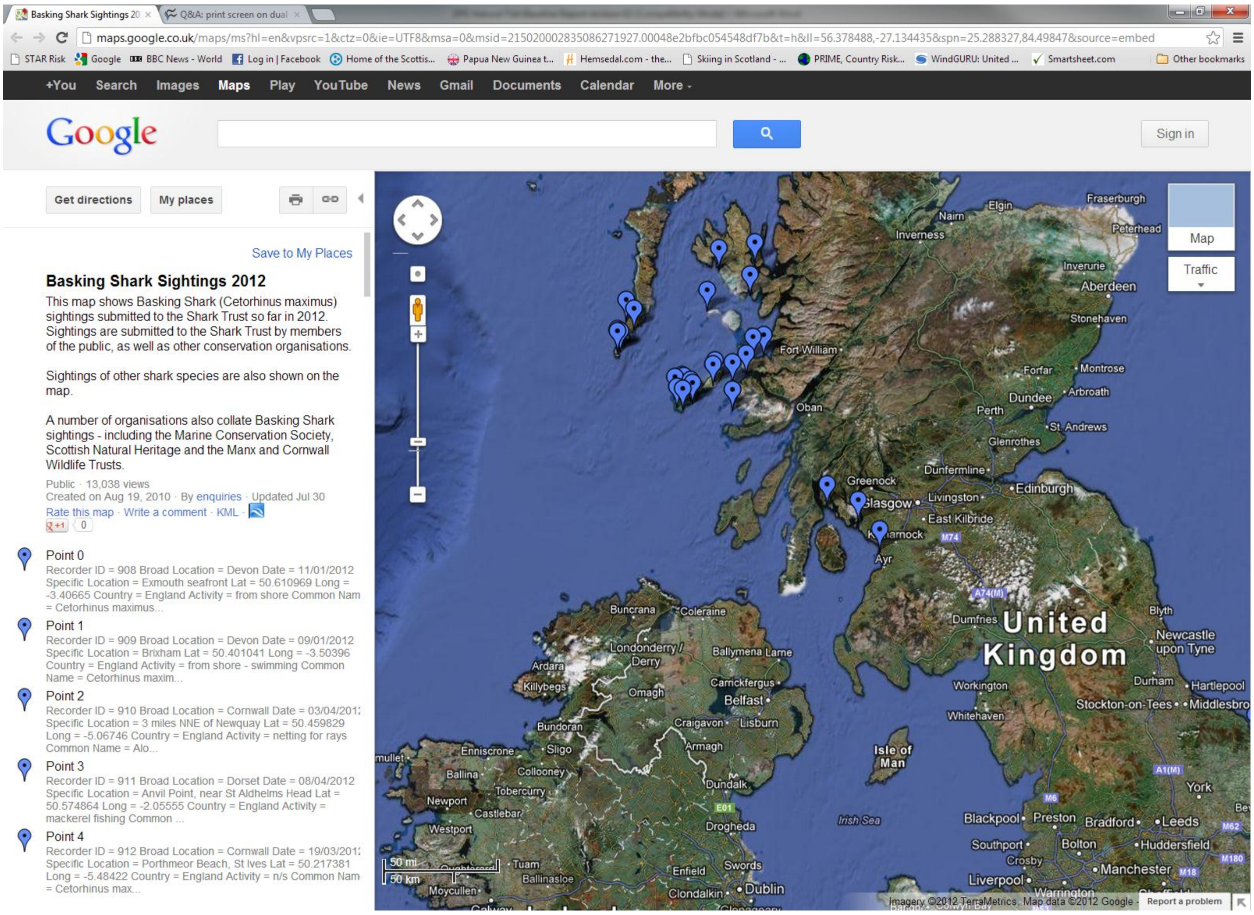

Figure 5: 2012 spot data for basking shark sightings from the Shark trust.

3.7.3 SNH are currently tracking a number of basking sharks and a real-time display of the data can be viewed at http://www.wildlifetracking.org/?project_id=753. Although some tracks have passed close, or through the proposed development site, none have moved towards the cable route. However, the number of tagged animals is a relatively small and the tags have only been deployed for a few weeks at present.

3.7.4 DP energy commissioned mammal observer trips, in and adjacent to the development area. The resulting report (Assessment of Marine Mammals and Basking Sharks in and around a proposed tidal-energy site, update report following two years effort, SRSL, August 2012) notes that "We might have expected to have seen minke whales and basking sharks in the survey area in summer but did not". Basking sharks were seen further to the north near Colonsay during Summer months, when the observation area was extended. However, none were observed on or near the Tidal Site.

3.7.5 Of other elasmobranchs of conservation concern, the Scottish groundfish survey hauls adjacent to the tidal site only caught common skate in two years but catches of other rays have fluctuated over time (Annex A, Figs. 8 and 9). Note that the Grande Ouverture Verticale

(GOV) trawl net gear is not designed to target larger benthic species, for example rays, and so these could be more common in the area than these data suggest.

3.8 Priority Marine Features (PMFs) and Other Sensitive Species

3.8.1 Ellis et al. (2010) listed mobile species of conservation concern and that report suggests that spurdog, basking shark, tope, common skate, thornback ray, spotted ray, common eel, herring, sea trout, cod, whiting, blue whiting, ling, hake, anglerfish, horse mackerel, sandeel, mackerel, blue-fin tuna, plaice, sole (and leatherback turtle) have been found in the waters adjacent to the proposed development. Apart from basking shark, tope, common eel and blue-fin tuna (all of which are not normally caught using GOV gear), this list is in agreement with analysis of West Scotland Groundfish survey hauls adjacent to the proposed development (Tables 3 and 4). Angel shark may have historically occurred in the waters adjacent to the proposed development but has not been recorded there recently and is generally regarded as being locally extinct (Ellis et al., 2010).

3.8.2 Table 1 below summarises the occurrence according to the SNH list of PMFs for Scottish Territorial Waters.

Table 1 - PMFs found relative to the tidal site during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	Taxon Group	Species	Found During Investigations/Surveys
European spiny lobster	Lobsters and sand hoppers	*Palinurus elephas*	Habitat subtidal rocky, exposed coasts in circalittoral zone, 5-70 m depth – noted as present via fisheries liaison discussions around the area of the tidal site.
Eel (marine part of life cycle)	Bony fish (catadromous)	*Anguilla anguilla*	See 3.5.1 – not recorded during surveys
Atlantic salmon (marine part of life cycle)	Bony fish (anadromous)	*Salmo salar*	See 3.5.1 – not recorded during surveys
European river lamprey (marine part of life cycle)	Bony fish (anadromous)	*Lampetra fluviatilis*	Islay is at edge of northern range in UK - not recorded during surveys
Sea lamprey (marine part of life cycle)	Bony fish (anadromous)	*Petromyzon marinus*	Occurs offshore throughout the UK and Ireland, migrates into freshwater to spawn – not recorded during surveys
Sea Trout (marine part of life cycle)	Bony fish (anadromous)	*Salmo trutta*	Not recorded during surveys
Sparling (marine part of life cycle)	Bony fish (anadromous)	*Osmerus eperlanus*	Does not occur in west of Scotland

Table 1 - PMFs found relative to the tidal site during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	Taxon Group	Species	Found During Investigations/Surveys
Anglerfish (juveniles)	Bony fish	*Lophius piscatorius*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route
Atlantic herring (juveniles and spawning adults)	Bony fish	*Clupea harengus*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – spawning status of fish not available in database – see Annex A, Table 6 for information on herring spawning and nursery grounds
Atlantic mackerel	Bony fish	*Scomber scombrus*	Not recorded during surveys - see Annex A, Table 6 for information on mackerel spawning and nursery grounds
Cod	Bony fish	*Gadus morhua*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – see Annex A, Table 6 for information on cod spawning and nursery grounds - area to west of Islay is indicated as a nursery area for young cod
Ling	Bony fish	*Molva molva*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route
Norway Pout	Bony fish	*Trisopterus esmarkii*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route
Saithe (juveniles)	Bony fish	*Pollachius virens*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – see Annex A, Table 6 for information on saithe spawning and nursery grounds - Area to west of Islay is indicated as a nursery area for young saithe
Sandeels	Bony fish	*Ammodytes marinus & Ammodytes tobianus*	See section 3.4
Sand Goby	Bony fish	*Pomatoschistus minutus*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route

Table 1 - PMFs found relative to the tidal site during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	**Taxon Group**	**Species**	**Found During Investigations/Surveys**
Whiting (juveniles)	Bony fish	*Merlangius merlangus*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – see Annex A, Table 6 for information on whiting spawning and nursery grounds - Closest spawning ground shown is in the North Channel of the Irish Sea; given prevailing south to north current flow, whiting eggs and larvae might be transported to the west of Islay
Basking Shark	Sharks, skates and rays	*Cetorhinus maximus*	Sitings reported adjacent to tidal site – See section 3.7
Common Skate	Sharks, skates and rays	*Formerly Dipturus batis now split provisionally into D. cf. flossada and D. cf. intermedia*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – See section 3.7.4
Spiny Dogfish (spurdog)	Sharks, skates and rays	*Squalus acanthias*	Caught during Scottish groundfish surveys adjacent to tidal site and cable route – See section 3.2.1

4 CABLE ROUTE

4.1 Introduction

4.1.1 The Islay Benthic Video Survey Report (Envision Mapping Ltd, Sept 2012), reports the physical habitat (see section 3.1.2, Fig. 4 for tidal site to Laggan Bay and Fig. 6 for Port Ellen to Glenacardoch Point) along the cable route as follows;

"The cable route from the array to Laggan Bay crossed the drop-off into deep water and the substrate here was of pebbles and shelly gravel. The sea floor gradually rose eastwards along the proposed cable route and was largely of boulders, pebbles and sand. Some predominantly sandy sites were located along the route, but with scattered boulders. The eastern end of the cable route rose into Laggan Bay and, at a depth of about 23m (2.5km from the shoreline), the substrate became predominantly of boulders.

The cable route from Port Ellen to Kintyre crossed a range of habitat types: the first 3 km was shallow and of shelly, gravelly sand before crossing an area of maerl. An outcrop of bedrock and boulders was located at 4 km from the shore after which the sediment returned to gravel and sand. A further outcrop of bedrock and boulders occurred at 7km before returning to pebbly sand. Mud became increasingly obvious with increasing depth (muddy gravel, muddy sand and mud) into the centre of the Sound of Jura. The sequence was reversed as the cable route rose from 100m to 20m. Boulders and pebbles continued from this point towards the shore. Maerl was observed at 18m about 1.5km from the shore".

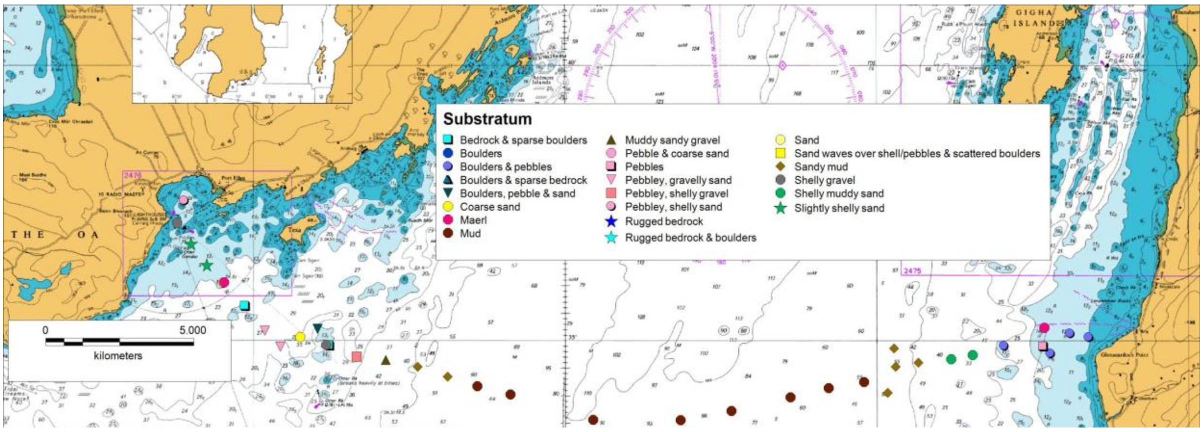

Figure 6 Classification of substratum at the tidal site and along cable route Port Ellen to Glenacardoch Point (Envision Mapping Ltd, Sept 2012)

4.2 Importance of the cable route for Fish Species

4.2.1 In terms of total numbers caught in Scottish groundfish surveys adjacent to the cable route, the top 10 species were Norway pout; whiting; herring; poor cod; sprat; blue whiting; dogfish; spurdog; haddock and sea-snail. There are slight differences in this ranking from the all hauls dataset (3.2.1) with presence of more spurdog and blue whiting perhaps being indicative of deeper water. Common skate were present on a greater percentage of the hauls and at higher numbers compared with the complete dataset. Conclusions regarding fish populations along the cable route are extremely preliminary as they are based on such a very low number of hauls.

4.2.2 Beam trawls conducted along the cable route caught low numbers of dab (*Limanda limanda*), long-rough dab (*Hippoglossoides platessoides*), plaice (*Pleuronectes platessa*), solenette (*Buglossidium luteum*), sole (*Solea solea*), lemon sole (*Microstomus kitt*), whiting (*Merlangius merlangus*), poor cod (*Trisopterus minutus*), red gurnard (*Aspitriglia cuculus*), dragonet (*Callionymus lyra*), three-bearded rockling (*Gaidropsarus vulgaris*) and cuckoo ray (*Leucoraja naevus*). With the exception of solenette and dragonet, all these species had also been recorded in the West Scotland Scottish Groundfish Trawls conducted adjacent to the cable route (Annex A).

4.3 Importance of the cable route for Shellfish Species

4.3.1 A number of crustacea were recorded in the beam trawl survey including *Nephrops norvegicus*, *Cancer pagurus*, *Pagurus bernhardus*, *Pagurus prideaux*, *Macropodia tenuirostris, Inachus phalangium*, *Hyas araneus*, *Carcinus maenas, Ebalia tumefacta*, *Crangon crangon*, *Liocarcinus depurator*, *Pandalus montagui*, and *Munida rugosa*. All of these species are quite common on the Scottish west coast.

4.3.2 The Islay Benthic Video Survey Report (Envision Mapping Ltd, Sept 2012) mentions squat lobsters (*Munida rugosa*) and Queenies (*Aequipecten opercularis*) on pebbly sand habitats between the array and Laggan Bay and *Nephrops norvegicus* being seen on muddy areas.

4.3.3 Discussions with local fishermen during fisheries liaison meetings noted that crayfish (European Spiny Lobsters) are present in and around the tidal site (DP Energy, Fisheries Liaison, Kintyre Information Day Notes, 05/10/12).

4.4 Distribution of Substrates Suitable for Sandeel

4.4.1 According to Holland et al. (2005) sandeel prefer sediments containing a high proportion of medium to course (0.25 – 2 mm) sand at depths of 30-70 m. Furthermore increased levels of silt (> 4% where silt was defined as particle sizes 0.1 to 63 µm) were associated with reduced abundance of sandeels since silt interferes with sandeel respiration when in the sediment (Holland et al., 2005).

4.4.2 Figure 4 indicates that a small area of sand-waves over shell/pebbles with scattered boulders lies around 30-35 m below chart datum just west of Laggan Bay and sand to the south-east of Port Ellen (Fig. 6). The rest of the cable route is mainly boulders, pebble and sand which may be less suitable for sandeel and mud which will be unsuitable. Small sections of the habitat along the cable route may therefore provide suitable habitat for sandeel.

4.5 Fish Migration Routes

4.5.1 See 3.5.1 for summary of current state of knowledge on migration routes for salmon, sea trout and eel. The same conclusions will apply to the cable route.

4.6 Spawning Areas

4.6.1 Specific data could not be found on the use of the cable route for spawning by fish or shellfish. However, given the abundance of *Nephrops* recorded by the beam-trawl survey in the mud habitats between Port Ellen and Kintyre it is likely that spawning of this species occurs here.

4.7 Elasmobranchs

4.7.1 See section 3.7.1 and 3.7.2 for an overview of basking shark information. Basking shark have been occasionally reported from the Sound of Jura but not as frequently as in the Firth of Clyde or further north around Mull, Coll and Tiree. 2012 spot data can be viewed at http://maps.google.co.uk/maps/ms?hl=en&vpsrc=1&ctz=0&ie=UTF8&msa=0&msid=215020002835086271927.00048e2bfbc054548df7b&t=h&ll=56.378488,-27.134435&spn=25.288327,84.49847&source=embed

4.7.2 There are numerous records for common skate being caught in the Sound of Jura e.g. http://www.tagsharks.com/a-weekend-skate-fishing. The Sound of Jura (to the north of the cable route) is proposed to be surveyed more intensively as a potential Marine Protected Area for common skate (Marine Scotland Position Paper on Marine Protected Areas and Common skate). Marine Scotland are reported to have acoustically tagged a number of skate in the Sound of Jura to study their movements in detail http://www.tagsharks.com/common-skate-acoustic-tagging-project-in-the-sound-of-jura. Results are not publically available yet (pers. comm. Francis Neat, Marine Scotland Science).

4.8 Priority Marine Features (PMFs) and Other Sensitive Species

4.8.1 Information on common skate is discussed in 4.7.2.

4.8.2 No PMF species or species of particular conservation interest (Annex A, Table 5) were caught by the beam-trawls conducted along the cable route.

4.8.3 Table 2 notes the PMFs found during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Table 2 - PMFs found along the cable route during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	Taxon Group	Species	Found During Investigations/Surveys
European spiny lobster	Lobsters and sand hoppers	*Palinurus elephas*	Habitat subtidal rocky, exposed coasts in circalittoral zone, 5-70 m depth – noted as present via fisheries liaison discussions around the area of the cable route.
Eel (marine part of life cycle)	Bony fish (catadromous)	*Anguilla anguilla*	See 3.5.1 – not recorded during surveys
Atlantic salmon (marine part of life cycle)	Bony fish (anadromous)	*Salmo salar*	See 3.5.1 – not recorded during surveys
European river lamprey (marine part of life cycle)	Bony fish (anadromous)	*Lampetra fluviatilis*	Islay is at edge of northern range in UK - not recorded during surveys

Table 2 - PMFs found along the cable route during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	Taxon Group	Species	Found During Investigations/Surveys
Sea lamprey (marine part of life cycle)	Bony fish (anadromous)	*Petromyzon marinus*	Occurs offshore throughout the UK and Ireland, migrates into freshwater to spawn – not recorded during surveys
Sea Trout (marine part of life cycle)	Bony fish (anadromous)	*Salmo trutta*	Not recorded during surveys
Sparling (marine part of life cycle)	Bony fish (anadromous)	*Osmerus eperlanus*	Does not occur in west of Scotland
Anglerfish (juveniles)	Bony fish	*Lophius piscatorius*	Caught during Scottish groundfish surveys adjacent to cable route
Atlantic herring (juveniles and spawning adults)	Bony fish	*Clupea harengus*	Caught during Scottish groundfish surveys adjacent to cable route – spawning status of fish not available in database – see Annex A, Table 6 for information on herring spawning and nursery grounds
Atlantic mackerel	Bony fish	*Scomber scombrus*	Not recorded during surveys - see Annex A, Table 6 for information on mackerel spawning and nursery grounds which lie away from cable route
Cod	Bony fish	*Gadus morhua*	Caught during Scottish groundfish surveys adjacent to cable route – see Annex A, Table 6 for information on cod spawning and nursery grounds
Ling	Bony fish	*Molva molva*	Caught during Scottish groundfish surveys adjacent to cable route
Norway Pout	Bony fish	*Trisopterus esmarkii*	Caught during Scottish groundfish surveys adjacent to cable route
Saithe (juveniles)	Bony fish	*Pollachius virens*	Not caught during Scottish groundfish surveys adjacent to cable route – see Annex A, Table 6 for information on saithe spawning and nursery grounds

Table 2 - PMFs found along the cable route during the baseline investigations and surveys, against the relevant entries in the recommended list of PMFs in Scottish Territorial Waters.

Priority Marine Feature (PMF)	Taxon Group	Species	Found During Investigations/Surveys
Sandeels	Bony fish	*Ammodytes marinus & Ammodytes tobianus*	See section 4.4
Sand Goby	Bony fish	*Pomatoschistus minutus*	Not caught during Scottish groundfish surveys adjacent to cable route but suitable habitat does occur in patches along cable route.
Whiting (juveniles)	Bony fish	*Merlangius merlangus*	Caught during Scottish groundfish surveys adjacent to cable route – see Annex A, Table 6 for information on whiting spawning and nursery grounds - Closest spawning ground is in the North Channel of the Irish Sea. Very low numbers of smaller whiting were caught during the beam trawl survey, at tow stations 4 & 5, around the mid point of the cable route between Islay and Kintyre.
Basking Shark	Sharks, skates and rays	*Cetorhinus maximus*	Sitings have been reported from Sound of Jura although more frequent in Firth of Clyde and around Mull, Tiree and Coll
Common Skate	Sharks, skates and rays	*Formerly Dipturus batis now split provisionally into D. cf. flossada and D. cf. intermedia*	Caught during Scottish groundfish surveys adjacent to cable route – See section 4.7.2
Spiny Dogfish (spurdog)	Sharks, skates and rays	*Squalus acanthias*	Caught during Scottish groundfish surveys adjacent to cable route – See section 4.2.1

5 SUMMARY

5.1 Baseline Data

5.1.1 A number of methods have been used to collate data for the natural fish baseline at both the tidal site and along the cable route. This has included specific surveys commissioned directly by DP Energy for this purpose (beam trawls, video survey and mammal/basking shark observation trips). Further sources of available data from published research and publications from Marine Scotland Science were also used in addition to local knowledge via fisheries liaison activities, undertaken by DP Energy.

5.1.2 The data has been presented for the tidal site and cable route separately, noting the differing nature of those areas. The baseline presents a specific focus on the data collated for sensitive species, PMFs, spawning/nursery grounds and migration routes.

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17. DP Marine Energy Project, Assessment of marine mammals and basking sharks in and around a proposed tidal-energy site, Update report following two years of survey effort, SRSL, August 2012.

18. Marine Scotland Position Paper, Marine Protected Areas and Common Skate (www.scotland.gov.uk web site, section 0038 document number 00389461.

7 ANNEX A – LITERATURE REVIEW DATA

7.1 Fish Fauna

7.1.1 Gordon and de Silva (1980) provided a general account of the hydrography and fish species found to the west of Scotland but their data came mainly from the Firth of Lorne and Clyde Sea and associated sea-lochs. The closest sea-lochs to the development site are Laggan Bay and Loch Gruinart but these were not covered in these reviews, although it may be expected that many of the species mentioned will occur in these areas.

7.1.2 The SEA7 review (Gordon, 2006) was also examined for data relevant to the west of Islay (within the 12 nm limit) although much of the report is based on data presented in Gordon and de Silva (1980) and Gordon (1981). Additionally, most of the SEA7 report is concerned with deep-water fisheries and is not relevant.

7.2 International Bottom Trawl Survey Data

7.2.1 A reasonable amount of survey data from trawl stations to the north and south of the development site and a few hauls from the cable route are available from the Q1 Scottish groundfish survey (Fig. 7). The survey started in 1981 and was initially intended to cover the fishing grounds on the continental shelf to the west of Scotland. The Scottish West Coast Surveys use an ICES rectangle based sampling strategy similar to that used in the North Sea. Trawl stations are selected at one tow per rectangle based on a library of clear tows. There is no explicit return to the same trawling position every year, although this is generally the case. The survey design has changed somewhat over time since 1999 as the potential for using a depth, rather than rectangle based stratification, has been under investigation. To this end, and where possible, those rectangles which display substantial internal depth variation have been sampled twice at different depths. In 1998 the new research vessel Scotia III was used and the duration of the hauls was decreased from 60 minutes to 30 minutes.

7.2.2 The gear deployed on all the Scottish surveys is the 36/47 GOV trawl fitted with heavy ground gear 'C' and a 20 mm internal liner. The gear includes a full suite of Scanmar sensors; headline height, wing and door spread and speed through the water.

7.2.3 The survey is usually carried out in March of each year but historically has varied from as late as December to May. The target species are cod, haddock, whiting, saithe and herring and age frequencies are constructed for these species. All other fish species encountered are also sampled for at least length frequencies.

7.2.4 Data from the survey were downloaded from ICES DATRAS and imported into an ACCESS database. The location of all hauls within proximity to Islay and the cable route was plotted (Fig. 7).

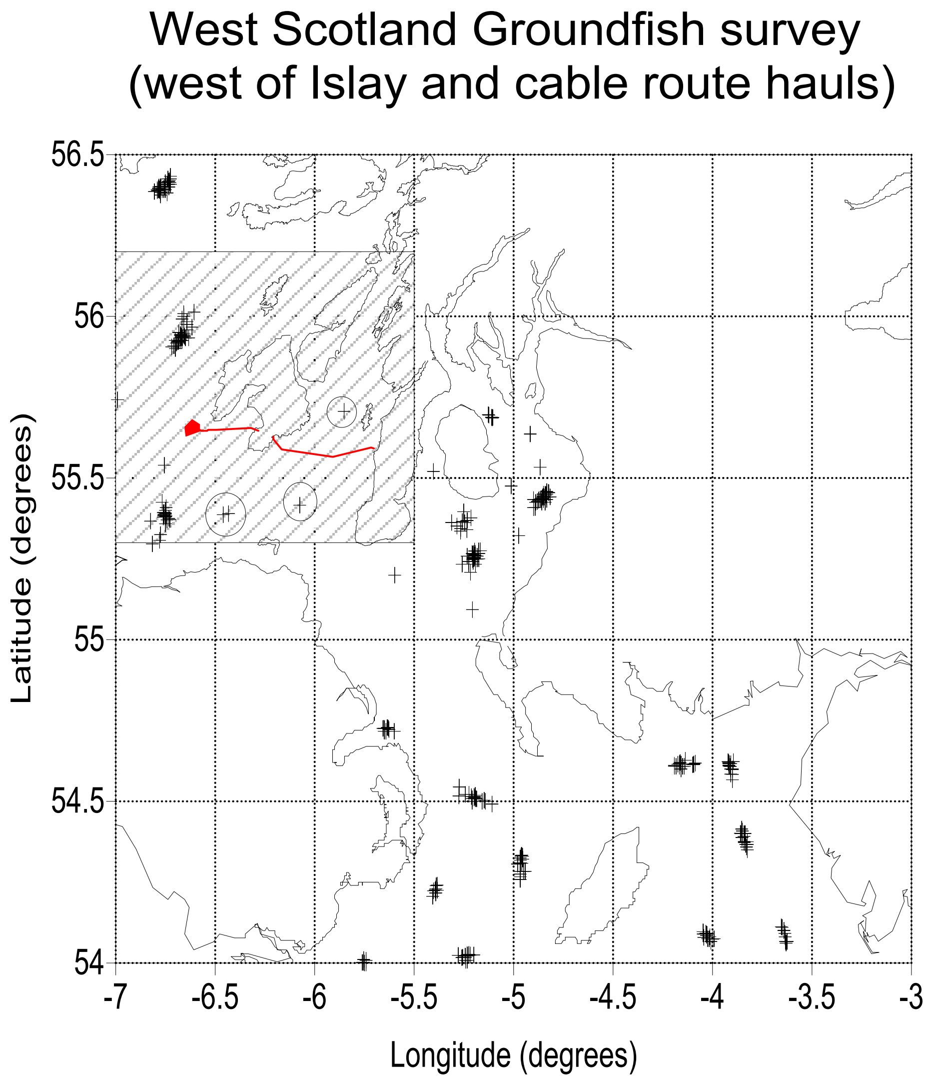

Figure 7: Locations of Scottish IBTS trawl stations. Infill red polygon - proposed tidal site and cable route boundaries; red polyline - proposed cable route; hatched rectangle - encloses trawl hauls selected for further analysis; circled crosses indicate trawl stations selected as lying adjacent to the cable route

7.2.5 The full dataset was filtered to hauls within the boundaries 56.2°N 007°W; 56.2°N 005.5°W; 55.3°N 007°W; 55.3°N 005.5°W (hatched area Fig. 7) which covers the site and cable route (although rather few hauls are available adjacent to the cable route). This filtering resulted in 63 valid hauls and 84 species recorded (which includes some crustaceans and molluscs recorded as present only and not included in the quantitative analysis presented in this report). These include: *Crangon* (brown shrimp); *Eledone cirrhosa* (curled octopus) and *Pasiphaeidae* (glass shrimp).

7.2.6 The data were sorted by the average number caught across the whole series resulting in the ranking shown in Table 3. Also shown is the percentage of hauls on which at least one individual of that species was calculated.

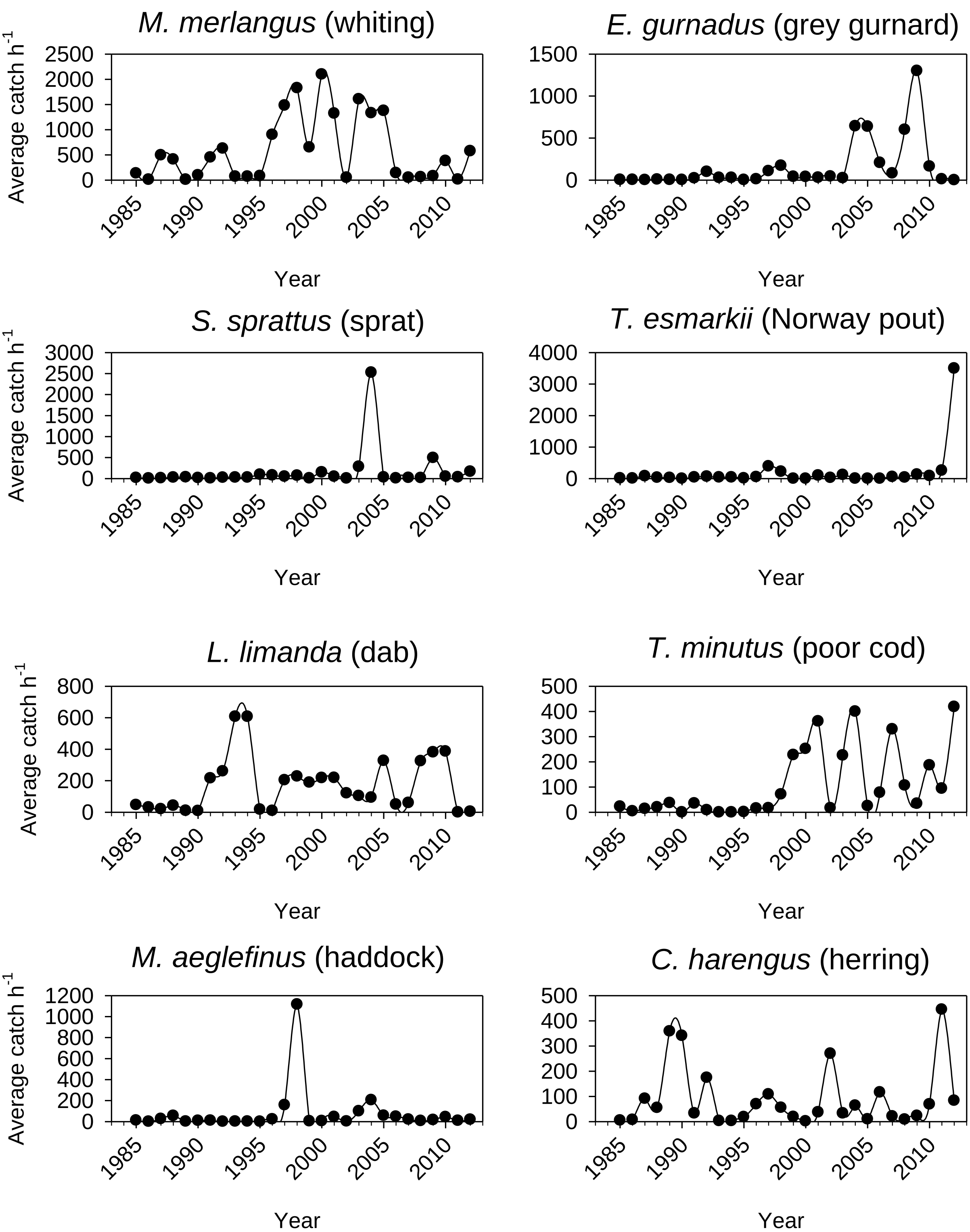

Figure 8: Average yearly catch species ranked 1 to 8 in terms of total numbers caught from the tows adjacent to the turbine site and cable route.

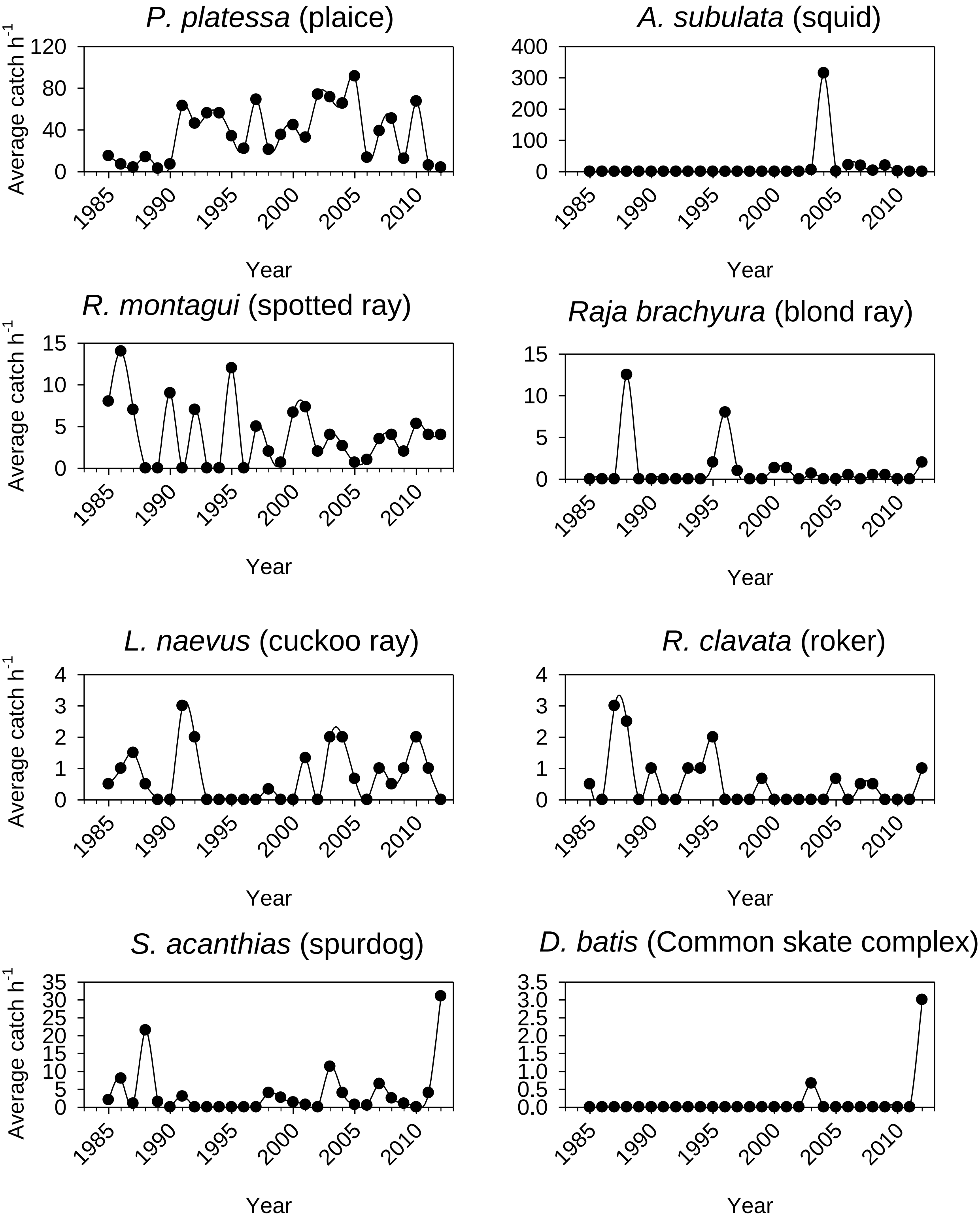

Figure 9: Average yearly catch of species ranked 9 and 10 in terms of total numbers caught and for skates, rays and spurdog (species of conservation interest) from the tows adjacent to the turbine site and cable route.

Table 3: Scottish Q1 groundfish survey (IBTS) results for stations adjacent to the proposed turbine site and cable route.

Rank	Species	Average catch (number) per hour over all hauls	Percentage hauls where positive
1	*Merlangius merlangus* (whiting)	630.45	96.8
2	*Eutrigla gurnardus* (grey gurnard)	225.55	90.5
3	*Sprattus sprattus* (sprat)	200.02	69.8
4	*Trisopterus esmarkii* (Norway pout)	173.98	66.7
5	*Limanda limanda* (dab)	168.91	84.1
6	*Trisopterus minutus* (poor cod)	139.44	82.5
7	*Melanogrammus aeglefinus* (haddock)	87.03	74.6
8	*Clupea harengus* (herring)	75.81	90.5
9	*Pleuronectes platessa* (plaice)	38.06	87.3
10	*Alloteuthis subulata* (common squid)	19.17	15.9
11	*Trachurus trachurus* (scad)	8.78	27.0
12	*Ammodytes marinus* (Raitt's sandeel)	7.84	11.1
13	*Scomber scombrus* (mackerel)	7.67	27.0
14	*Scyliorhinus canicula* (dogfish)	7.56	77.8
15	*Callionymus lyra* (dragonet)	7.42	77.8
16	*Gadus morhua* (cod)	7.34	69.8
17	*Microstomus kitt* (lemon sole)	7.05	74.6
18	*Aspitrigla (Chelidonichthys) cuculus* (red gurnard)	6.42	27.0
19	*Loligo forbesii* (veined squid)	5.69	28.6
20	*Micromesistius poutassou* (blue whiting)	4.53	15.9
21	*Squalus acanthias* (spurdog)	4.28	39.7
22	*Raja montagui* (spotted ray)	4.20	63.5
23	*Solea solea (vulgaris)* (sole)	2.84	47.6
24	*Agonus cataphractus* (hooknose)	1.97	31.7
25	*Hippoglossoides platessoides* (long-rough dab)	1.88	25.4
26	*Microchirus variegatus* (thickback sole)	1.89	28.6
27	*Gobiidae* (gobies)	1.73	15.9
28	*Raja brachyura* (blonde ray)	1.08	20.6
29	*Leucoraja (Raja) naevus* (cuckoo ray)	1.14	33.3
30	*Nephrops norvegicus* (Nephrops)	0.83	4.8
31	*Liparis liparis* (sea snail)	0.73	1.6
32	*Conger conger* (conger eel)	0.81	17.5
33	*Pollachius pollachius* (pollack)	0.78	14.3
34	*Cancer pagurus* (edible crab)	0.73	14.3
35	*Lophius piscatorius* (angler)	0.78	25.4
36	*Hyperoplus lanceolatus* (greater sandeel)	0.58	9.5
37	*Zeugopterus norvegicus* (Norwegian topknot)	0.67	19.0
38	*Trigla lucerna* (tub gurnard)	0.61	14.3

Table 3: Scottish Q1 groundfish survey (IBTS) results for stations adjacent to the proposed turbine site and cable route.

Rank	Species	Average catch (number) per hour over all hauls	Percentage hauls where positive
39	*Merluccius merluccius* (hake)	0.64	19.0
40	*Entelurus aequoreus* (snake pipefish)	0.52	7.9
41	*Buglossidium luteum* (solenette)	0.56	15.9
42	*Raja clavata* (roker)	0.58	17.5
43	*Zeus faber* (John dory)	0.56	15.9
44	*Callionymus maculatus* (spotted dragonet)	0.48	15.9
45	*Psetta maximai* (turbot)	0.44	12.7
46	*Pollachius virens* (saithe)	0.42	12.7
47	*Triglops murrayi* (moustache sculpin)	0.31	6.3
48	*Glyptocephalus cynoglossus* (witch)	0.34	11.1
49	*Engraulis encrasicolus* (anchovy)	0.23	1.6
50	*Lepidorhombus whiffiagonis* (megrim)	0.27	7.9
51	*Liparis montagui* (Montagu's sea-snail)	0.22	3.2
52	*Trisopterus luscus* (bib)	0.25	6.3
53	*Ctenolabrus rupestris* (goldsinny)	0.27	9.5
54	*Echiichthys vipera* (lesser weaver)	0.23	7.9
55	*Sepiolida* (cuttlefish)	0.36	15.9
56	*Argentina sphyraena* (argentine)	0.19	4.8
57	*Maurolicus muelleri* (pearlside)	0.20	6.3
58	*Dipturus batis* (common skate complex)	0.16	3.2
59	*Gaidropsarus vulgaris* (three-bearded rockling)	0.17	4.8
60	*Galeorhinus galeus* (tope)	0.17	4.8
61	*Galeus melastomus* (black mouthed dogfish)	0.11	1.6
62	*Raniceps raninus* (tadpole fish)	0.13	3.2
63	*Lumpenus lampretaeformis* (snake blenny)	0.11	3.2
64	*Molva molva* (ling)	0.13	4.8
65	*Myoxocephalus scorpius* (bull-rout)	0.13	4.8
66	*Scophthalmus rhombus* (brill)	0.13	4.8
67	*Sardina pilchardus* (pilchard)	0.09	3.2
68	*Taurulus lilljeborgi* (Norway bullhead)	0.08	1.6
69	*Arnoglossus laterna* (scaldfish)	0.08	3.2
70	*Hyperoplus immaculatus* (Corbin's sandeel)	0.08	3.2
71	*Argentina silus* (greater argentine)	0.05	1.6
72	*Cyclopterus lumpus* (lumpsucker)	0.06	3.2
73	*Gymnammodytes semisquamatus* (smooth sandeel)	0.05	1.6
74	*Labrus mixtus* (cuckoo wrasse)	0.05	1.6
75	*Mustelus mustelus* (smooth hound)	0.05	1.6
76	*Pecten maximus* (scallop)	0.06	3.2

Table 3: Scottish Q1 groundfish survey (IBTS) results for stations adjacent to the proposed turbine site and cable route.

Rank	Species	Average catch (number) per hour over all hauls	Percentage hauls where positive
77	*Platichthys flesus* (flounder)	0.06	3.2
78	*Pomatoschistus minutus* (sand goby)	0.05	1.6
79	*Zeugopterus punctatus* (topknot)	0.05	1.6
80	*Salmo trutta* (trout)	0.03	1.6

7.3 Separate Analysis of Hauls Adjacent to the Cable Route

7.3.1 Only 4 hauls in the IBTS dataset lie adjacent to the cable route and these were collected in 2011 and 2012. A total of 48 species were recorded (Table 4).

Table 4: Scottish Q1 groundfish survey (IBTS) results for stations adjacent to the cable route

Rank	Species	Average catch (number) per hour over all hauls	Percentage hauls where positive
1	*Trisopterus esmarkii* (Norway pout)	1874.75	75.0
2	*Merlangius merlangus* (whiting)	294.00	75.0
3	*Clupea harengus* (herring)	263.75	100.0
4	*Trisopterus minutus* (poor cod)	256.00	100.0
5	*Sprattus sprattus* (sprat)	99.50	75.0
6	*Micromesistius poutassou* (blue whiting)	43.75	100.0
7	*Scyliorhinus canicula* (dogfish)	32.50	100.0
8	*Squalus acanthias* (spurdog)	17.50	100.0
9	*Melanogrammus aeglefinus* (haddock)	13.00	100.0
10	*Liparis liparis* (sea snail)	11.50	25.0
11	*Solea solea* (vulgaris) (sole)	10.50	100.0
12	*Gadus morhua* (cod)	9.00	100.0
13	*Microstomus kitt* (lemon sole)	6.00	75.0
14	*Eutrigla gurnardus* (grey gurnard)	5.00	50.0
15	*Pleuronectes platessa* (plaice)	5.00	75.0
16	*Pollachius pollachius* (pollack)	4.50	50.0
17	*Raja montagui* (spotted ray)	4.00	100.0
18	*Agonus cataphractus* (hooknose)	4.00	25.0
19	*Engraulis encrasicolus* (anchovy)	3.50	25.0
20	*Nephrops norvegicus* (Nephrops)	3.00	25.0
21	*Zeugopterus norvegicus* (Norwegian topknot)	3.00	75.0
22	*Loligo forbesii* (veined squid)	2.50	50.0
23	Sepiolida (cuttlefish)	5.00	100.0
24	*Limanda limanda* (dab)	2.00	25.0
25	*Aspitrigla (Chelidonichthys) cuculus* (red gurnard)	2.00	25.0
26	*Microchirus variegatus* (thickback sole)	2.00	25.0
27	*Conger conger* (conger eel)	2.00	50.0
28	*Cancer pagurus* (edible crab)	2.00	75.0
29	*Merluccius merluccius* (hake)	1.50	50.0
30	*Glyptocephalus cynoglossus* (witch)	1.50	50.0
31	*Liparis montagui* (Montagu's sea-snail)	1.50	25.0

Table 4: Scottish Q1 groundfish survey (IBTS) results for stations adjacent to the cable route

Rank	Species	Average catch (number) per hour over all hauls	Percentage hauls where positive
32	*Trisopterus luscus* (bib)	1.50	50.0
33	*Maurolicus muelleri* (pearlside)	1.50	50.0
34	*Dipturus batis* (common skate complex)	1.50	25.0
35	*Galeus melastomus* (black mouthed dogfish)	1.50	25.0
36	*Hippoglossoides platessoides* (long-rough dab)	1.00	25.0
37	*Raja brachyura* (blonde ray)	1.00	25.0
38	*Zeus faber* (John dory)	1.00	25.0
39	*Lepidorhombus whiffiagonis* (megrim)	1.00	25.0
40	*Trachurus trachurus* (scad)	0.50	25.0
41	Gobiidae (gobies)	0.50	25.0
42	*Leucoraja (Raja) naevus* (cuckoo ray)	0.50	25.0
43	*Lophius piscatorius* (angler)	0.50	25.0
44	*Raja clavata* (roker)	0.50	25.0
45	*Ctenolabrus rupestris* (goldsinny)	0.50	25.0
46	*Gaidropsarus vulgaris* (three-bearded rockling)	0.50	25.0
47	*Molva molva* (ling)	0.50	25.0
48	*Zeugopterus punctatus* (topknot)	0.50	25.0

7.4 Other Fish Records for Sound of Jura (Cable Route)

7.4.1 Because of the limited number of IBTS trawl hauls available adjacent to the cable route, a wider internet search was conducted for other fish records for the Sound of Jura.

7.5 Mobile Species of Conservation Concern

7.5.1 Ellis et al. (2009) considered the distribution of mobile species in relation to siting of Marine Conservation Zones. Ellis et al. (2009) was conducted primarily in relation to identifying Marine Conservation Zones so the species list used was compiled by the Statutory Conservation Agencies based on species identified from the OSPAR list of Threatened and/or Declining Species and Habitats (OSPAR Commission, 2008), the UK List of Priority Species and Habitats (UK BAP, including the grouped plans for commercial and deep-water species) and Schedule 5 of the Wildlife and Countryside Act (1981). The selected species are shown in Table 5 and those which might occur in, or adjacent to, the proposed development site and cable route are highlighted (based on their reported depth range). As well as commercial landings records, Ellis et al. (2009) used the standard IBTS trawl survey data so the analysis is not independent of that presented in Tables 3 and 4 of this report.

Table 5. Taxonomic list of the highly mobile species considered in Ellis et al. (2010). Species listed as threatened and declining by OSPAR are denoted *; species with light grey background are those likely to occur to west of Islay based on their depth range

Common Name	Scientific name	Habitat	Depth range (m)
Elasmobranchii			
Gulper shark *	*Centrophorus granulosus*	Demersal	350-500
Leafscale gulper shark *	*Centrophorus squamosus*	Demersal	400-1875
Portuguese dogfish *	*Centroscymnus coelolepsis*	Demersal	400-2700
Kitefin shark	*Dalatias licha*	Demersal	100-1000
Spurdog *	*Squalus acanthias*	Bentho-pelagic	10-200
Angel shark *	*Squatina squatina*	Demersal	5-100
Basking shark*	*Cetorhinus maximus*	Pelagic	-
Shortfin mako	*Isurus oxyrinchus*	Pelagic	-
Porbeagle shark *	*Lamna nasus*	Pelagic	-
Tope	*Galeorhinus galeus*	Bentho-pelagic	-
Blue shark	*Prionace glauca*	Pelagic	-
Common skate *[1]	*Dipturus batis*	Demersal	10-600
Sandy ray	*Leucoraja circularis*	Demersal	70-275
Thornback ray *	*Raja clavata*	Demersal	5-300
Spotted ray *	*Raja montagui*	Demersal	5-100
Undulate ray	*Raja undulata*	Demersal	5-200
White skate *	*Rostroraja alba*	Demersal	40-400
Teleostei			
European eel *	*Anguilla anguilla*	Demersal	-
Herring	*Clupea harengus*	Pelagic	0-200
Smelt	*Osmerus eperlanus*	Pelagic	0-50
Brown/Sea trout	*Salmo trutta*	Pelagic	-
Cod *	*Gadus morhua*	Demersal	0-600
Whiting	*Merlangius merlangus*	Demersal	0-200

Table 5. Taxonomic list of the highly mobile species considered in Ellis et al. (2010). Species listed as threatened and declining by OSPAR are denoted *; species with light grey background are those likely to occur to west of Islay based on their depth range

Common Name	Scientific name	Habitat	Depth range (m)
Blue whiting	*Micromesistius poutassou*	Benthopelagic	160-3000
Blue ling	*Molva dypterygia*	Demersal	200-1000
Ling	*Molva molva*	Demersal	15-400
European hake	*Merluccius merluccius*	Demersal	100-300
Roundnose grenadier	*Coryphaenoides rupestris*	Demersal	400-1500
Anglerfish	*Lophius piscatorius*	Demersal	5-500
Orange roughy *	*Hoplostethus atlanticus*	Demersal	200-400
Horse mackerel	*Trachurus trachurus*	Pelagic	5-500
Sandeels[2]	Ammodytidae	Benthopelagic	0-200
Black scabbardfish	*Aphanopus carbo*	Benthopelagic	200-1600
Mackerel	*Scomber scombrus*	Pelagic	5-250
Blue-fin tuna *	*Thunnus thynnus*	Pelagic	-
Atlantic halibut	*Hippoglossus hippoglossus*	Demersal	50-2000
Plaice	*Pleuronectes platessa*	Demersal	0-100
Greenland halibut	*Reinhardtius hippoglossoides*	Demersal	200-2000
Sole	*Solea solea*	Demersal	0-200
Reptilia			
Leatherback turtle	*Dermochelys coriacea*		

[1] Since Ellis et al. (2010) the common skate has been reported to be comprised of two distinct species. As available data cannot be disaggregated between these species, Ellis *et al*. retained *Dipturus batis* to refer to the common skate species complex.

[2] Includes five species (Raitt‟s sandeel *Ammodytes marinus*, sandeel *A. tobianus*, smooth sandeel *Gymnammodytes semisquamatus*, Corbin‟s sandeel *Hyperoplus immaculatus* and greater sandeel *H. lanceolatus*).

7.6 Spawning and Nursery Grounds

7.6.1 Coull et al. (1998) collated available information on spawning and nursery areas for 14 commercial species: Mackerel; Herring; Cod; Haddock; Whiting; Saithe; Plaice; Lemon Sole; Sole; Norway Pout; Blue Whiting; Sandeels; Sprat and *Nephrops*. Data came from ichthyoplankton surveys where available and relevant or from interpretation of catches of young fish in either dedicated surveys or the standard International Bottom Trawl surveys. Observations relevant to West of Islay and the cable route are shown in Table 6.

Table 6: Spawning and nursery ground information according to Coull et al. (1998). species with light grey background indicates where spawning, likely egg and larval drift or nursery grounds are adjacent to the proposed development site and cable route.

Species	Spawning	Nursery	Timing spawning (only selected species)
Mackerel	Spawn along shelf edge well to west of proposed site.	Juvenile areas are well to west of proposed site.	
Herring	Autumn spawning along N. Ireland coast and to west of Tiree and Coll. No spawning areas to west of Islay noted.	Juvenile area is indicated to north of Islay but not to west.	
Cod	No spawning areas to west of Islay noted.	Area to west of Islay is indicated as a nursery area for young cod.	Jan - Apr.
Haddock	Haddock spawning shown to the north and further offshore. No spawning areas to west of Islay noted.	Nursery areas shown to the north and further offshore.	
Whiting	Closest spawning ground shown is in the North Channel of the Irish Sea; given prevailing south to north current flow, whiting eggs and larvae might be transported to the west of Islay.	Nursery areas to south of Tiree and Coll further suggesting drift of eggs and larvae from the North Channel.	Feb - Jun.
Saithe	Spawning grounds north-west of the Outer Hebrides. No spawning areas to west of Islay noted.	Area to west of Islay is indicated as a nursery area for young saithe.	Jan - Apr.
Plaice	A spawning ground is noted to the west of Islay.	No nursery areas shown but likely any sandy beaches are used (as at other west coast sites).	Dec - Mar.
Lemon sole	Spawning grounds principally on east coasts of Ireland and UK. No spawning areas to west of Islay noted.	Nearest nursery area shown off north-eastern Ireland.	
Sole	Spawning grounds mainly eastern	Nursery grounds mainly eastern Irish Sea to southern North Sea.	

Table 6: Spawning and nursery ground information according to Coull et al. (1998). species with light grey background indicates where spawning, likely egg and larval drift or nursery grounds are adjacent to the proposed development site and cable route.

Species	Spawning	Nursery	Timing spawning (only selected species)
	Irish Sea to southern North Sea. No spawning areas to west of Islay noted.		
Norway pout	Spawning ground is shown to north-east of Islay. Given prevailing currents eggs and larvae would likely be carried northwards, rather than towards Islay.	Nursery grounds start to north-east of proposed site but further offshore. Again comparison of spawning and nursery ground locations supports general south to north transport of eggs and larvae	
Blue whiting	Spawns in deep water, well to west of the Islay site	Well to west and north of proposed development site	
Sandeel	Closest spawning ground shown is to the north of Islay. Given prevailing currents larvae would likely be carried northwards, rather than towards Islay.	Closest nursery ground shown is to the north of Islay.	
Sprat	Sprat spawn all around the UK, including to west of Islay.	No juvenile areas shown on west of Scotland but unlikely to be accurate given spawning map.	May - Aug.
Nephrops	*Nephrops* are indicated to spawn to west of Islay.	Nursery grounds for *Nephrops* are indicated to west of Islay.	All year but peak Mar-May.

7.6.2 For the area to the west of Islay, Coull et al. (1998) indicates suggests a period of seismic sensitivity from December through March.

7.6.3 Ellis et al. (2010) extended the analysis of Coull et al. (1998) to cover 40 highly mobile species of potential conservation interest including 23 teleosts, 16 elasmobranchs and one sea turtle (Table 5). The review of Ellis et al. (2010) used updated information where available, for example from more recent ichthyoplankton surveys. New plankton data was available mainly for the North Sea and Irish Sea but not for the inshore waters to the west of Islay. The presence of juvenile fish (assumed to indicate potential nursery grounds) was based on the International Bottom Trawl Survey data considered earlier in this report (Tables 4 and 5). Ellis et al. (2010) also provided estimate of the confidence of mapping for each species recognising that for many, especially deep-water species, data are inadequate.

8 ANNEX B – BEAM TRAWL DATA

Table 5 – Beam Trawl Physical Data

Tow Code	Date	Time in	Time out	Mins	Lat Deg In	Lat Minutes in	Long Deg In	Long Minutes in	Lat Deg out	Lat Minutes out	Long Deg out	Long Minutes out	Depth In (m)	Depth out (m)	Tow speed (knots)	Swept Area (m2)	Notes
ISL12TOW1	14/08/2012	15:50:00	15:58:00	00:08:00	55	39.314	6	26.96	55	39.616	6	26.892	63		3	1481	Fair: E SS-4
ISL12TOW2	14/08/2012	16:29:00	16:35:00	00:06:00	55	39.602	6	24.321	55	39.47	6	23.857	43				Net torn- no data
ISL12TOW3	15/08/2012	06:57:00	07:02:00	00:05:00	55	34.65	6	5.464	55	34.601	6	5.062	45.11	44.71	2.6	802	Cod end full of dead shells. Total catch incl. dead shells was 3/4 of a fish box
ISL12TOW4	15/08/2012	06:19:00	06:30:00	00:11:00	55	34.157	6	2.623	55	34.049	6	2.006	66.15	70.01	2.2	1493	Clean catch, no pebbles no shell material, low mass
ISL12TOW5	15/08/2012	08:04:00	08:15:00	00:11:00	55	33.567	5	55.922	55	33.638	5	55.189	91.36	86.85	2.4	1629	1/3 Fish box of *Lamanaria* sp. & red algaes (inc *Polysiphonia* sp. *Plocamium cartilagineum*) - nephrops sub sampled (number raised in size frequency sheet)
ISL12TOW6	15/08/2012	08:36:00	08:45:00	00:09:00	55	33.976	5	52.657	55	33.993	5	52.044	72.78	70.58	2.5	1389	
ISL12TOW7	15/08/2012	08:59:00	09:10:00	00:11:00	55	34.182	5	51.249	55	34.185	5	50.506	65.97	61.85	2.2	1493	Small clean catch more sessile organisms, mainly hyroids
ISL12TOW8	15/08/2012	09:26:00	09:39:00	00:13:00	55	34.188	5	49.241	55	34.464	5	48.728	58.26	49.5	2.3	1845	

Table 6: - Beam Trawl Catch - Fish

		TOWCODE	ISL12TOW1	ISL12TOW2	ISL12TOW3	ISL12TOW4	ISL12TOW5	ISL12TOW6	ISL12TOW7	ISL12TOW8
		Date	14/08/2012	14/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012
		Notes		Ripped Net						
Fish										
Dab	***Limanda limanda***	**40mm**	0		0	0	0	1	1	0
		50mm	0		0	0	0	0	0	0
		60mm	0		0	0	0	0	0	0
		70mm	0		0	0	0	0	0	0
		80mm	0		0	0	0	0	0	0
		90mm	0		0	0	0	0	0	0
		100mm	0		0	2	0	0	0	0
		110mm	0		0	0	0	0	0	0
		120mm	0		0	1	0	0	0	0
		130mm	0		0	1	0	0	0	0
		140mm	0		0	1	0	0	0	0
		150mm	0		0	1	0	0	0	0
		160mm	0		0	0	0	0	0	0
		170mm	0		0	1	0	0	0	0
		tot dab	0		0	7	0	1	1	0
Long rough Dab	***Hippoglossoides platessoides***	**100mm**	0		0	0	0	0	0	2
		…	0		0	0	0	0	0	0
		240mm	0		0	0	1	0	0	0
		Tot rough dab	0		0	0	1	0	0	2
Plaice	***Pleuronectes platessa***	**180mm**	0		0	1	0	0	0	0
		190mm	0		0	0	0	0	0	0
		200mm	0		0	0	0	0	0	0
		210mm	0		0	0	0	0	0	0
		220mm	0		0	0	0	0	0	0
		230mm	0		0	0	0	0	0	0
		240mm	0		0	0	0	0	0	0
		250mm	0		0	0	0	0	0	1
		tot plaice	0		0	1	0	0	0	1
Solenette	***Buglossidium luteum***	**90mm**	0		0	0	0	0	1	0
		100mm	0		0	0	0	0	1	0
		110mm	0		0	1	0	0	0	0
		120mm	0		0	0	0	0	0	0
		130mm	0		0	1	0	0	0	0
		tot solenette	0		0	2	0	0	2	0
Sole	***Solea solea***	**100mm**	0		0	0	0	1	1	0
		110mm	0		0	0	0	0	0	0
		120mm	0		0	0	0	0	0	0
		130mm	0		0	0	1	1	0	0
		140mm	0		0	0	0	0	0	0
		150mm	0		0	0	0	0	0	0
		160mm	0		0	0	1	0	0	0
		170mm	0		0	0	0	0	0	0
		180mm	0		0	0	0	0	0	0
		190mm	0		0	0	0	0	0	0
		200mm	0		0	1	0	0	0	0
		total sole	0		0	1	2	2	1	0
Lemon sole	***Microstomus kitt***	**280mm**	0		0	0	0	0	0	1
		Total lemon sole	0		0	0	0	0	0	1

Table 6: - Beam Trawl Catch - Fish

		TOWCODE	ISL12TOW1	ISL12TOW2	ISL12TOW3	ISL12TOW4	ISL12TOW5	ISL12TOW6	ISL12TOW7	ISL12TOW8
		Date	14/08/2012	14/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012
		Notes		Ripped Net						
Whiting	***Merlangius merlangus***	**40mm**	0		0	0	1	0	0	0
		50mm	0		0	0	0	0	0	0
		60mm	0		0	0	1	0	0	0
		70mm	0		0	0	1	0	0	0
		80mm	0		0	0	3	0	0	0
		90mm	0		0	0	3	0	0	0
		100mm	0		0	1	2	0	0	0
		110mm	0		0	0	0	0	0	0
		120mm	0		0	0	0	0	0	0
		130mm	0		0	0	0	0	0	0
		140mm	0		0	0	0	0	0	0
		150mm	0		0	0	1	0	0	0
		160mm	0		0	0	1	0	0	0
		total whiting	0		0	1	13	0	0	0
Poor Cod	***Trisopterus minutus***	**50mm**	0		0	0	0	1	0	0
		60mm	0		0	0	0	0	0	0
		70mm	0		0	1	0	0	7	0
		80mm	0		0	1	1	1	16	0
		90mm	0		0	0	3	0	4	0
		100mm	0		0	0	0	0	1	0
		110mm	0		0	0	0	0	0	0
		120mm	0		0	0	0	0	0	0
		130mm	0		0	0	0	0	0	0
		140mm	0		0	0	0	0	0	0
		150mm	0		0	0	0	0	0	0
		160mm	0		0	0	0	0	0	0
		170mm	0		0	0	0	0	0	0
		180mm	0		0	0	0	0	0	0
		190mm	1		0	0	0	0	0	0
		tot poor cod	1		0	2	4	2	28	0
Red gurnard	***Aspitriglia cuculus***	**120mm**	0		0	0	0	0	1	0
		130mm	0		0	0	0	0	0	0
		total red gurnard	0		0	0	0	0	1	0
Dragonet	***Callionymus lyra***	**80mm**	0		0	0	0	0	1	0
		90mm	0		1	0	0	1	0	0
		100mm	0		0	0	0	0	0	0
		110mm	0		0	0	0	0	0	0
		120mm	0		0	0	0	0	0	0
		130mm	0		0	1	0	0	0	0
		140mm	0		0	0	0	0	0	0
		150mm	0		2	1	0	0	1	0
		160mm	1		1	0	0	0	0	0
		170mm	0		1	1	0	0	0	0
		180mm	0		0	1	0	0	0	0
		190mm	0		0	0	0	1	0	0
		200mm	0		0	0	0	0	0	1
		220mm	0		0	0	0	0	0	1
		230mm	0		0	0	0	0	0	2
		240mm	0		0	0	0	0	0	1
		total dragonet	1		5	4	0	2	2	5
Three barbed rocking	***Gaidropsarus vulgaris***	**150mm**	0		0	0	2	0	0	0
		total 3b rocklings	0		0	0	2	0	0	0
Cuckoo Ray	***Leucoraja naevus***	**240mm**	0		0	0	0	0	0	1
		250mm	0		0	0	0	0	0	1
		Total Skate	0		0	0	0	0	0	2

Table 7: – Beam Trawl Catch - Nephrops

		TOWCODE	ISL12TOW1	ISL12TOW2	ISL12TOW3	ISL12TOW4	ISL12TOW5	ISL12TOW6	ISL12TOW7	ISL12TOW8
		Date	14/08/2012	14/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012
		Notes		Ripped Net						
Nephrops	***Nephrops norvegicus***	**140mm**	0		0	0	1.456	0	0	0
		150mm	0		0	0	0	0	0	0
		160mm	0		0	1	4.368	0	0	0
		170mm	0		0	0	4.368	0	0	0
		180mm	0		0	1	0	0	0	0
		190mm	0		0	1	2.912	0	0	0
		200mm	0		0	0	10.192	1	0	0
		210mm	0		0	5	18.928	0	0	0
		220mm	0		0	3	13.104	0	0	0
		230mm	0		0	4	13.104	0	0	0
		240mm	0		0	5	23.296	0	0	0
		250mm	0		0	2	2.912	0	0	0
		260mm	0		0	8	11.648	0	0	0
		270mm	0		0	1	14.56	0	0	0
		280mm	0		0	0	7.28	0	0	0
		290mm	0		0	3	5.824	0	0	0
		300mm	0		0	2	4.368	0	0	0
		310mm	0		0	5	2.912	0	0	0
		320mm	0		0	1	4.368	0	0	0
		330mm	0		0	2	0	0	0	0
		340mm	0		0	2	0	0	0	0
		350mm	0		0	1	1.456	0	0	0
		360mm	0		0	0	1.456	0	0	0
		370mm	0		0	0	0	1	0	0
		380mm	0		0	1	0	0	0	0
		390mm	0		0	0	0	0	0	0
		400mm	0		0	0	0	0	0	0
		410mm	0		0	0	0	0	0	0
		420mm	0		0	0	0	0	0	0
		430mm	0		0	0	0	0	0	0
		440mm	0		0	0	0	0	0	0
		450mm	0		0	0	1.456	0	0	0
		TOTAL NEPHROPS	0		0	48	149.968*	2	0	0

*150 Nephrops were recovered during tow ISL12TOW5, however, only 100 were measured for size, with the results then factored up to represent the full number caught.

Table 8 – Beam Trawl Catch – Other Invertebrates

		TOWCODE	ISL12TOW1	ISL12TOW2	ISL12TOW3	ISL12TOW4	ISL12TOW5	ISL12TOW6	ISL12TOW7	ISL12TOW8
		Date	14/08/2012	14/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012	15/08/2012
		Notes		Ripped Net						
Edible crab	***Cancer pagurus***	**170mm**	0		0	0	0	0	0	1
Hermit crabs	***Pagurus bernhardus***	**not measured**	2		0	0	1	15	7	1
Hermit Crabs (no-hydroids on back)	***Pagurus prideaux***	**not measured**	3		30	3	0	1	0	5
Spider crabs	***Macropodia tenuirostris***	**not measured**	6		3	1	0	4	15	11
Spider crab	***Inachus phalangium***	**not measured**	0		0	1	0	4	2	3
Giant spider crab	***Hyas araneus***	**not measured**	15		0	0	0	0	0	0
Shore crab	***Carcinus maenas***	**not measured**	0		0	0	1	0	0	0
Bryers Nut Crab	***Ebalia tumefacta***	**not measured**	0		1	0	0	0	0	0
Brown shrimps	***Crangon crangon***	**not measured**	0		0	1	6	0	0	0
Harbour crabs	***Liocarcinus depurator***	**not measured**	0		0	0	0	0	1	0
Pink shrimp	***Pandalus montagui***	**not measured**	0		0	0	11	0	0	0
Queen Scallop	***Aequipecten opercularis***	**not measured**	0		4	0	0	11	0	0
Sting Winkle	***Ocenebra erinacea***	**not measured**	1		0	0	0	0	0	0
Bivalve	***Clausinella fasciata***	**not measured**	1		1	0	0	0	0	0
Cuttle fish	***Sepiola atlantica***	**not measured**	0		0	2	6	0	0	1
Brittle stars	***Ophura ophura***	**not measured**	0		0	1	0	0	0	9
Brittle stars	***Ophiura albida***	**not measured**	13		2	1	0	0	0	5
Brittle stars	***Ophiocomina nigra***	**not measured**	1		0	0	0	0	0	0
Brittle stars	***Ophiothrix fragilis***	**not measured**	0		1	0	0	0	1	5
Starfish	***Asterias rubens***	**not measured**	0		2	1	0	1	2	0
Goosefoot starfish	***Anseropoda placenta***	**not measured**	1		0	0	0	0	0	0
Starfish	***Henricia oculata***	**not measured**	1		1	0	0	0	1	0
Red cushion star	***Porania pulvillus***	**not measured**	1		0	0	0	0	0	0
Hydroid	***Plumularia setacea***	**not measured**	0		Present	0	0	0	0	0
Hydroid (sea beard)	***Nemertesia antennina***	**not measured**	Present		0	0	Present	0	Present	Present
Dead Mans fingers	***Alcyonium digitata***	**not measured**	0		Present	0	0	0	0	Present
Lions mane jellyfish	***cyanea capillata***	**not measured**	0		0	3	0	0	0	0
North atlantic octopus	***Bathypolypus arcticus***	**not measured**	0		0	1	0	0	0	0
Sponge (Sea orange sulphur)	***Suberites domuncula***	**not measured**	0		0	0	0	0	0	Present
Star Ascidian	***Botryllus schlosseri***	**not measured**	31		0	0	0	0	0	0
Sea Squirt	***Ascidiella scabra***	**not measured**	0		0	0	0	0	3	1
Hornedwrack	***Flustra foliacea***	**not measured**	Present		0	0	0	0	0	0
Bryozoan	***Securiflustra securifrons***	**not measured**	Present		Present	0	0	0	0	0
Squat Lobster	***Munida rugosa***	**not measured**	2		0	0	3	4	5	2
Scale worm	***Aphroditidae sp.***	**not measured**	0		0	0	0	0	0	1
Sea Lemon	***Archidoris pseudoargus***	**not measured**	0		0	0	0	0	1	1
Cloak anemone	***Adamsia carcinopados***	**not measured**	3		30	0	0	1	0	5
Juvenile Prawns	***Decapoda sp.***	**not measured**	0		0	0	70	0	0	0

WESTISLAY TIDAL

ENERGY PARK

volume 4 // appendix 12.1 //

Commercial Fisheries Baseline Report

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West Islay Tidal Energy Farm

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Commercial Fisheries Baseline

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West Islay Tidal Farm Commercial Fisheries Technical Report	**DRAFT1**	JL	JHM	25/10/2012
	DRAFT2	JL	JHM	16/11/2012
	FINAL	JL	JHM	26/11/2012

Contents

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Glossary of Terms

ANIFPO- Anglo Northern Irish Fish Producers Organisation
BMM – Brown and May Marine Limited
Cefas – Centre for Environment, Fisheries and Aquaculture Science
CFA – Clyde Fishermen's Association
CFP – Common Fisheries Policy
CSV – Comma separated variable
Defra – Department for Environment, Food and Rural Affairs
DFO – District Fishery Officer
EC – European Commission
EIA – Environmental Impact Assessment
EU – European Union
FIN – Fisheries Information Network
FIR – Fishing Industry Representative
hp – horsepower
ICES – International Council for the Exploration of the Sea
LOA – Length Overall
MAGP – Multi Annual Guidance Programme
MHW – Mean High Water
MLS – Minimum Landing Size
MLW – Mean Low Water
MMO – Marine Management Organisation
MPA – Marine Protected Area
MSY – Maximum Sustainable Yield
nm – nautical mile
RSS – Registry of Shipping and Seamen
SFF – Scottish Fishermen's Federation
SMP – Square Mesh Panel
SI – Statutory Instrument
SSB– Spawning Stock Biomass
TAC – Total Allowable Catch
VCU – Vessel Capacity Unit
VMS – Vessel Monitoring System (satellite tracking data)
UWTV - Underwater Television

12nm limit – Territorial waters of EU Member States extend to 12nm. Member States manage these waters exclusively within these limits
6nm-12nm limit – some access to certain EU Member States in identified areas around the UK coast, based upon historic access
6nm limit – exclusive access to UK vessels only within 6nm

Under-10 metre –Category of fishing vessels that are less than 10 metres in length
10 - 15 metre – Category of fishing vessels that are between 10 and 15 metres in length
Over-15 metres – Category of fishing vessels that are greater than 15 metres in length

Creeling – The Scottish designation for potting
Demersal – Activities or species located near or on the sea bed
Pelagic – Activities or species located in the water column
Quota – A measure of the quantity of a species that can legally be landed within a set period

1.0 Introduction

The purpose of this document is to define the current commercial fisheries baseline in the vicinity of the West Islay Tidal Energy Farm. Commercial fishing is defined as any legal fishing activity which is declared for taxable profit. There is no single data source or recognised model for establishing commercial fisheries baselines within small, discrete sea areas such as offshore tidal energy sites, and the following baseline has therefore been derived using data and information from a number of sources. In addition to analysis of fisheries statistical datasets, consultation was undertaken with fishermen and their representatives to further describe relevant fishing activities.

Establishing a baseline of commercial fishing activity is complicated by a number of factors: target species, the location and productivity of fishing grounds, and levels of effort may all change over short time scales in response to fluctuations in landings and changes in quota allocations, legislation, economic constraints, weather and conservation restrictions.

Due to the migratory nature of salmon and sea trout, their fisheries are considerably different from others described within the commercial fisheries baseline, involving a recreational aspect which is of high socio-economic importance to Scotland. In light of these differences salmon and sea trout fisheries are assessed in a separate section at the end of the report.

2.0 Study Area

The study area for the assessment of commercial fishing activity is shown in Figure 2.1. The approach has been to provide a brief national overview (national study area) in order to put fishing grounds in the general area of the West Islay Tidal Farm within a national context. The regional study area has subsequently been defined to ensure sufficient coverage of those areas surrounding the site, and the local study area is the smallest available spatial unit for the collation of fisheries statistics. Where possible, fishing activities in the specific area of the site have been further described.

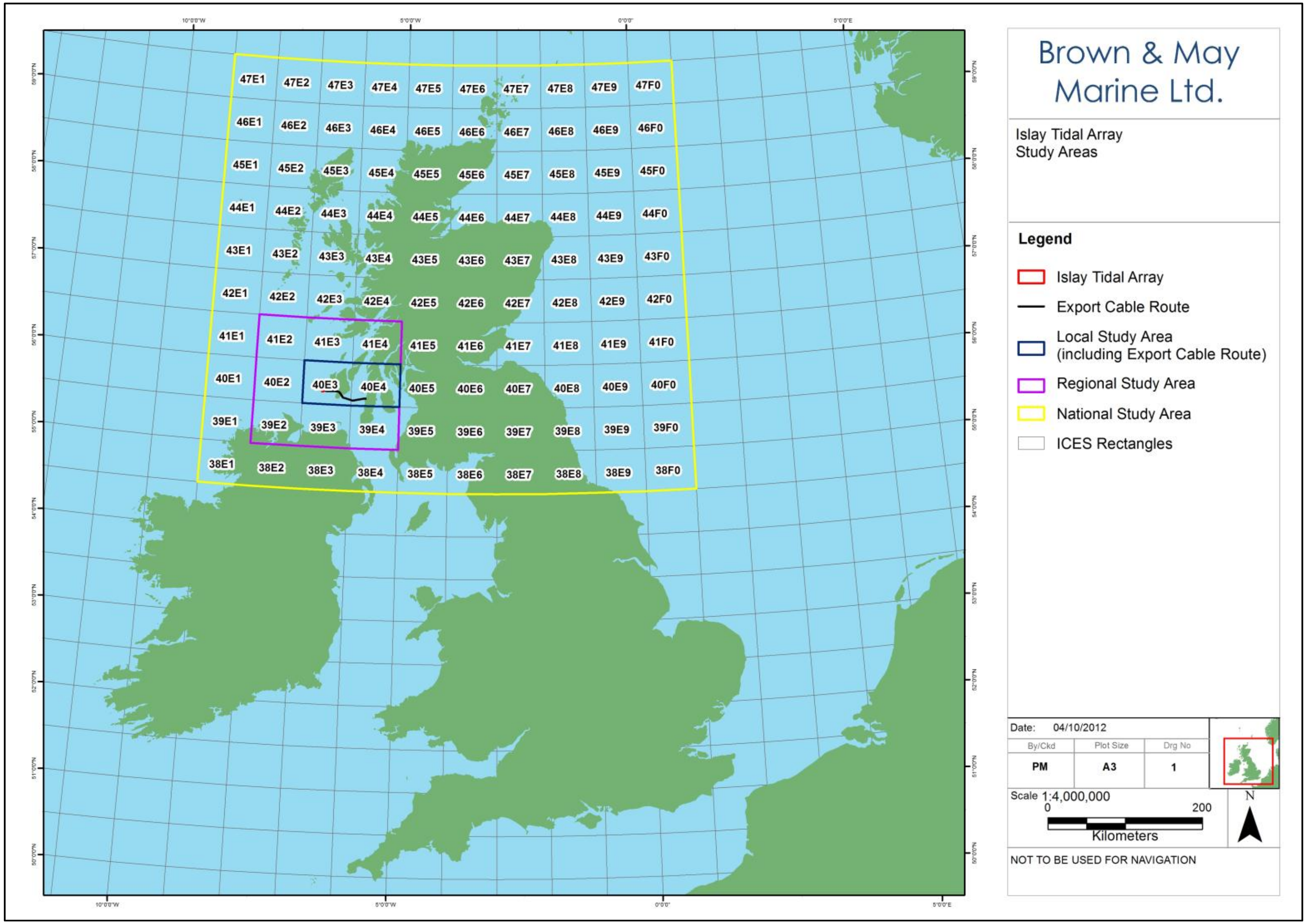


Figure 2.1 West Islay Tidal Farm Study Areas

3.0 Data Information and Sources

As stated previously, there is currently no single data source or recognised model for establishing commercial fisheries baselines. It is therefore necessary to use an approach that incorporates a number of relevant data and information sources, each subject to varying sensitivities and limitations, as described below. The relevant fisheries, methods and associated effort are described in progressive detail by building upon the sources and analysis outlined below.

The principal sources of data and information used were:

- International Council for the Exploration of the Seas (ICES);
- MMO;
- Marine Scotland;
- Marine Scotland Science;
- Campbeltown District Fishery Office (DFO);
- Scottish Fishermen's Federations (SFF); and
- Fishermen and their representatives.

It should be noted that fishing terminology may vary by data set. Specifically, the use of static gear to target crustaceans is known as 'potting' in England and 'creeling' in Scotland.

Analysis of the data and information sources are subject to the following qualifications, limitations, sensitivities and gaps.

3.1 International Council for the Exploration of the Sea (ICES)

ICES statistical rectangles are the smallest spatial unit used for the collation of fisheries statistics by the European Commission (EC) and member states. The boundaries of ICES rectangles align to 1° 0f latitude and 30' of latitude. Consideration should be given to the relative size of an ICES rectangle, which is large compared to the development and associated cable route (located in ICES rectangles 40E3 and 40E4, see Figure, 4.3). Furthermore, fishing activity is unlikely to be evenly distributed within a given rectangle. Therefore, analysis of fisheries statistics by ICES rectangles should take into account the small proportion of a statistical area that the development covers and the variation in levels of activity within a given rectangle.

3.2 MMO Data

3.2.1 MMO Fisheries Statistics

Fisheries statistical data covering a five year period (2006 to 2010) have been collected and provided to Brown and May Marine Ltd. (BMM) by the Marine Management Organisation (MMO). The MMO collects and collates fisheries data for the whole of the UK by ICES rectangle including all UK vessels landing into non-UK ports. The primary data source is the EC daily log sheets that the over-10 metre fleet must complete and submit. The data include information on landings (weight and value) and effort (days fished). The fisheries statistics have been analysed to identify:

- Species targeted;
- Fishing methods used;
- Vessels by category (under-10 metres, 10-15 metres, over-15 metres and non-UK);
- Annual variations;
- Seasonal variations; and
- Landings values and effort by port.

It should be noted that analyses of annual variation have used a 10 year dataset (2001-2010) in order to demonstrate a pattern of activity over a longer time period.

Vessels under-10 metres in length are not currently required to submit daily log sheets, although voluntary submissions can be made. Local fisheries officers also undertake dockside checks on the under-10 metre fleet. To facilitate further collection of fisheries data from the under-10 metre fleet, two schemes have been introduced: The Shellfish Entitlement Scheme (2004), which is discussed further in section 4.4 and the 'Registration of Buyers and Sellers of First Sale Fish and Designation Auction Site Scheme' (2005). Due to the relatively recent introduction of these schemes, it should be noted that prior to 2005 the MMO fisheries statistics for the under-10 metre fleet may, to some extent, underestimate the true levels of fishing in the area where a large percentage of the activity is by vessels in this category.

Vessels referred to as 'non-UK' in the MMO fisheries statistics only include foreign vessels landings into UK ports and therefore do not take into account non-UK vessels fishing in the area but landing into non-UK ports. The values given for the non-UK fleet derived from the analysis of this data set should therefore take this into account and not be considered as a true indication of the total foreign activity in this area.

3.2.2 MMO Fisheries Surveillance Sightings Data

Fisheries surveillance data record sightings of all fishing vessels in UK waters by fishing method and nationality and have been provided by the MMO (2001 to 2010). To manage fisheries legislation, fishery protection boats and aircraft record surveillance sightings of all vessels in UK waters. This data is used to give an indication of the distribution of fishing activity by method and nationality: it should not be used for quantitative assessments of activity due to the low frequency of flights over an area, which are usually once a week and only during daylight hours.

3.2.3 MMO UK Satellite Tracking (VMS) Data

The MMO has provided satellite tracking data (VMS) for the years 2007 to 2010 for all UK fishing vessels over-15 metres in length. The data set is not broken down by fishing method due to concerns over data protection. A basic 0.05° by 0.05° grid has been cross-referenced with the landings data to provide values in a grid format. The total time (hours) spent by vessels in each grid has also been provided.

Satellite tracking of European Union (EU) registered vessels currently applies to all vessels of over-15 metres in length. A transmitter on-board each vessel transmits the vessel's position approximately once every two hours via satellite link to the MMO and other national EU control centres. The MMO receives information from all UK vessels, regardless of location, and all non-UK vessels within UK waters. At present however, the MMO is unable to release data on foreign vessels without prior permission from the regulating body of the vessels Member State.

The coordinates of individual vessels are currently unavailable. At present the MMO only provide the aggregated number of position plots by general vessel type (mobile or static gear). Any rectangles that record less than five transmissions have been removed from the data set by the MMO for data protection purposes.

It should be noted that satellite data does not differentiate between vessels steaming and vessels fishing and the data has been speed filtered: vessels have been presumed to be fishing if their speed is greater than 0 knots, but less than 6 knots[1] . The disclosure of independent UK vessels' identities is restricted under the Data Protection Act (1998).

3.3 Marine Scotland Data Analysis

Charts derived from Marine Scotland Science VMS data (2007-2011) have been provided to BMM by Marine Scotland to assist in the compilation of a commercial fisheries baseline in the area of the West Islay Tidal Energy Farm. The charts were produced by applying VMS records to the Fisheries Information Network (FIN), which is the Scottish Government's sea fisheries database. FIN holds information on voyages (catches, gear and mesh size) and landings (weight, price at sale). Both the VMS records and FIN database use the Registry of Shipping and Seamen (RSS) number, which identifies vessels (this identifier is otherwise protected information) as a common denominator. *Logtime* (the date and time of each VMS transmission) identifies each vessel's voyage and enables the location of a vessel during each trip to be linked to the gear used and the weight of the landings.

In order to distinguish between vessels steaming and fishing, the speed of the vessel at the time of each VMS transmission has been used as a filter. It has been assumed that vessels travelling at speeds of over six knots would be steaming as opposed to fishing. The information provided in the charts describes the landings of each fishing trip. A fishing trip generally comprises of a number of fishing events, however information on catches per fishing event are not available and due to this, multiple fishing events all contribute to the overall landings weight for the fishing trip. All information provided in the charts below is anonymous. As previously stated, VMS records do not capture vessels under-15m and so may not represent the true extent of fishing activities in a given area.

3.4 Fishery Specific Information

Information provided by fishermen and their representatives assists in the identification of the fisheries that occur in the regional and local areas relative to the development, and the vessels that target those fisheries. The information has been collated through on going consultation and liaison with fishing organisations, fishermen and their representatives.

3.5 Future Fisheries

Research and consultation has been undertaken by BMM in order to identify potential future changes to the existing baseline relevant to the timeframe of the development. An assessment of this nature is, however, potentially limited by the ongoing and proposed changes to the management of commercial fisheries.

[1] Lee, J., South, A.B. and Jennings, S. (2010) Developing reliable, repeatable, and accessible methods to provide high-resolution estimates of fishing-effort distributions from vessel monitoring system (VMS) data. ICES Journal of marine science, 67: 1260-1271.

4.0 Fisheries Controls and Legislation

Whilst the international aspect of European fisheries management, such as the setting of quotas, remains a reserved power, the implementation of fisheries regulations are devolved to the Scottish Government and administrated by Marine Scotland.

4.1 Fishing Vessel Licenses

All fishing vessels must hold a valid license. A fishing license is a permit for the boat to be legally engaged in valid commercial fishing activities (i.e. to be entitled to catch fish and sell for profit). The current licensing scheme is designed to prevent increases in fleet numbers and catching capacities through the use of vessel capacity units (VCUs). Since 1983, the EU Common Fisheries Policy (CFP) has primarily dictated the structure and capacity of the UK and Scottish fishing fleets. Between 1997 and 2002, a Multi Annual Guidance Programme (MAGP) was devised within the CFP to manage fleet structures and fishing by method was restricted by capacity limits and effort reduction targets. When the MAGP ended in 2002, it was replaced by Member State level controls which implement a system of exit/entry restrictions to impose effort level limits. Essentially, a fleet capacity cannot be increased and vessels can only enter the fleet when an equivalent or larger capacity vessel has exited.

The most significant reduction schemes upon the Scottish fleet in recent years have been the successive decommissioning schemes in 2001/2002 and 2003/2004, which removed 165 vessels from the national demersal fleet.

In 2010 the License Parking scheme was introduced by the Scottish Government to assist the fleet in adjusting to current restrictive conditions. The purpose of the scheme is to enable the licenses of multiple vessels to be combined and placed upon one vessel, therefore reducing both the long and short term fixed and variable costs through vessel sharing. The inactive vessels become ‘parked’, although this process is reversible. There is also the possibility that the effort generated by those vessels wishing to leave the industry can be bought and concentrated on the remaining vessels (this is currently not possible under licensing rules alone). Currently, over 40 vessels have applied and been accepted for the License Parking scheme. Ministers have also introduced a publicly funded (co-funded by the European Fisheries Fund) fleet resilience grant scheme through consultation with industry stakeholders and the Scottish Fisheries Council. This scheme is designed to dispose of those vessels that have been made dormant through License Parking.

4.2 Territorial Limits

The territorial fishing limits of an independent nation extend out to 12nm. Access within 6nm of the coast is generally restricted to the vessels of that country. Access to fishing grounds between the 6 to 12nm limit is only granted to vessels from other Member States on the basis of historic rights. France and the Republic of Ireland currently hold historic rights between the 6 and 12nm limit in ICES area VIa (west coast of Scotland).

4.3 Quota Restrictions

Quota for fish stocks, activities of fishing vessels and fishing effort (days at sea) in Scottish waters are managed and controlled by the Scottish Government[2] . These controls and regulations have direct and indirect impacts on existing and future commercial fishery baselines.

The primary responsibility of the CFP, since its ratification in the early 1980s, is the long-term conservation of fish stocks in EU waters. The CFP aims to protect pressure stocks (species identified as requiring management) though a system of quotas by ICES area and sub-area. A quota is

[2] The Scottish Government, Fisheries Section: http://www.scotland.gov.uk/Topics/Fisheries/Sea-Fisheries

measured as the quantity of landed fish and does not count discards. Total Allowable Catch (TACs) are calculated annually and allocated for each pressure stock by area or Sub-area.

The development is located within Sub- area VIa (west of Scotland); it should however be noted that with the exception of herring the TACs presented below are not allocated solely to Area VIa but for up to two Sub-areas or Area VI as a whole (West of Scotland and Rockall). This applies to haddock and skates and rays for which the listed TAC applies to Sub- areas VIa and VIb, all other TACs are allocated for the whole of VI. ICES sea areas are shown in Figure 4.1 .

Figure 4.2 shows the TACs for ICES Area VI (but see preceding paragraph) for the top ten species for all EU countries combined. It can be seen that the blue whiting TAC has declined considerably since 2008 in response to concerns over stock sustainability. The mackerel fishery is allocated the second highest TAC and has remained relatively stable for the last five years. Allocated TACs for other all other species are considerably lower.

Figure 4.3 shows the TACs for the UK only in ICES Area VI. *Nephrops* (a shellfish species) and horse mackerel currently have the highest allocated TACs. *Nephrops* is of high importance to the Scottish fleet and a significant proportion of the total TAC is allocated to the UK in Area VI. TACs for demersal whitefish species are comparatively low. The Clyde herring stock is managed separately from other Area VI herring stocks and the UK is allocated the entire TAC. Due to a disproportionately high quota allocation the Area VI mackerel TAC for 2008-2012 is listed separately in Table 4.1, below.

Table 4.1. UK Area VI Mackerel TAC

Year	UK TAC (Tonnes)
2008	136 522
2009	181 694
2010	172 268
2011	189 694
2012	151 132

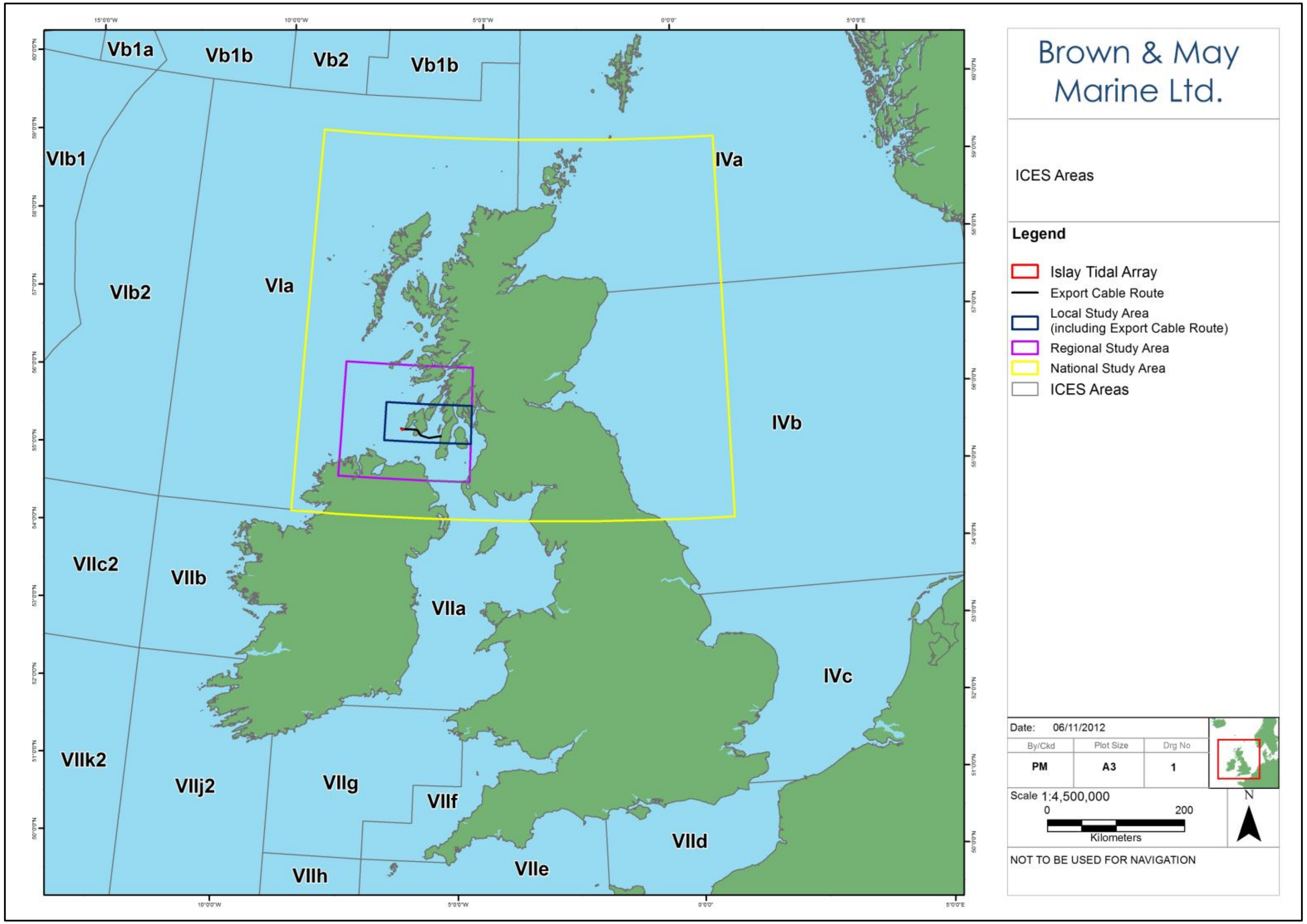
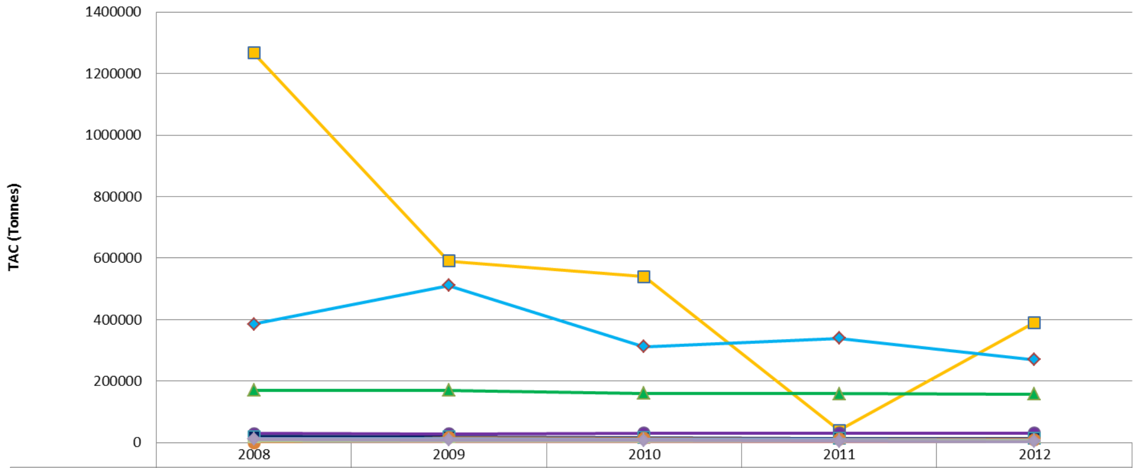


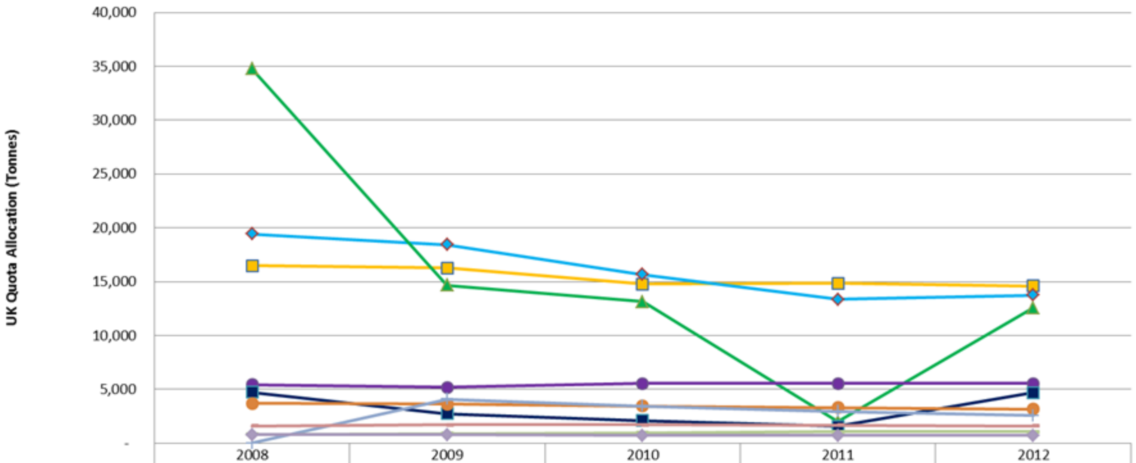
Figure 4.1 ICES Sea Areas



	2008	2009	2010	2011	2012
Blue whiting	1266282	590000	540000	40100	391000
Mackerel	385366	511287	311528	339295	269592
Horse mackerel	170000	170000	159881	158787	157989
Hake	30281	28879	30900	30900	30900
Nephrops	19885	18891	16057	13681	14091
Skates and Rays	0	15748	13387	11379	9915
Saithe	14100	13066	11106	9682	8230
Haddock	6120	3516	2673	2005	6015
Anglerfish	5155	5567	5567	5456	5183
Herring	11642	9314	7451	4471	4247

Year

Figure 4.2 Combined National TACs (Top 10 Species) in ICES Area VI (West Scotland and Rockall), 2008-2012 (Source: MMO)



	2008	2009	2010	2011	2012
Horse mackerel	16,470	16,276	14,765	14,850	14,587
Nephrops	19,415	18,445	15,677	13,357	13,758
Blue whiting	34,759	14,670	13,141	1,990	12,563
Hake	5,442	5,190	5,553	5,553	5,553
Haddock	4,743	2,737	2,081	1,561	4,683
Saithe	3,708	3,617	3,443	3,317	3,154
Skates and Rays	-	4,070	3,460	2,941	2,562
Anglerfish	1,586	1,713	1,713	1,679	1,595
Megrims	813	878	966	1,062	1,062
Clyde herring	800	800	720	720	720

Year

Figure 4.3 TACs (Top 10 Species) in ICES Area VI (West Scotland and Rockall), 2008-2012, UK only (Source: MMO)

The TAC system has been heavily criticised by some in the industry because it is considered that the system encourages the discarding of below minimum landing size (MLS) or over-quota fish at sea. Due to these concerns, the CFP has been undergoing review since 2009[3]. In June 2012 ministers agreed on a joint approach to the reform of the CFP based on an objective of increasing sustainability of stocks. In September 2012 the European Parliament endorsed the Commission's call for a thorough reform of the Common Fisheries Policy (CFP) to ensure long-term environmental sustainability and to secure economic and social viability. The reform proposals were adopted by the College of Commissioners (who implement new EU laws) in 2012[4]. The proposed changes to the CFP are discussed further in Section 10.0, Future Fisheries.

4.3.1 Over-10 Metre Fleet

National, regional and individual quotas for the over-10 metre fleet are assigned on the basis of historical rights. Vessel quotas are tangible assets which are eligible to be sold or leased, and national quotas may be exchanged between Member States.

Over-10 metre vessels are either a member of producer organisations (POs) who will manage quota for a number of vessels, or are non-sector vessels and are allocated quota on the basis of the vessels historic rights.

4.3.1.1 Effort (Days at Sea) Restrictions

In addition to quota restrictions, the over-10 metre fleet are subject to days at sea restrictions. This is part of the EC's policy which aims to reduce fishing effort in EU waters (one of the foundations of the CFP). The regulation itself (Annex V, EU Regulation 2287/2003) is somewhat complex, relating to gear type, mesh size and elected management periods, but effectively the measures included within the regulation effectively restricts vessels using demersal whitefish gears to the equivalent of 14 to 15 days a month at sea.

4.3.2 Under 10 Metre Fleet

In Scotland over two thirds of the fleet are under-10 metres[5], although the sector only receives approximately 3% of the TAC. The under-10 metre fleet is also subject to sea area and quota restrictions for certain species: restrictions on the *Nephrops* fishery for the under-10 metre fleet were introduced in 1999 as catch limits. The aim of these restrictions is to maintain the integrity to submit a NEP1 form to the local Fishery Office[6].

4.4 Shellfish Entitlements

In 2004, Shellfish Entitlements were issued to owners of licensed vessels with a track record (between 1st January 1998 and 31st March 2004) of landings over a particular weight of these species per year (200kg lobster and 750kg crab). This entitlement allowed unrestricted amounts of crab and lobster to continue to be caught. Vessels that are under-10 metres and have a shellfish entitlement must submit weekly log sheets for crab and lobster landings to the local Fishery Office.

4.5 Scallop Dredging Restrictions

The scallop fishery is managed in the main through minimum landing sizes (100mm shell width), restrictions on dredge numbers and seasonal closures. There are currently no additional limits in the form of catch or effort quota. Restrictions on the number of dredges that can be used depend upon the distance the vessel is operating from the coast. In Scottish waters, vessels are allowed up to

[3] Synthesis of the Consultation on the Reform of the Common Fisheries Policy (2010) European Commission
[4] Reform on the common fisheries policy available at: http://ec.europa.eu/fisheries/reform/index_en.htm accessed 12.10.2012
[5] Natural Scotland (2010) Scottish Sea Fisheries Statistics 2009. *Scottish Government*
[6] Day to day management of fishing activities is the responsibility of regional Fishery Officers

eight dredges per (vessel) side inside 6nm; ten dredges per side between 6 and 12nm and 14 dredges per side outside 12nm. In English waters, there are no restrictions outside 6nm. It is possible that revisions to the number of dredges operated will apply in the future, potentially to align the number of dredges employed in Scottish and English waters (pers. comm. Scallop industry representative, 2012).

4.6 Regional and Local Fishing Restrictions

There are a number of closures and restrictions on fishing activity which apply within the regional study area. In Scottish waters, in addition to restrictions placed upon fishing activities transposed from EU and UK law, there are Scottish specific legislations, known as Statutory Instruments (SIs). These represent a form of secondary legislation in Scotland, created by the Scotland Act (1998) and are used to exercise devolved powers.

In response to ICES advice regarding the sensitive state of cod stocks a number of seasonal closures aimed at protecting spawning cod were introduced during 2001 and 2002 in EU waters. The Firth of Clyde (
Figure 4.4) is a key spawning area for cod and as such has had a seasonal closure imposed since 2001 under the long-term Cod Recovery Plan (EC 1342/2008). Since 2002 the decision relating to the closure has been the sole responsibility of the Scottish Government under the Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2010 (SSI 2010 No.9). The closure operates as follows:

- The closure operates during the cod spawning season from 14th February to 30th of April inclusive.
- In the larger and more easterly zone, only scallop dredging, creeling and *Nephrops* trawls are permitted during this period (Figure 4.4)
- Bottom (demersal) trawling in the outer area at the mouth of the Clyde is prohibited (Figure 4.3). Creeling and scallop dredging are permitted.

Emergency measures introduced in 2009 under the long term cod management plan (Reg. (EC) 850/1998 Annex I and Reg. (EC) 2056/2001) stipulate further gear and catch composition regulations which apply to ICES division VIa (West of Scotland):

- For demersal trawlers targeting white fish a minimum mesh size of 120mm for vessels > 15m LOA (110mm for vessels < 15m LOA) and inclusion of a 120mm square mesh panel (SMP)
- Demersal otter trawlers targeting *Nephrops* are required to use 120mm SMP or sorting grid and minimum mesh size of 80mm.
- For whitefish fisheries no more than 30% of the retained catch can consist of cod, haddock, and whiting
- For *Nephrops* directed fisheries, no more than 10% of the retained catch can consist of cod, haddock, and whiting

It should be noted that in 2012 there is a zero TAC for cod in area VIa and a 1.5% bycatch by live weight limit, but the catch composition limit on haddock (as described above) has been removed (Reg. (EU) 161/2012).

Since 2009 the Irish Government has implemented a seasonal cod closure from October 31st to March 31st in the North West Cape area of ICES rectangle 39E3[7] (Fisheries Management Notice No.7 of 2012). The closure operates under the same gear restrictions as detailed previously for other areas of area VIa and is shown in Figure 4.4.

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[7] ICES advice Book 5 (2012) Celtic Sea and West of Scotland. Cod in area VIa

Further SI restrictions which apply in the regional study area are shown in Figure 4.4 and are as follows:

- The restriction in Loch Ryan applies to the area inshore of a line drawn from Milleur Point to Garry Point. Use of mobile or active gears is prohibited all year. Dredging for mussels and oysters is the only method permitted within the area.
- Use of all mobile gear is prohibited on the Ballantrae Bank from 1st of February to 30th April each year. This relates to the protection of spawning herring from the Clyde stock.
- All mobile or active gear is prohibited throughout the Firth of Clyde from midnight on Friday until midnight Sunday all year.
- In Loch Sween, the use of suction dredges is prohibited all year.
- In the Firth of Clyde, vessel size is restricted to less than 21.3m (70ft) LOA

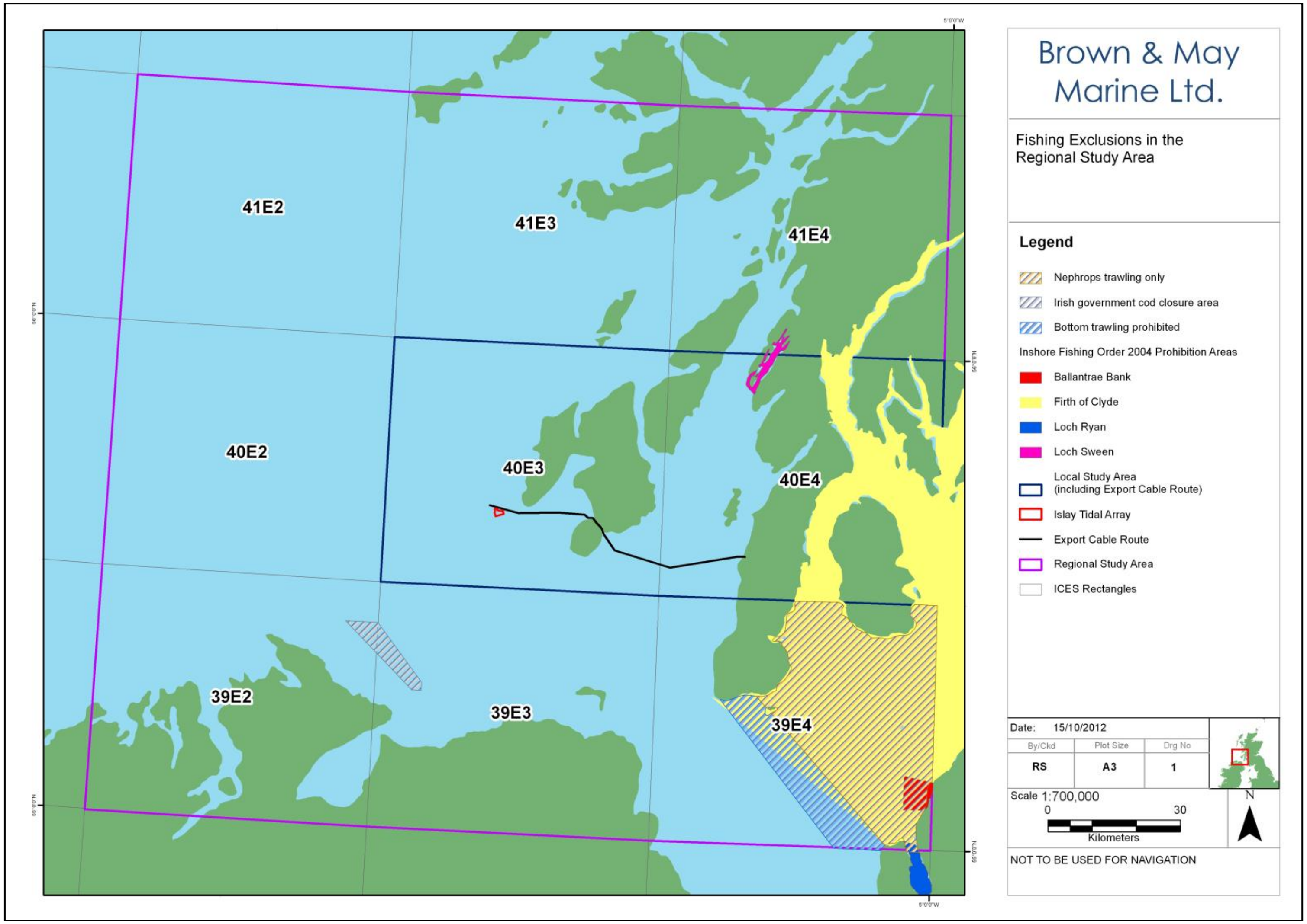


Figure 4.4 SI Restrictions upon Inshore Fishing Activities Relevant to the Regional Study Area (Source: Scottish Government)

5.0 MMO Fisheries Statistics (Landings Values and Effort Data Sets)

5.1 Landings Values

5.1.1 National Overview

Figure 5.1 shows the landings values of the top 10 commercial species. Total combined landings from ICES rectangle 40E3 in which the development is located are of moderate importance on a national scale are principally formed by shellfish such as edible crab, lobster, velvet crab and scallops. Landings values from 40E4 are amongst the highest recorded nationally, with Nephrops landings representing 75% of the total. The remainder is formed by scallops, velvet crab and razor clams.

Figure 5.2 to Figure 5.5 show the relative distribution of landing values by individual species or species groups. Comparisons between species or species groups should not be made due to the respective difference in maximum landings values for each.

Figure 5.2 shows that the combined value of edible crab, velvet crab and lobster landings in the local study area are among the highest recorded nationally and approximately similar to those from other high values areas on the east coast and Orkney Islands. Landings of edible crab represent the greater proportion of landings by species in the area of the local study area in which the development is located (40E3). This is in contrast to the east coast, where lobster forms the highest value component of total crustacean landings. Landings from the area of the export cable route (40E4) record more moderate values and crab and lobster landings are of secondary importance to velvet crab.

Figure 5.3 shows the landings values of king scallops on a national scale. Scallop landings from both local study area rectangles are of moderate to high value and slightly greater from 40E4 (export cable route) compared to 40E3. These values are similar to those recorded from other grounds on both west and east coasts.

Figure 5.4 shows the value of *Nephrops* on a national scale. In 40E4 (export cable route) *Nephrops* landings values are among highest recorded in Scottish (and UK) waters; contrasting with those from 40E3 which are among the lowest.

Figure 5.5 shows the value of razor clams landings on a national scale. Landings from 40E4 are the highest recorded in UK waters. Razor clam landings in 40E3 are of considerably lower value, similar to those recorded in around the Orkneys, and other localised areas of the west and east coasts of Scotland. The relatively low level of landings values compared to the other principal commercial species should be noted.

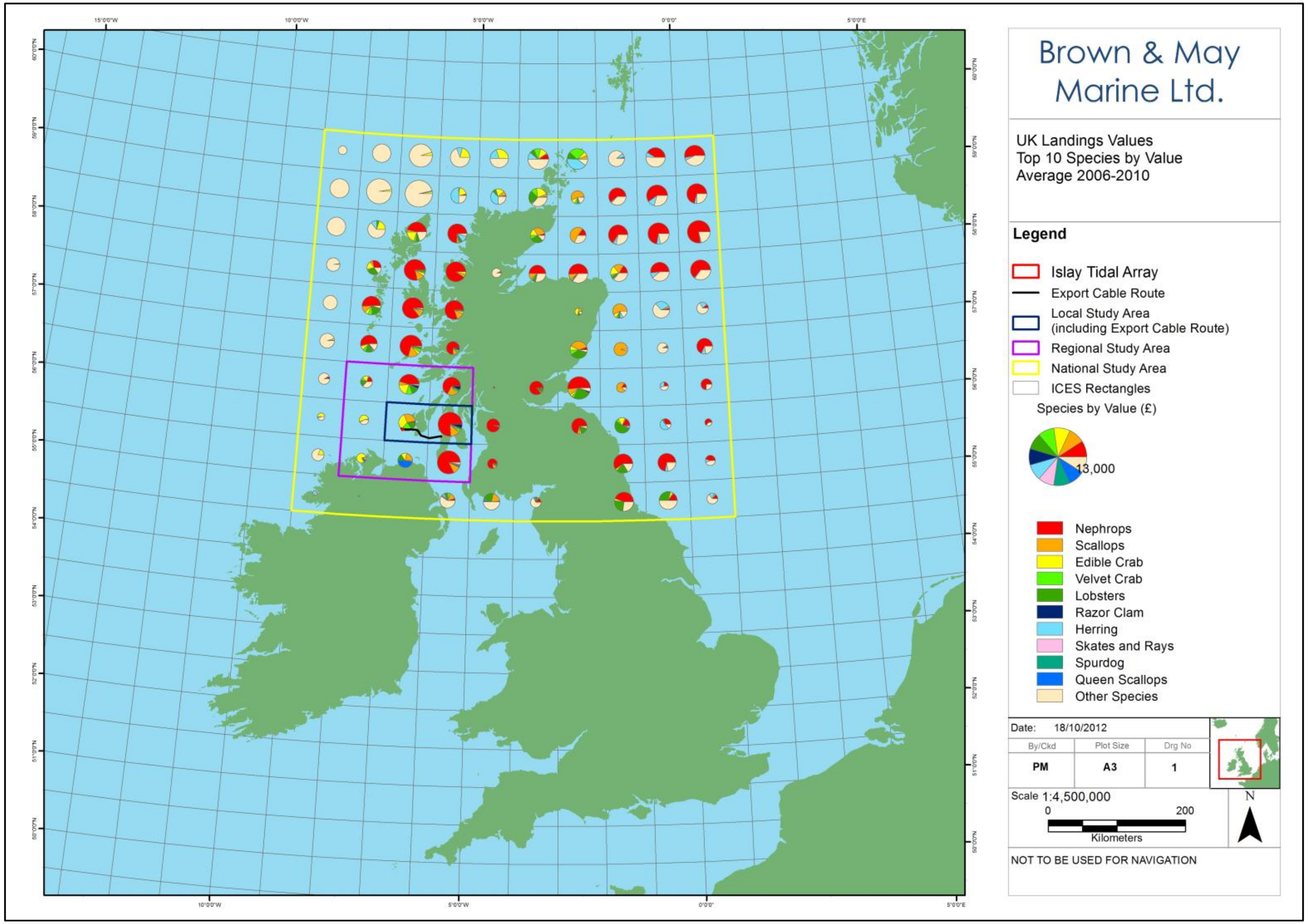


Figure 5.1. Landings Values by Species (Average 2006-2010) by in the National Study Area

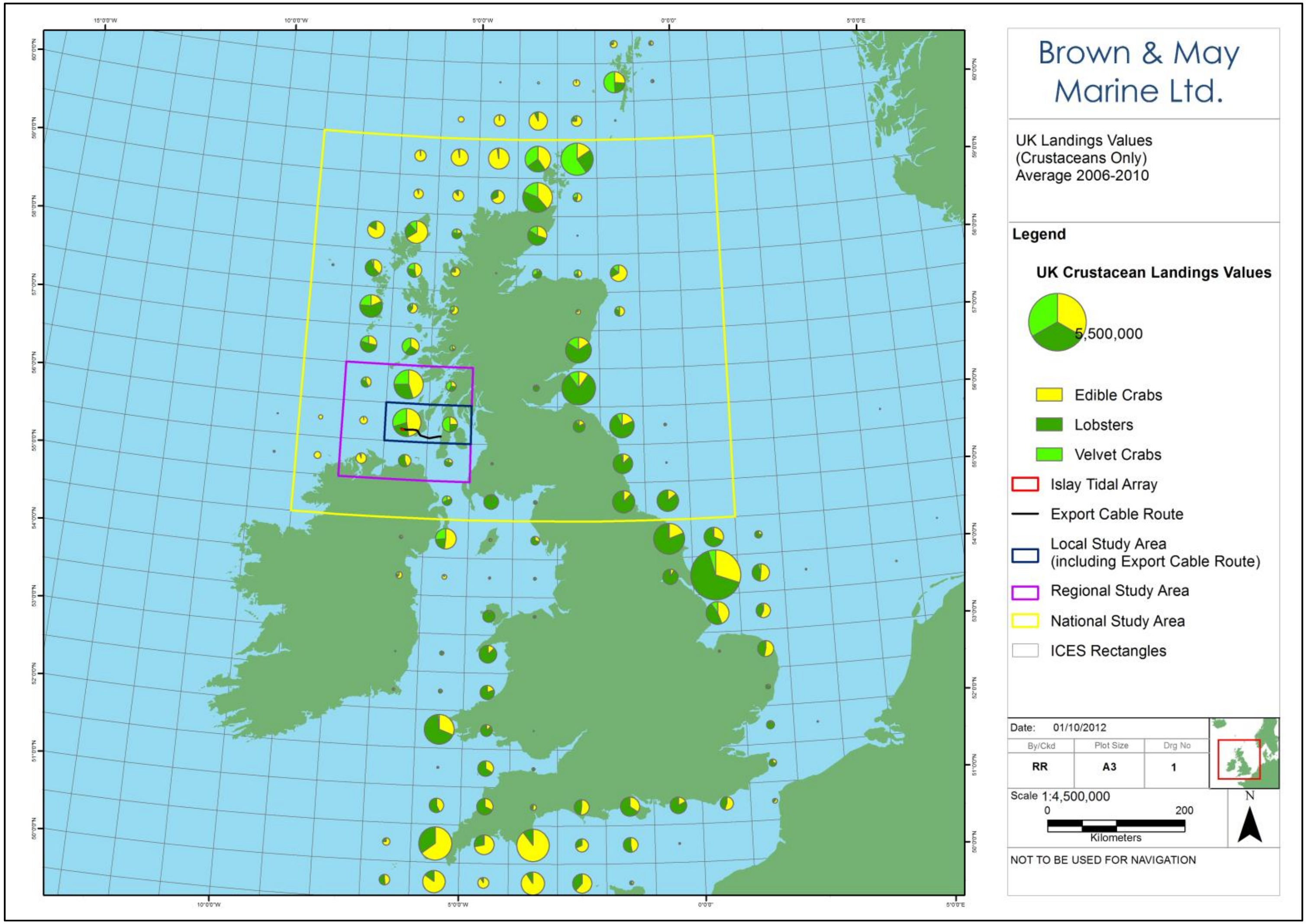


Figure 5.2 Landings Values by Species, Crustaceans only (Average 2006-2010) in the National Study Area (Source: MMO)

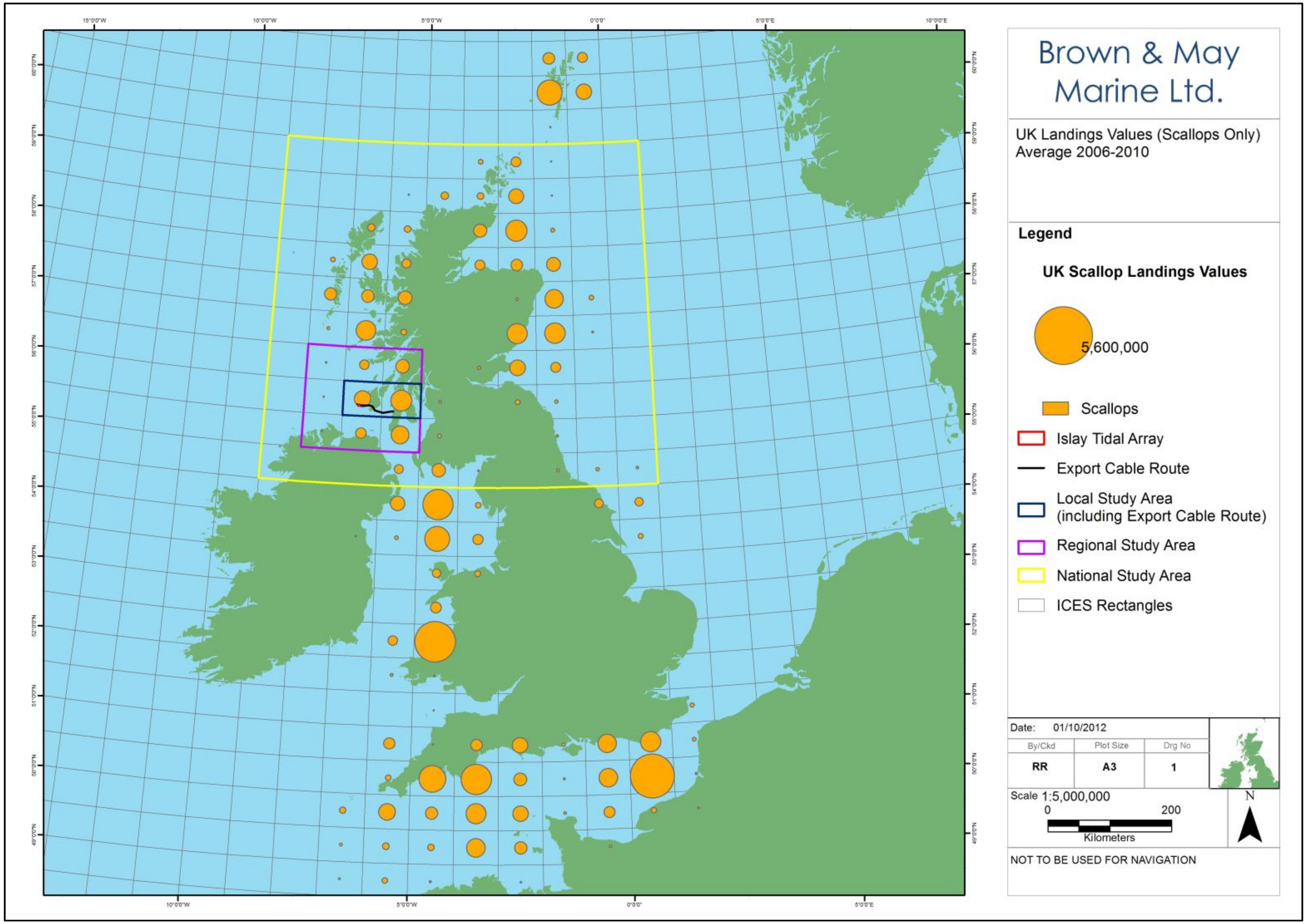


Figure 5.3 Landings Values by Species, King Scallops Only (Average 2006-2010) in the National Study Area (Source: MMO)

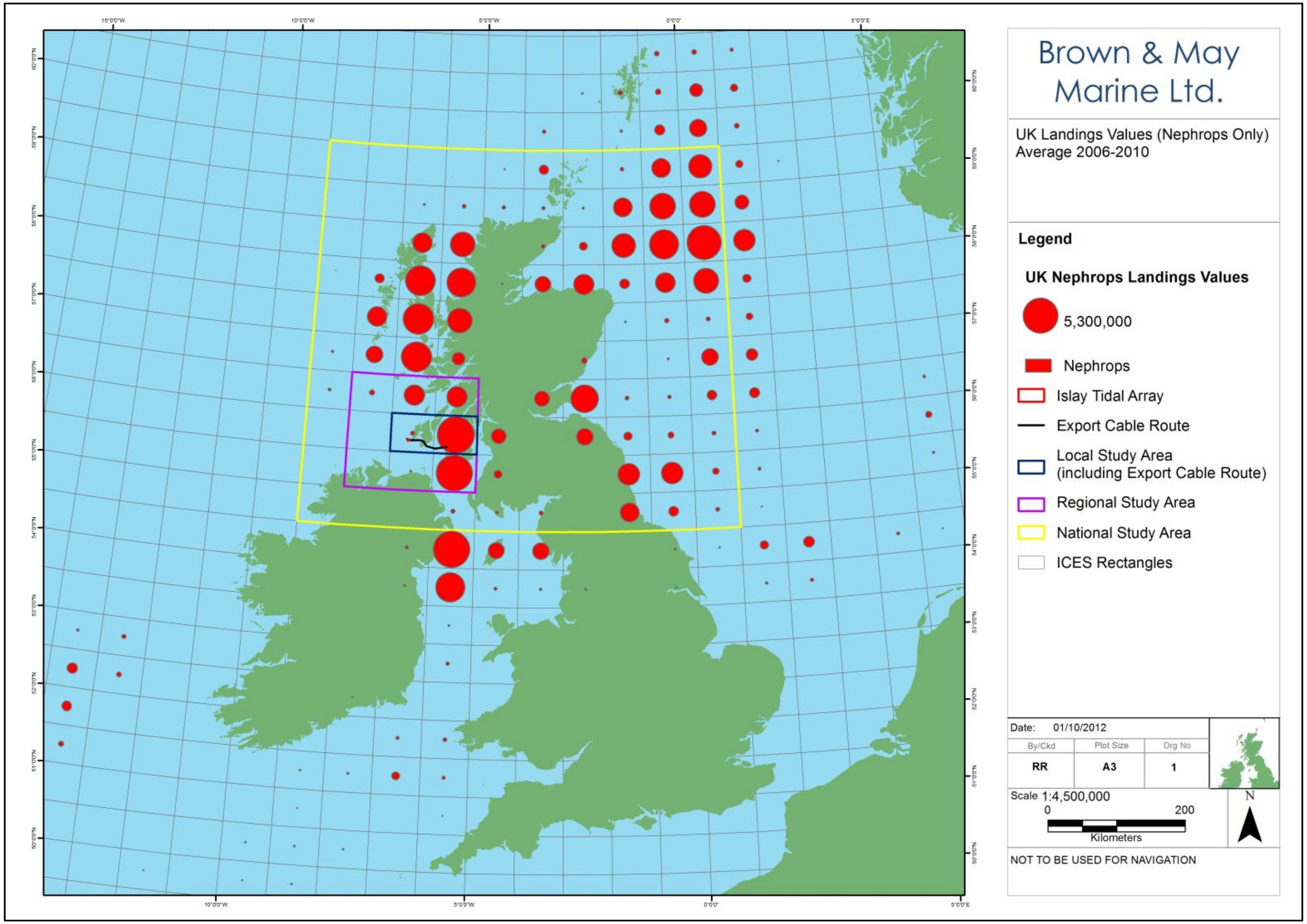


Figure 5.4 Landings Values by Species, *Nephrops* Only (Average 2006-2010) in the National Study Area (Source: MMO)

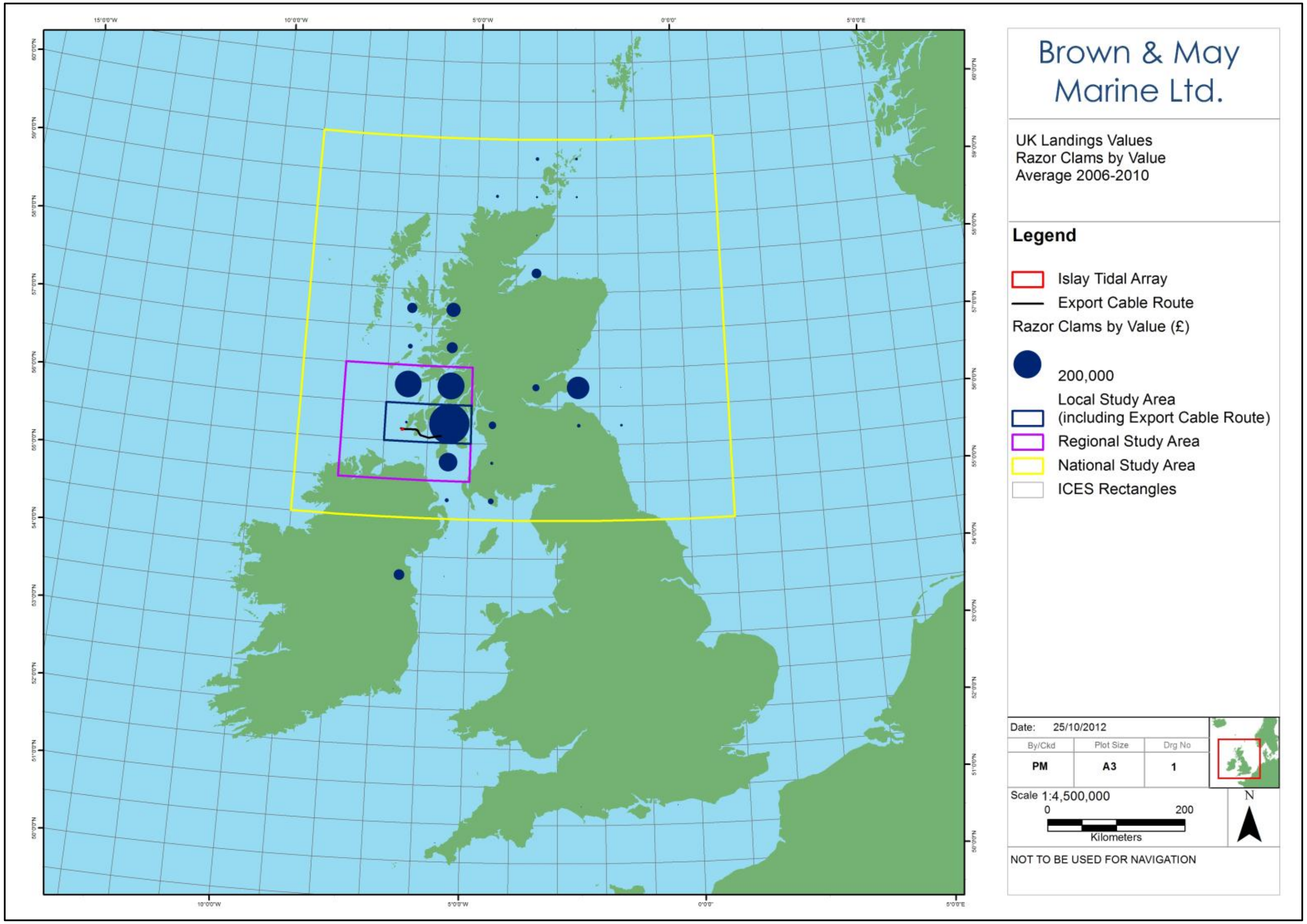


Figure 5.5 Landings Values by Species, Razor Clams Only (Average 2006-2010) in the National Study Area (Source: MMO)

5.1.2 Regional Overview

Figure 5.6 and Figure 5.7 illustrate landings values recorded in the regional study area by species and method, respectively. In terms of value, landings show some spatial variability, generally being higher from central and eastern rectangles. Landings values from 40E4 (export cable route) are particularly high. Overall, landings are dominated by shellfish with significant landings of finfish recorded from 41E2 and 40E2 only (haddock and mackerel respectively). These values are low compared to those recorded by shellfish elsewhere in the study area.

On the eastern side of the study area *Nephrops* form the greater proportion of total landings values and are also important north of the site in 41E3. Landings of *Nephrops* from 40E3, in which the development is located, are comparatively low. In contrast approximately 75% (£5,987,513) of landings values in 40E4 (export cable route) originate from this fishery. Bottom otter trawls (including both categorisations of demersal and *Nephrops* trawls) record the highest landings values by method and are the principal gears used to target the fishery. Creels are also used to target *Nephrops,* though with the exception of 41E4, record considerably lower landings values.

Creels are used to target crustaceans such as edible crab, lobster and velvet crab. Landings of edible crab represent the greatest contribution to the total landings from 40E3, 40E2, and 39E2. Lobsters represent relatively high landings values in 40E3, 41E3, and 41E2. Velvet crabs represent significant proportions of landings by value in 40E3 and 41E3 only. All three species are targeted solely by vessels operating creels. The proportions of landings values represented by this method correspond to those observed for lobster and both crab species in rectangles where these species dominate landings.

Scallops form an important component of total landings values in central (40E3, 39E3) and eastern areas (39E4, 40E4, and 41E4). Landings of queen scallops contribute significantly to the total value recorded in 39E3. It should be noted that landings of queen scallop by boat dredges are principally by Scottish vessels, with a type of dredge different to those used to target king scallops, known as 'gate gear'. Queen scallops are also captured by bottom otter trawls. King scallops are principally targeted by boat dredges.

Razor clams record comparatively low landings values in 40E4 and 39E4. The methods used the target the species differ by rectangle: in 40E4 hand fishing records the majority of landings values, replaced by mechanized dredges in 39E4.

Figure 5.8 shows the distribution of landings values by vessel categories in the regional study area. The over-15m fleet record a significant proportion of landings values in 39E3, 39E4, 40E4 (export cable route). As outlined previously, vessel size in the Firth of Clyde is restricted to less than 21.3m LOA. A significant proportion of vessels targeting *Nephrops* and scallops in eastern areas of 39E4 and 40E4 will therefore be under this length. The contribution of the over-15m fleet to the total landings values in 39E3 likely reflects increased activity by larger vessels targeting both queen and king scallop fisheries. Vessels under- 15m (both under 10m and 10-15m categories) tend to record higher proportions of landings values where creel caught shell fish such as crab and lobster are commercially important.

Figure 5.9 shows average landings values by vessels from different licensing authorities in the British Isles in the regional study area. Scottish vessels record the highest overall values. The comparatively high landings values recorded by Northern Irish vessels is due to the Clyde *Nephrops* fishery 39E4 and 40E4) which visiting N.I vessels typically target during the spring and summer[8]. Landings in

[8] Fishing News, 13th July 2012. *Campbeltown services diverse prawn fleet*

rectangles close to from Northern Irish vessels represent approximately 50% in rectangles 39E2 and 39E3, and 90% in 40E2. English, Welsh and Irish vessels record much lower values.

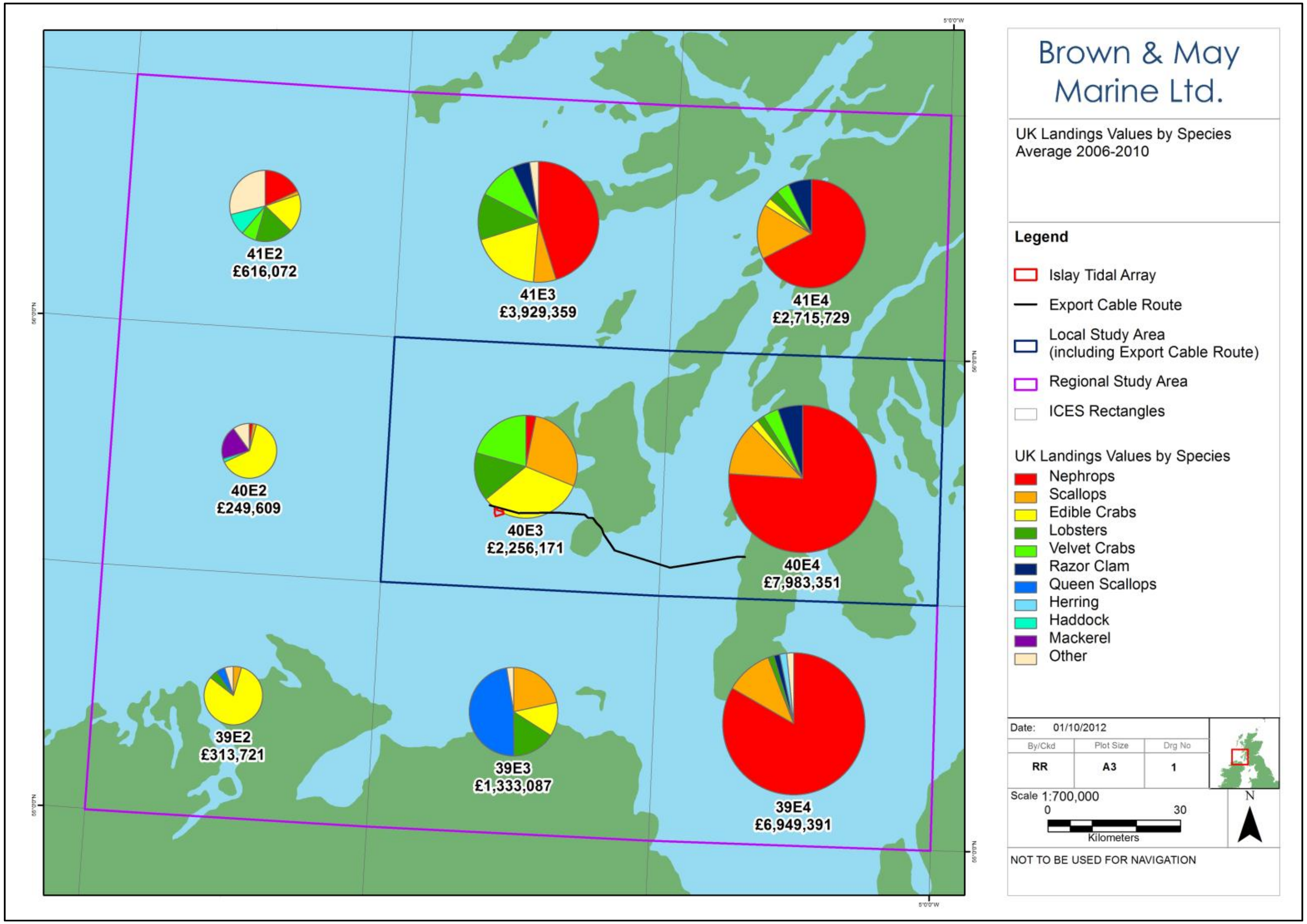


Figure 5.6 Landings Values by Species (Average 2006-2010) in the Regional Study Area (Source: MMO)

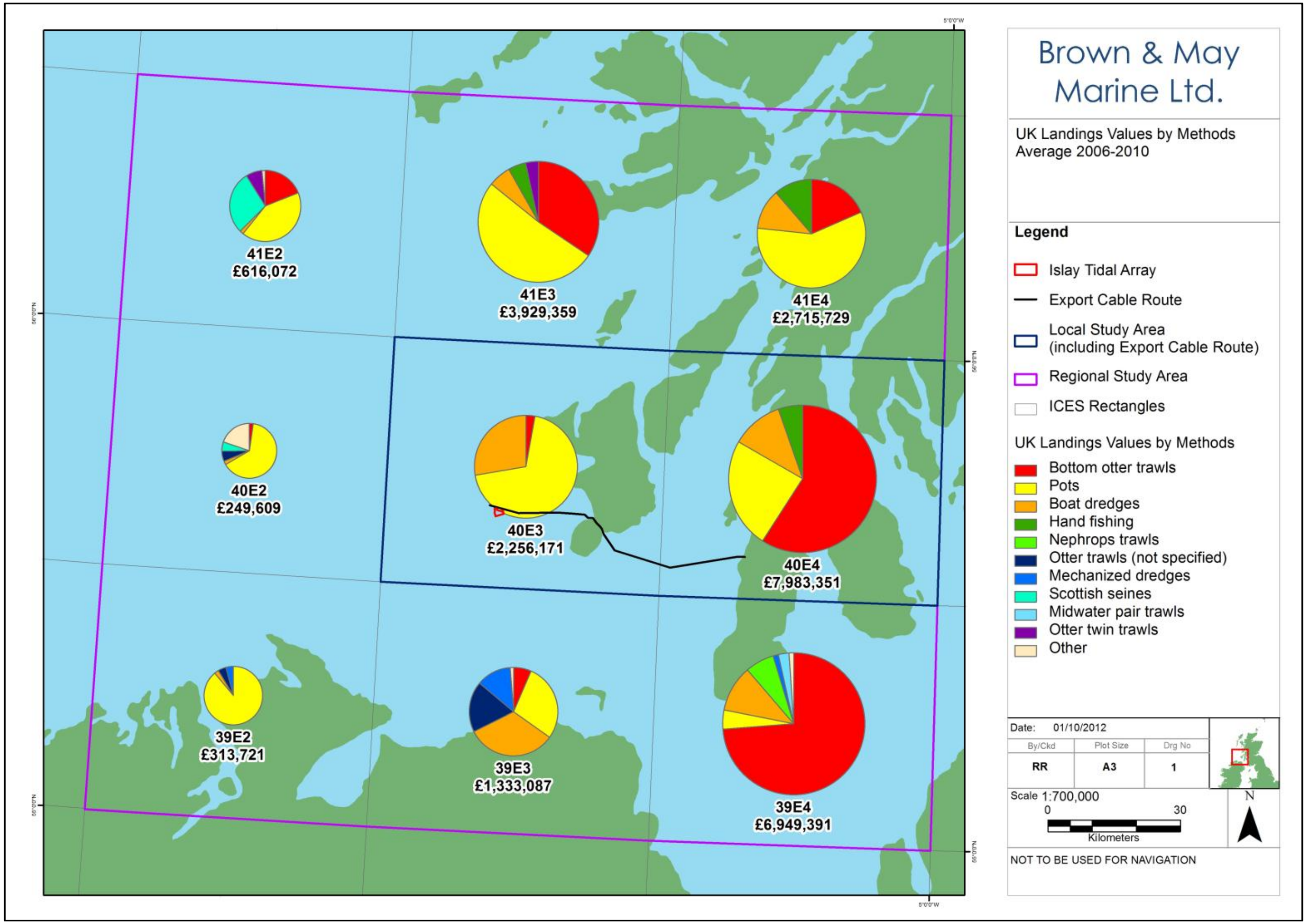


Figure 5.7 Landings Values by Method (Average 2006-2010) in the Regional Study Area (Source: MMO)

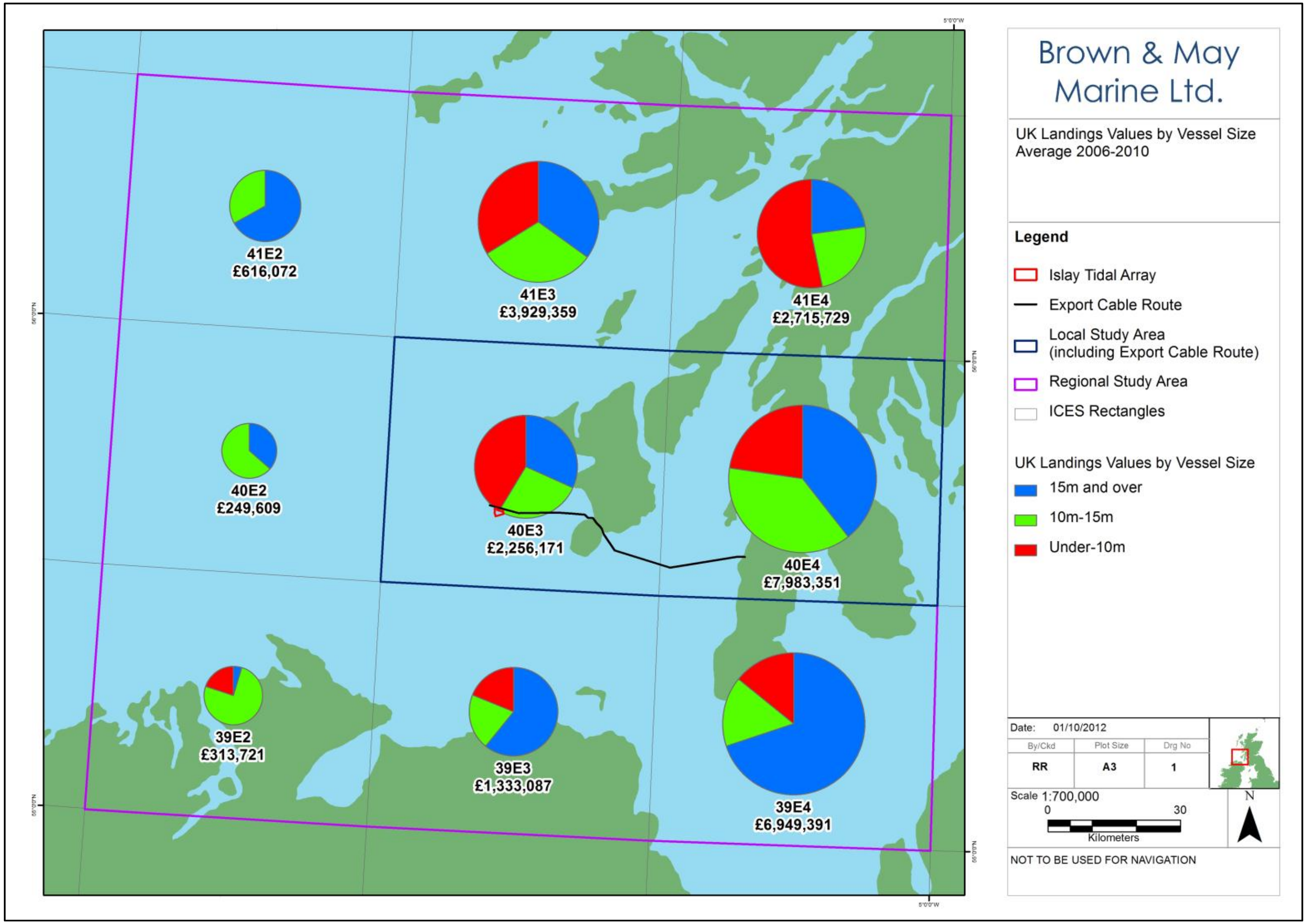


Figure 5.8 Landings Values by Vessel Category (Average 2006-2010) in the Regional Study Area (Source: MMO)

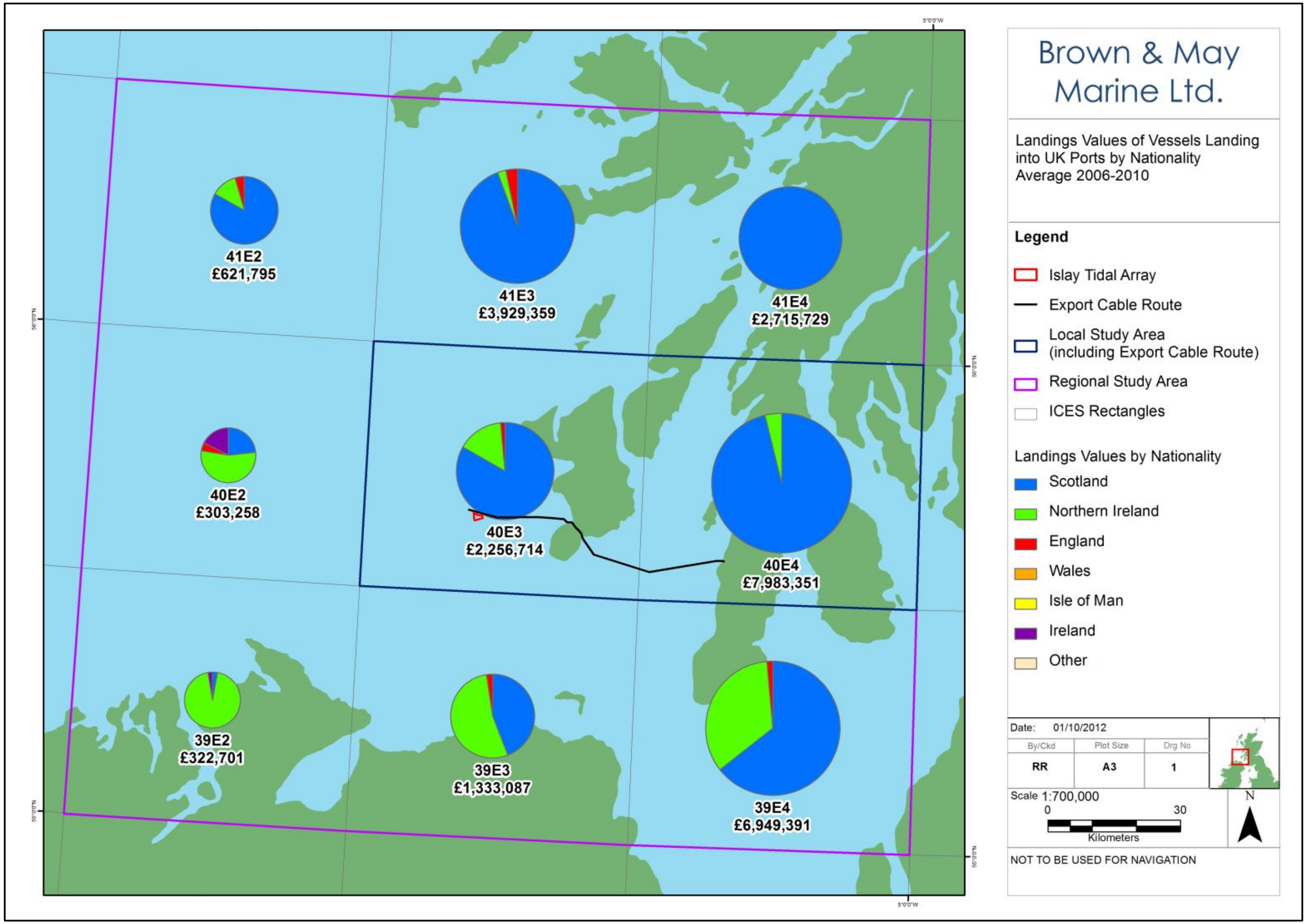


Figure 5.9 Landings Values (Average 2006-2010) by Licensing Authority within the British Isles (Source: MMO)

5.1.3 Local Study Area (ICES Rectangles 40E3 and 40E4)

Figure 5.10 shows the landings values of the five species of greatest commercial importance in 40E3. Landings are comprised almost entirely of high value shellfish species. Edible crab represent the highest value landings (£734,803, 33%), followed by scallops (£622,573, 28%), velvet crab (£458,884, 20%) and lobster (£339,314, 15%). *Nephrops* landings in the local study area are of low value compared to adjacent south and south eastern areas, constituting only 3% (£69,763) of total landings. Combined values of all other species comprise a minimal component of the total average landings values for 40E3 (£24,171, 1%).

Figure 5.11 shows the distribution of landings values for the most commercially important species from 40E4 (export cable route). As with 40E3, shellfish species represent the majority of landings values. Total landings from 40E4 (£7,983,351) are approximately 3.5 times greater than those from 40E3 (£2,256,171). This is principally related to the high value landings originating from *Nephrops* fisheries located in the Firth of Clyde (east) and Sound of Jura (west), parts of which are both located in 40E4 (£5,955,796, 75%). It is important to note that at this level of statistical analysis, given that landings cannot be broken down by location within an ICES rectangle, it is not possible to ascertain which grounds contribute the greater proportion to total *Nephrops* landings within 40E4.

Scallops (£918,734; 11%) record the second highest value landings in 40E4. On average, landings from the razor clam fishery (5%; £ 424,726) record approximately half that recorded by scallops. In all cases, the commercial values of velvet crab (3%; £268,284), edible crab (£135,748; 2%) and lobster (£125,494; 2%) are less than half those recorded for the same species in 40E3. Herring (£57,832; 1%) and other species (£96,738; 1%) contribute minimally to total landings value of 40E4.

Figure 5.12 shows the average annual landings values from 40E3 by species and method. The contribution of each method to total average landings values are given in parentheses. Creels (£1,555,193; 69%) are used to the exclusion of all other methods to target edible crab, velvet crab and lobster. A small proportion of *Nephrops* landings also originate from the creel fishery although demersal otter trawls (£63,680; 3%) are the primary method employed to target this species. Boat dredges (£617,740; 27%) record the highest value landings of scallops which are also targeted by hand fishing, although this represents a minor contribution to the total landings for the species. All other species and methods record low landings values in the local area.

Figure 5.13 shows the average annual landings by species and method in 40E4 (export cable route). Contributions of each method to total average landings values for 40E4 are also given in parentheses. Demersal otter trawls (£4,640,549; 58.1%) are the principal gear type used to target *Nephrops*. In contrast to 40E3, creels (£1,904,004; 23.8%) also record significant landings of *Nephrops* (£1,328,024). Otter twin trawls (£10,666; 0.1%) and *Nephrops* trawls (£11,176; 0.1%) account for much smaller proportions but are effectively the same gear as demersal otter trawls under different categorisation. Creels are used exclusively to target edible crab, velvet crab, and lobster. Scallops are primarily targeted by dredges (£892,136; 11.2%) with lower value landings recorded by hand fishing (£419,967; 5.3%). Hand fishing accounts for the majority of razor clam landings, with a smaller proportion taken by mechanised dredges (£15,354; 0.2%) and scallop dredges. Herring are targeted solely by mid-water pair trawls (£60,598).

Figure 5.14 shows the annual average landings values by method and vessel category in 40E3. Vessels under-15m LOA (both 10m and 10-15m categories) record the highest proportion of landings values overall. The majority of value from the creel fishery originates from vessels in the under- 10m sector (£1,555,193), with a smaller proportion from the 10-15m (£463,233) and over -15m (£222,991) categories, respectively. Landings values recorded by the scallop dredging fleet are divided approximately equally by vessels in the under- 10m (£617,740) and over-15m categories (£422,565). Activity by the 10-15m sector is comparatively lower (£136,354). Patterns in the demersal trawl fishery are similar, with recorded value distributed approximately equally between the under 10m (£63,630) and over-15m categories. (£56,263) Very low values are recorded by non-UK vessels operating creels, with negligible values recorded in all other gear categories.

Figure 5.15 shows the annual average landings values by method and vessel category in 40E4. In terms of value, landings by the demersal otter trawl fleet are distributed approximately evenly between the 10-15m (£ 2,051,253) and over-15m (£2,316,580) categories, with a smaller proportion originating from vessels under 10m in length (£272,716). All landings from the creel fishery are from vessels under -15m, with the greater percentage of the value recorded by the under-10m category (£1,186,272). The majority of scallop dredgers are over -15m in length (£714,285) the 10-15m and under-10m fleets record lower landings values (£165,011, £12,841, respectively).

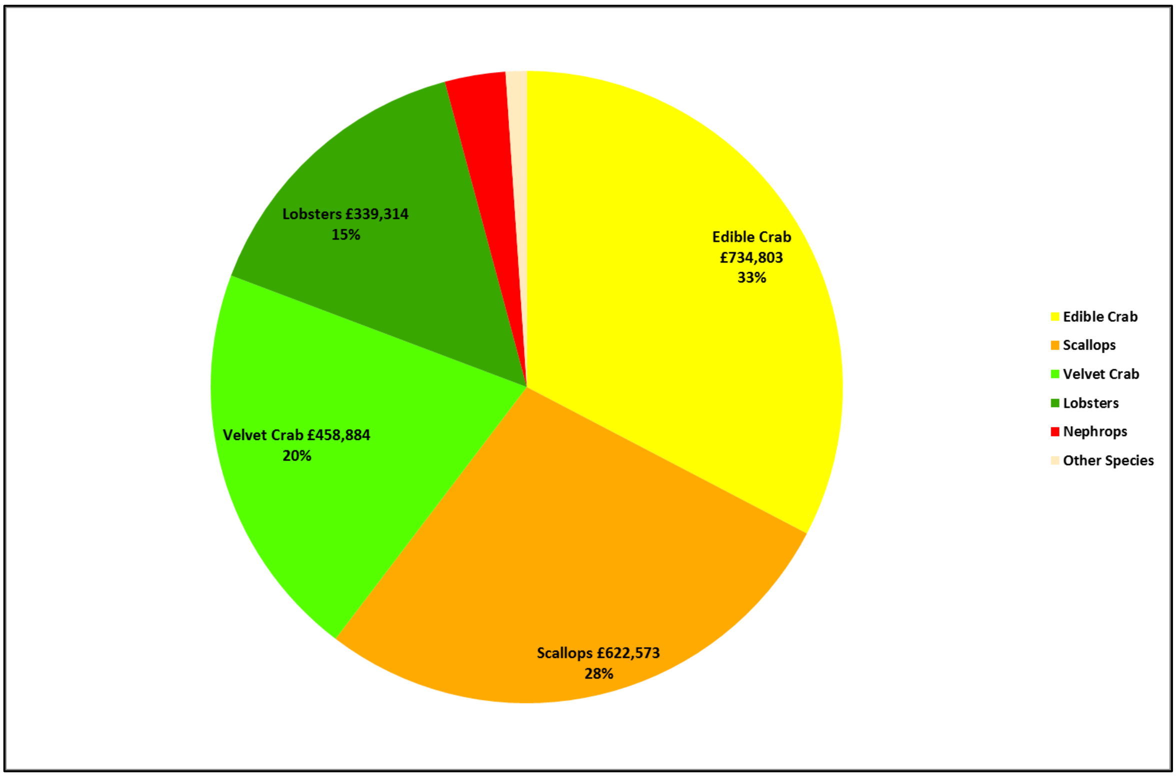


Figure 5.10 Percentage Distribution of Landings Values (Average 2006-2010) by Species in ICES Rectangle 40E3 (Source: MMO)

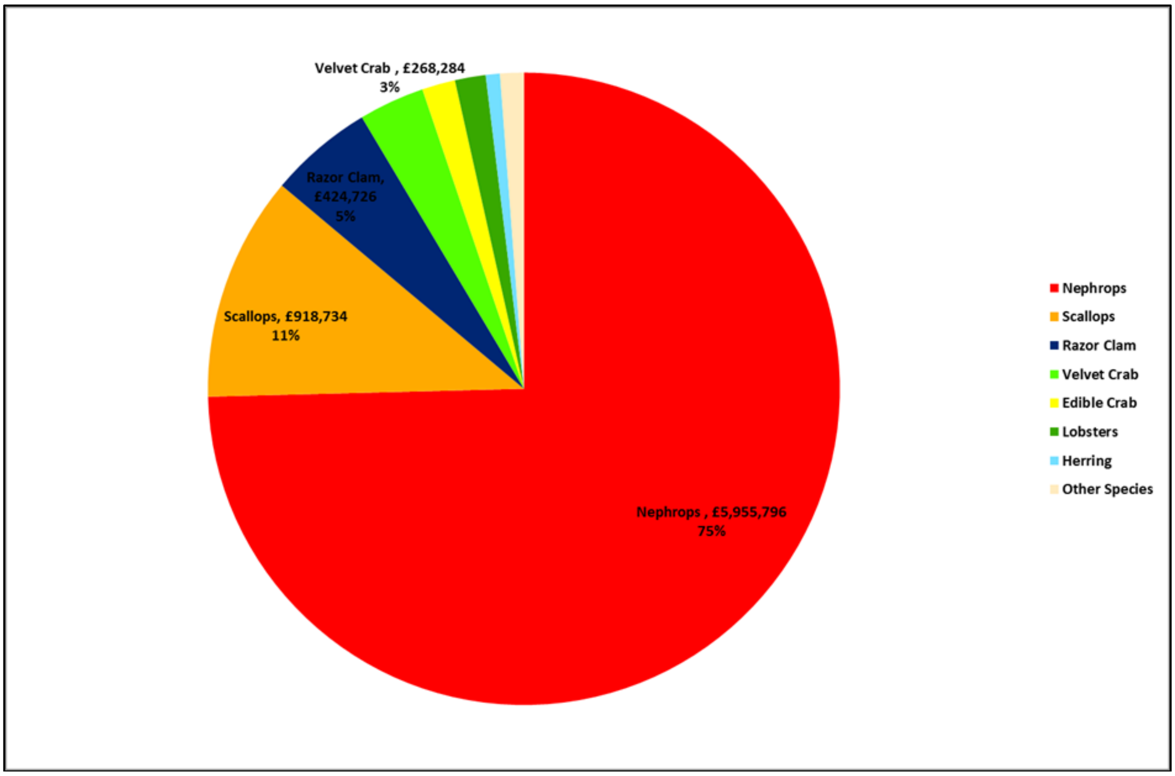
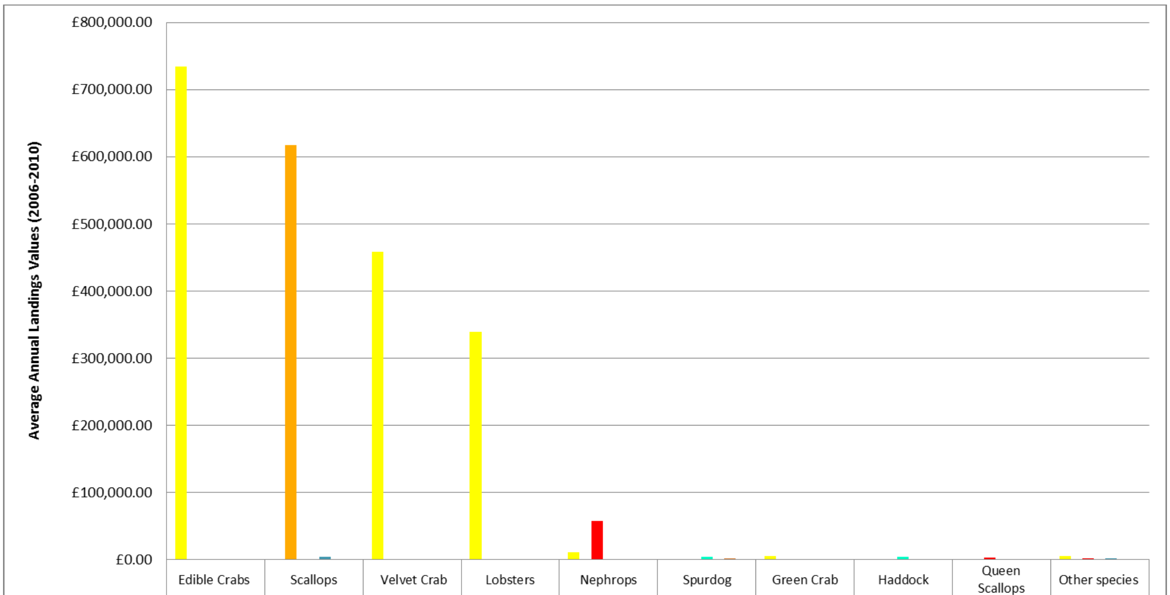
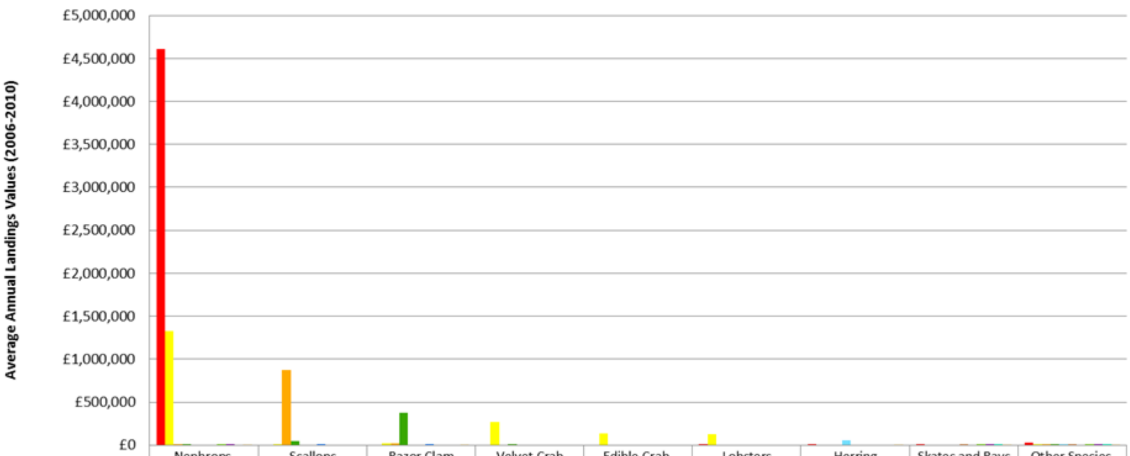


Figure 5.11 Percentage Distribution of Landings Values (Average 2006-2010) by Species in ICES Rectangle 40E4 (Source: MMO)



	Edible Crabs	Scallops	Velvet Crab	Lobsters	Nephrops	Spurdog	Green Crab	Haddock	Queen Scallops	Other species
Pots	£734,718.58	£271	£458,743	£339,302	£11,562	£0	£5,109	£0	£0	£5,488
Boat dredges	£0	£617,685	£52	£2	£0	£0	£0	£0	£0	£0
Bottom otter trawls	£0	£0	£0	£0	£57,876	£27	£0	£262	£3,009	£2,456
Scottish seines	£0	£0	£0	£0	£0	£4,621	£0	£4,553	£0	£126
Hand fishing	£80	£4,347	£78	£8	£0	£0	£4	£0	£0	£1,616
Longlines	£0	£0	£0	£0	£0	£2,559	£0	£7	£0	£1,158
Other methods	£4	£270	£11	£1	£325	£0	£0	£0	£376	£0

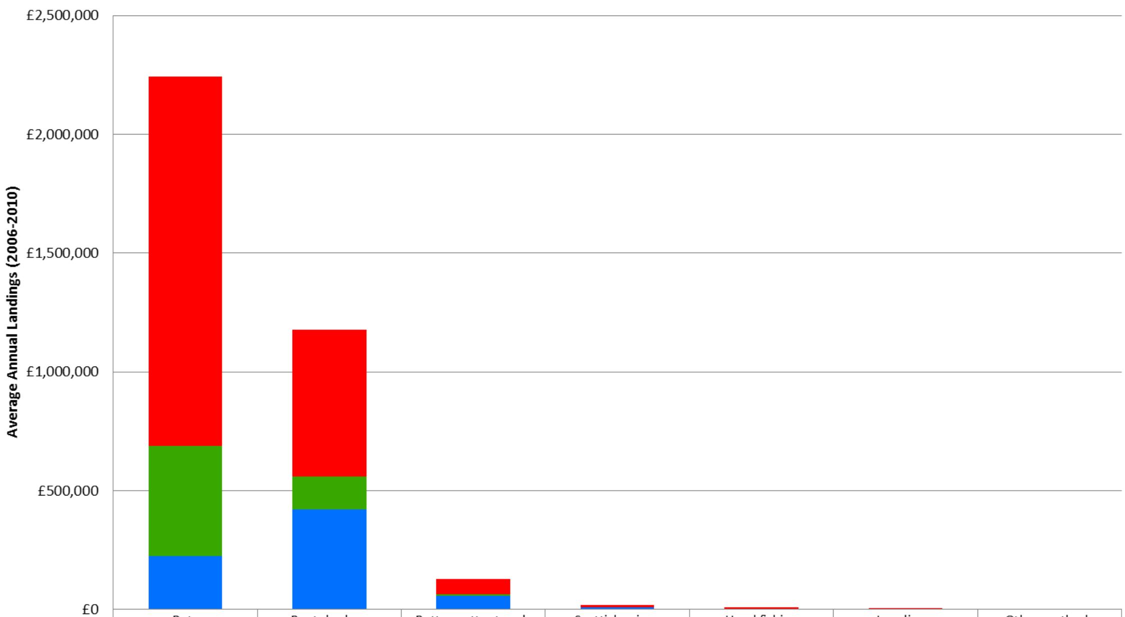
Figure 5.12 Annual Landings Values (Average 2006-2010) by Species and Method in ICES Rectangle 40E3 (Source: MMO)



	Nephrops	Scallops	Razor Clam	Velvet Crab	Edible Crab	Lobsters	Herring	Skates and Rays	Other Species
Bottom otter trawls	£4,605,946	£0	£0	£0	£0	£177	£1,040	£6,638	£26,748
Pots	£1,328,024	£349	£19,334	£268,229	£135,748	£125,316	£0	£0	£14,164
Boat dredges	£118	£873,872	£16,783	£0	£0	£0	£0	£0	£1,363
Hand fishing	£36	£44,036	£373,483	£55	£0	£0	£0	£0	£2,358
Midwater pair trawls	£0	£0	£0	£0	£0	£0	£56,628	£0	£3,971
Longlines	£0	£0	£0	£0	£0	£0	£0	£9,788	£11,268
Mechanized dredges	£0	£477	£14,878	£0	£0	£0	£0	£0	£0
Nephrops trawls	£10,793	£0	£0	£0	£0	£0	£0	£9	£375
Otter twin trawls	£10,498	£0	£0	£0	£0	£0	£0	£17	£151
Scottish seines	£0	£0	£0	£0	£0	£0	£0	£164	£5,249
Other Methods	£382	£0	£248	£0	£0	£0	£164	£1	£1,635

Species

Figure 5.13 Annual Landings Values (Average 2006-2010) by Species and Method in ICES Rectangle 40E4 (Source: MMO)



	Pots	Boat dredges	Bottom otter trawls	Scottish seines	Hand fishing	Longlines	Other methods
U10m	£1,555,193	£617,740	£63,630	£9,299	£6,134	£3,724	£994
10m-15m	£463,233	£136,354	£6,965	£0	£2,240	£0	£166
15m and over	£222,991	£422,565	£56,263	£9,299	£0	£3,724	£808
Non-UK	£543	£0	£0	£0	£0	£0	£0

Method

Figure 5.14 Average Annual Landings Values (Average 2006-2010) by Method and Vessel Category in ICES Rectangle 40E3 (Source: MMO)

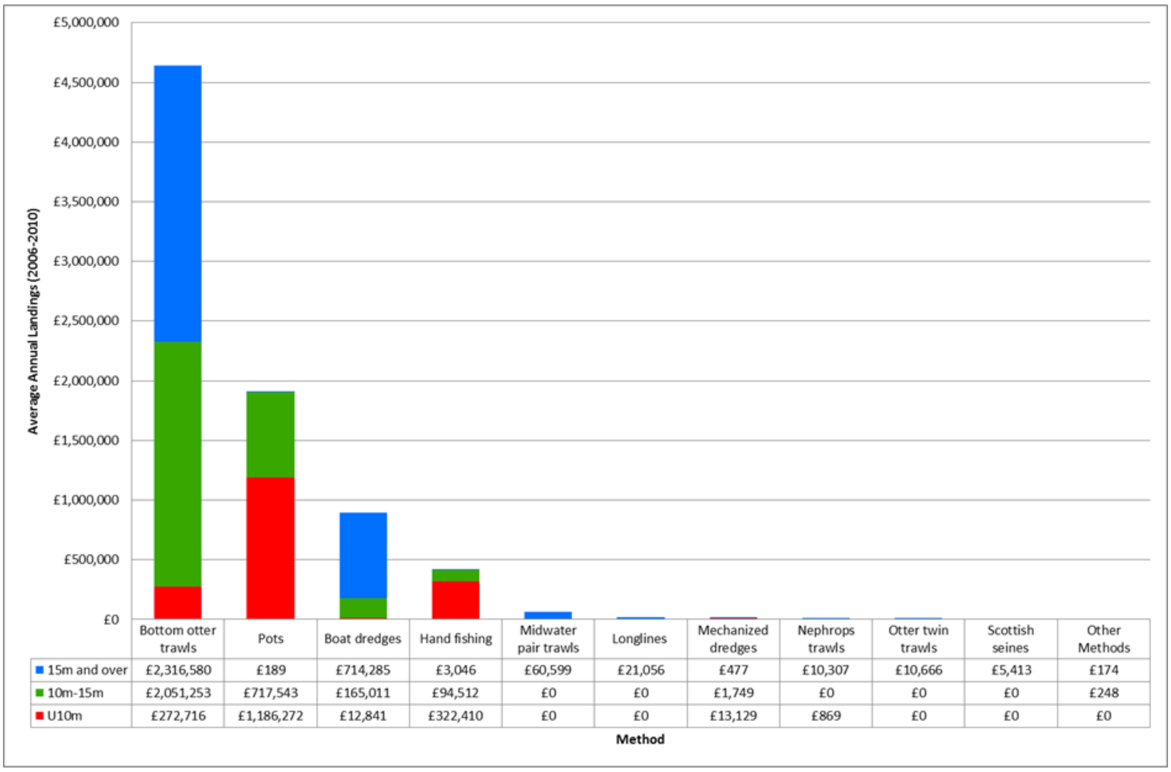


Figure 5.15 Average Annual Landings Values (Average 2006-2010) by Method and Vessel Category in ICES Rectangle 40E4 (Source: MMO)

5.1.3.1 Annual Landings

Figure 5.16 shows the annual variability in landings values by species in 40E3. Over the ten year period for which data is presented, landings values have remained relatively consistent for velvet crab, lobster and *Nephrops*. Edible crab landings values exhibit more variability, increasing steadily from 2001 then sharply rising from 2006-2007 (£658,474 to £1,610,404) before subsequently declining in 2008 (£518,665) and 2009 (£294,491). Landings values of scallops have increased almost yearly since 2004, rising markedly in value from £375,836 in 2006 to £958,564 in 2010. Values of scallops have in fact been consistently higher than those of edible crab since 2007. Landings of queen scallops were highest during 2001 (£47,582), 2002 (£39,373) and 2005 (£49,986), but considerably lower in other years. No landings of queen scallops from 40E3 have been recorded into UK ports since 2006.

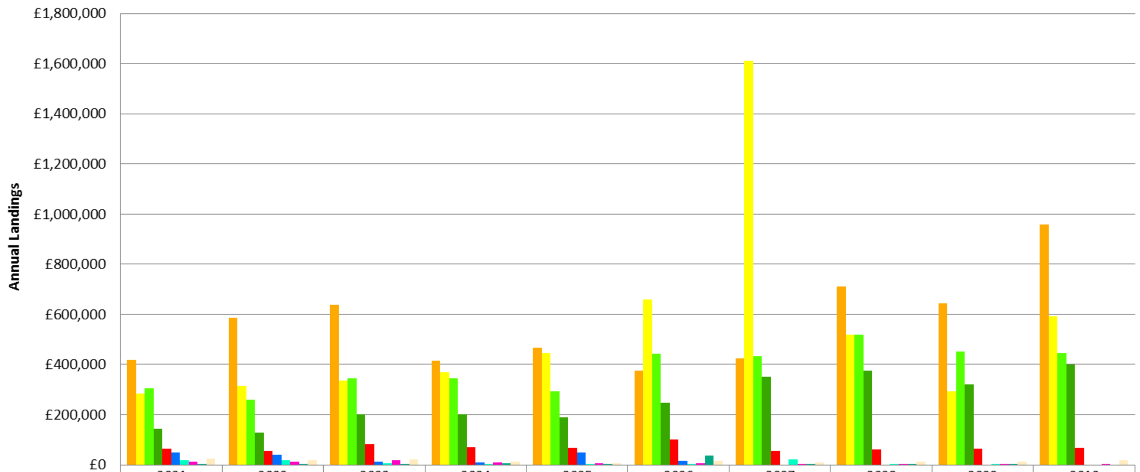
Figure 5.15, shows the annual landings for the species of highest commercial importance in ICES rectangle 40E4. As with 40E3, landings values have remained relatively stable over the ten years for which data are presented. Landings values of *Nephrops* are considerably higher in the second half of the time series and increased by approximately £2,000,000 between 2006-2007 (£4,806,260 to £6,711,855) remaining stable with the exception of a decline in value during 2009 (£5,637,057).

Landings of other species show smaller fluctuations. Scallop landings were broadly greatest between 2001-2004 recording lower values between 2005 -2007 then increasing from £721,146 in 2007 to £1,069,994 in 2008, and remaining stable until the end of the time series (2010). Velvet crab landings increased from 2006 -2008 (£261,814 and £310,785, respectively) but declined by over 50% from 2009-2010 (£303,960, and £174,359, respectively).

Landings of herring show a high degree of variability. Very low landings were recorded in 2001 (£6,702) increasing in 2002 and 2003 (£29,249 and £30,831, respectively) no landings were recorded from 2004-2006. In 2007 the fishery recorded a value of £26,698; subsequently falling by 50% in

2008 (£13,636) then increasing again by approximately 90% in 2009 (£133,296). Herring landings declined again in 2010 (£115,528).

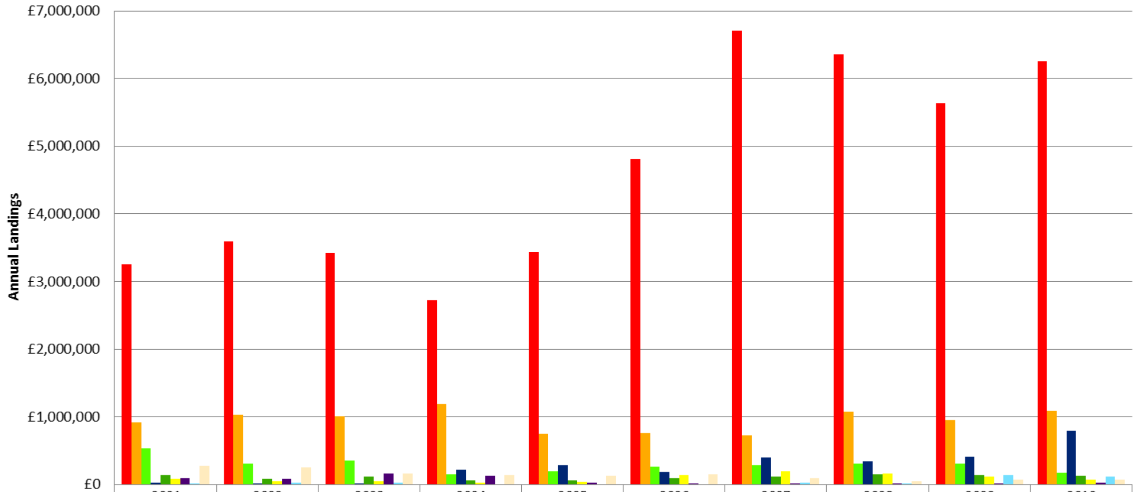
Razor clam landings values were low from 2001 (£6,702) -2003 (£12,111) increasingly markedly in 2004 and 2005 (£219,411 and £280,038, respectively) before declining in 2006 (£179,214). Excluding a moderate dip in value during 2008, landings increased steadily from 2006 – 2010 (£798,310), representing a fourfold increase over five years.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Scallops	£418,752	£584,724	£636,993	£413,805	£466,780	£375,836	£424,357	£711,547	£642,561	£958,564
Edible Crab	£285,336	£313,429	£336,457	£370,626	£446,284	£658,474	£1,610,404	£518,665	£294,491	£591,981
Velvet Crab	£305,244	£259,356	£343,790	£346,042	£293,558	£442,412	£434,465	£518,508	£452,754	£446,281
Lobsters	£142,284	£129,688	£202,746	£201,980	£188,366	£248,220	£350,016	£376,603	£321,400	£400,329
Nephrops	£63,410	£56,600	£81,305	£70,006	£68,082	£100,750	£56,217	£61,159	£64,189	£66,499
Queen Scallops	£47,582	£39,373	£12,129	£10,727	£49,986	£16,928				
Haddock	£19,428	£17,933	£6,661	£2,408	£1,602	£2,131	£21,260	£389	£328	
Crawfish	£13,674	£13,257	£18,245	£9,718	£5,523	£5,299	£2,255	£2,581	£914	£400
Spurdog	£3,332	£914	£1,766	£6,132	£2,679	£35,920	£15	£29	£72	
Other Species	£25,849	£19,221	£20,132	£12,501	£7,169	£16,620	£8,267	£11,425	£13,992	£18,066

Year

Figure 5.16 Annual Variations in Landings Values of Species in ICES Rectangle 40E3 (Source: MMO)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Nephrops	£3,253,312	£3,591,942	£3,422,449	£2,724,853	£3,438,951	£4,806,260	£6,711,855	£6,362,411	£5,637,057	£6,261,400
Scallops	£921,640	£1,028,345	£1,009,434	£1,188,543	£748,784	£756,532	£721,146	£1,069,994	£956,470	£1,089,527
Velvet Crab	£538,035	£303,845	£355,774	£148,598	£189,445	£261,814	£289,500	£310,785	£303,960	£175,359
Razor Clam	£21,864	£13,421	£12,111	£219,411	£280,038	£179,214	£401,149	£336,121	£413,339	£793,810
Lobsters	£135,429	£85,614	£113,294	£56,596	£60,156	£98,368	£111,483	£145,401	£140,057	£132,161
Edible Crab	£79,017	£43,167	£42,177	£23,550	£32,880	£137,858	£190,572	£163,366	£114,290	£72,657
Whelks	£94,342	£85,595	£157,655	£124,912	£29,723	£4,378	£13,627	£6,143	£16,319	£23,727
Herring	£6,702	£29,249	£30,831	£0	£0	£0	£26,698	£13,636	£133,296	£115,528
Other Species	£273,303	£253,182	£161,937	£134,540	£129,301	£147,152	£95,728	£43,200	£65,688	£67,725

Year

Figure 5.17 Annual Variations in Landings Values of Species in ICES Rectangle 40E4 (Source: MMO)

5.1.3.2 Seasonality

Figure 5.18 illustrates the average seasonal variation in landings for all species in rectangle 40E3. Variation is evident between species and seasons: excluding February (£153,635), landings of edible crab are highest during the third and fourth quarters, with peaks recorded in October (£78,400) and December (£111,004). For scallops, this pattern is reversed, where landings values are highest in the first six months of year and peak in June (£80,607). Landings values of lobster and *Nephrops* are broadly greatest during spring summer with peak values in both fisheries recorded during August (£50,336 and £ 10,864, respectively).

Figure 5.19 to Figure 5.22 show the average annual landings values for the most commercially important species in 40E3: edible, scallops, velvet crab, and lobster, respectively.

Figure 5.19 shows that with the exception of the peak during February (£153, 635), landings of edible crab are generally low from January (£26,999) to June (£31,534). Values increase in the third and fourth quarters, increasing steadily from July (£48,720) onwards to a peak in December (£111,004); an increase of approximately 70% from June.

Figure 5.20 shows the seasonal distribution of scallop landings. Values increase significantly from January (£33,492) to the June peak (£80,607), subsequently declining by in July (£38,269).

Figure 5.21 indicates that on average, seasonal distribution of velvet crab landings corroborate broadly with those of edible crab. Landings values remain relatively low from January (£23,769) – July (£18,621). Values increase sharply in August (£53,034) during which time they are similar to those of edible crab. Slight declines are observed in subsequent months until December when values are three times greater than those recorded in November (£42,550).

Figure 5.22 shows that in comparison to both edible and velvet crab, landings of lobster are more seasonally restricted, with much lower values recorded during the winter months. Landings increase markedly from March to April (£19,667 and £41,709, respectively) remaining relatively stable until August (£50,336) and declining rapidly from September to November. A small, secondary peak is observed in December (£19,262).

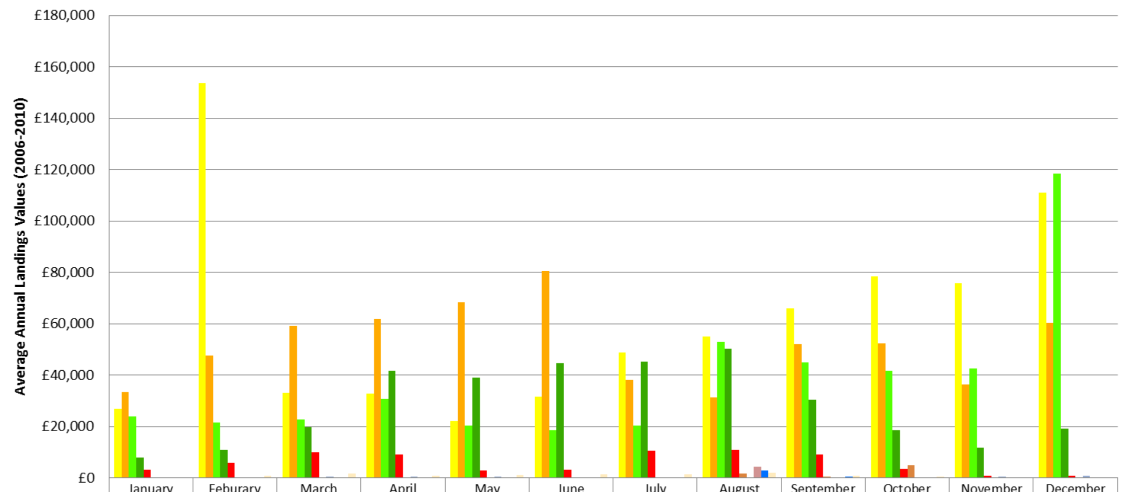
Figure 5.23 illustrates average seasonal variability in landings values for commercial species in 40E4. The highest value landings are recorded between from June- October, peaking in August (£908, 637). With the exception of January, which records the lowest values on average (£ 474,385) landings remains in excess of £500,000 in all remaining months. *Nephrops* represent the greater proportion of landings throughout the year. Landings of herring are restricted to the fourth quarter, recording significantly higher values during November (£38,465), compared to October (£ 16,432) and December (£2,395).

Figure 5.24 to Figure 5.26 show the seasonal variation in landings values for the three most commercially important species in 40E4; *Nephrops*, scallops and razor clams.

Figure 5.24 shows that *Nephrops* landings remain relatively high throughout the year, with two seasonal peaks; one in late winter and one during the summer. Summer values are considerably higher than those recorded during winter: respective maximum values are recorded in March (£503,358) and August (£736,831).

Figure 5.25 shows that with the exception of March (£106,171) landings of scallop are relatively stable between January and August, and are broadly highest from September to November. The peak value is recorded during October (£150,489). On average the lowest landings values are recorded during July (£51,930).

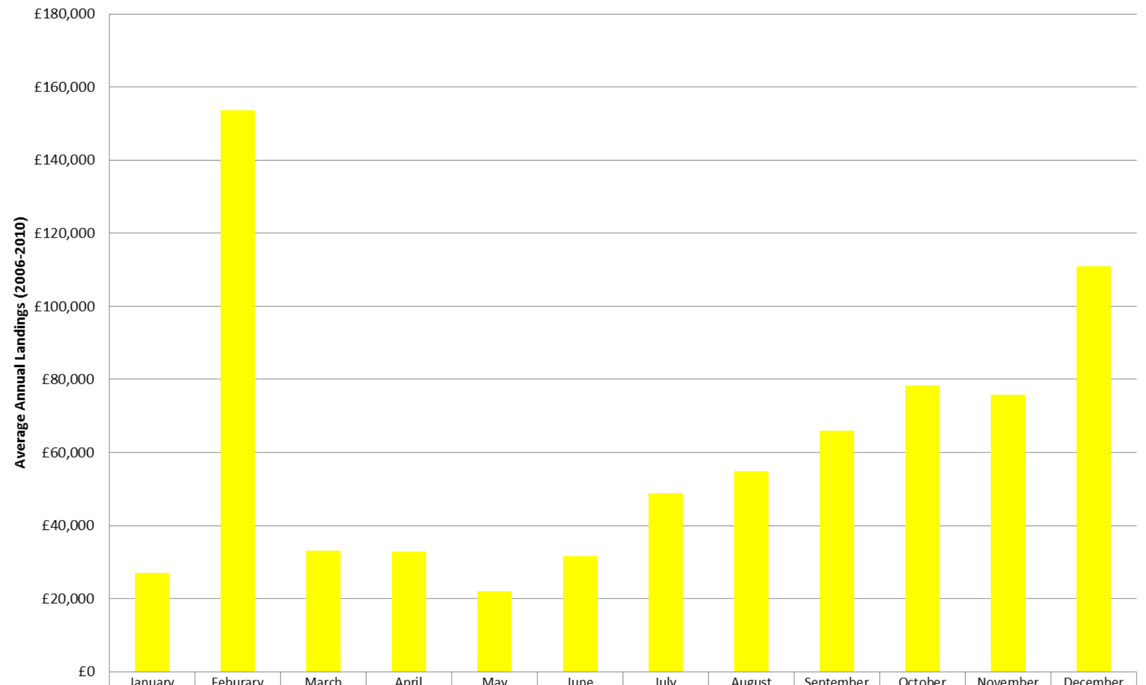
Figure 5.26 shows the seasonal distribution of razor clam landings. Values increase sharply by from January to February (£12,350 and £43,017, respectively) subsequently declining until June. Landings then show a marked increase during July (£50,292) and August (£49,512) before decreasing steadily throughout the autumn and winter.



	January	Feburary	March	April	May	June	July	August	September	October	November	December
Edible Crab	£26,999	£153,635	£33,057	£32,818	£21,993	£31,534	£48,720	£54,960	£65,852	£78,400	£75,831	£111,004
Scallops	£33,492	£47,751	£59,281	£61,955	£68,432	£80,607	£38,269	£31,452	£52,147	£52,373	£36,470	£60,343
Velvet Crab	£23,769	£21,600	£22,800	£30,657	£20,451	£18,621	£20,494	£53,034	£44,832	£41,715	£42,550	£118,361
Lobsters	£7,838	£10,965	£19,667	£41,709	£39,109	£44,655	£45,220	£50,336	£30,352	£18,529	£11,672	£19,262
Nephrops	£3,051	£5,949	£9,934	£9,186	£2,913	£3,203	£10,556	£10,864	£9,067	£3,615	£722	£703
Spurdog	£0	£0	£0	£0	£0	£0	£0	£1,745	£440	£4,990	£18	£14
Green Crab	£346	£346	£489	£601	£517	£334	£158	£268	£309	£350	£585	£809
Haddock	£0	£37	£183	£32	£0	£0	£0	£4,222	£0	£31	£111	£206
Queen Scallops	£0	£0	£0	£0	£0	£0	£0	£3,009	£376	£0	£0	£0
Other species	£130	£737	£1,609	£711	£1,220	£1,526	£1,419	£2,130	£809	£462	£42	£57

Month

Figure 5.18 Annual (Average 2006-2010) Seasonality of Species in ICES Rectangle 40E3 (Source: MMO)



	January	Feburary	March	April	May	June	July	August	September	October	November	December
Edible Crab	£26,999	£153,635	£33,057	£32,818	£21,993	£31,534	£48,720	£54,960	£65,852	£78,400	£75,831	£111,004

Month

Figure 5.19 Annual (Average 2006-2010) Seasonality of Edible Crab in ICES Rectangle 40E3 (Source: MMO)

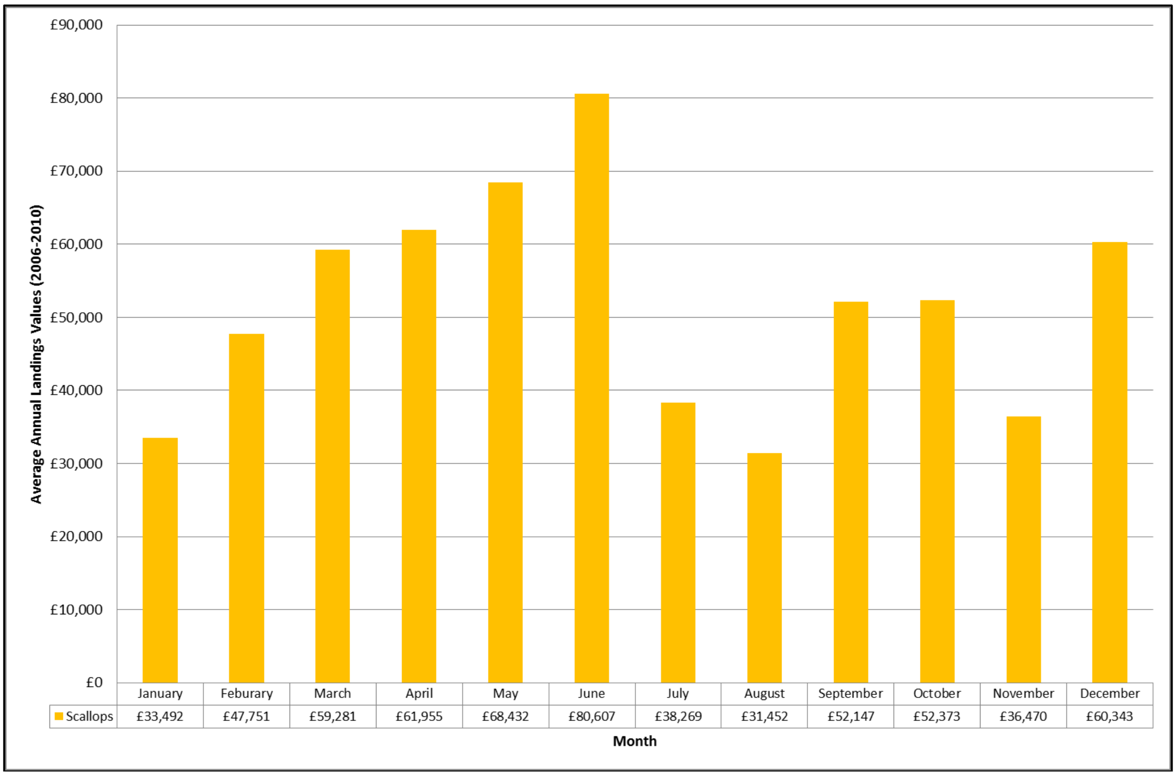


Figure 5.20 Annual (Average 2006-2010) Seasonality of Scallops in ICES Rectangle 40E3 (Source: MMO)

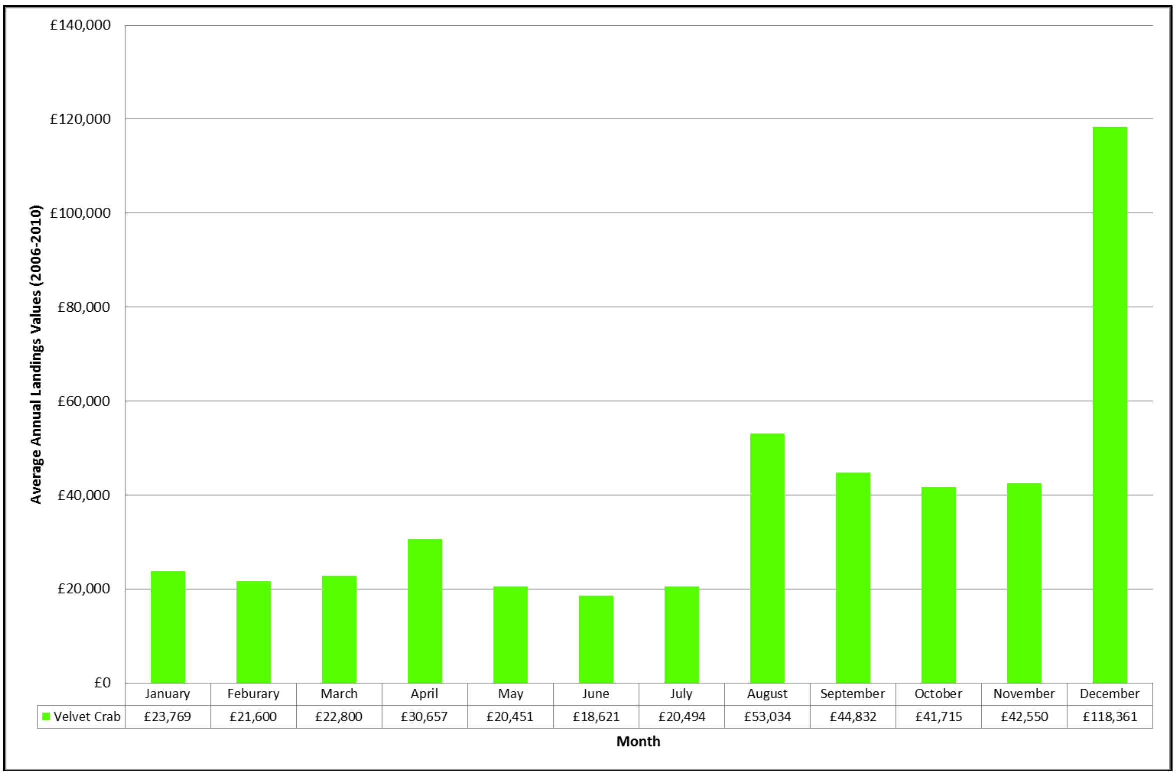
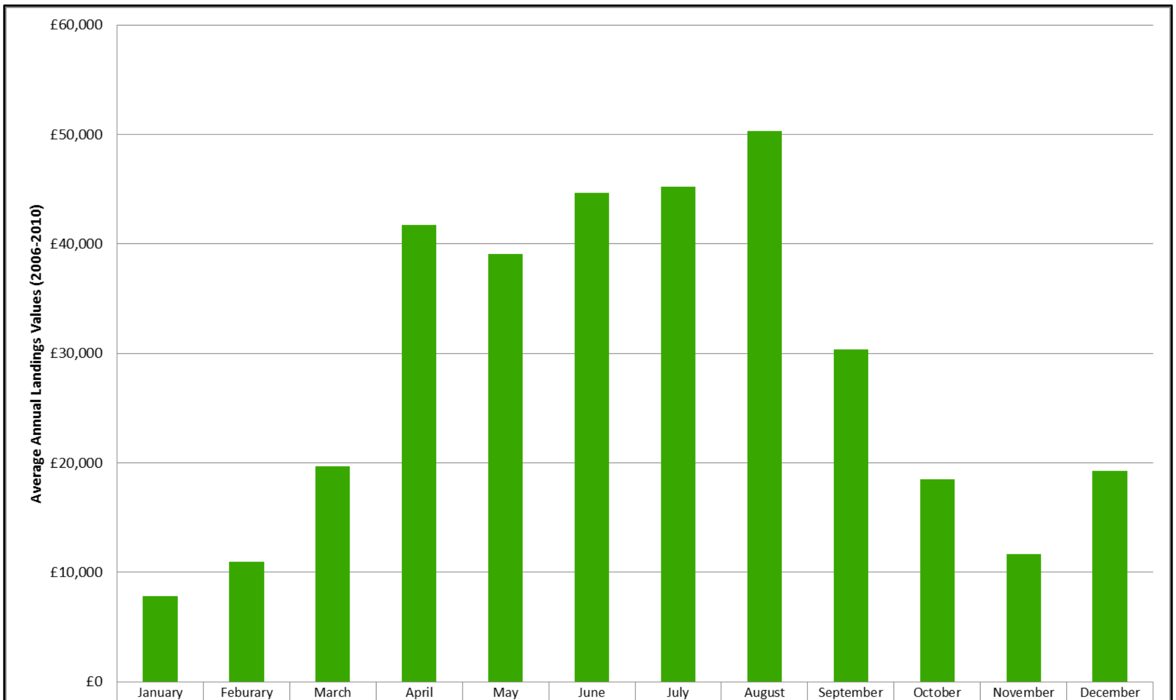
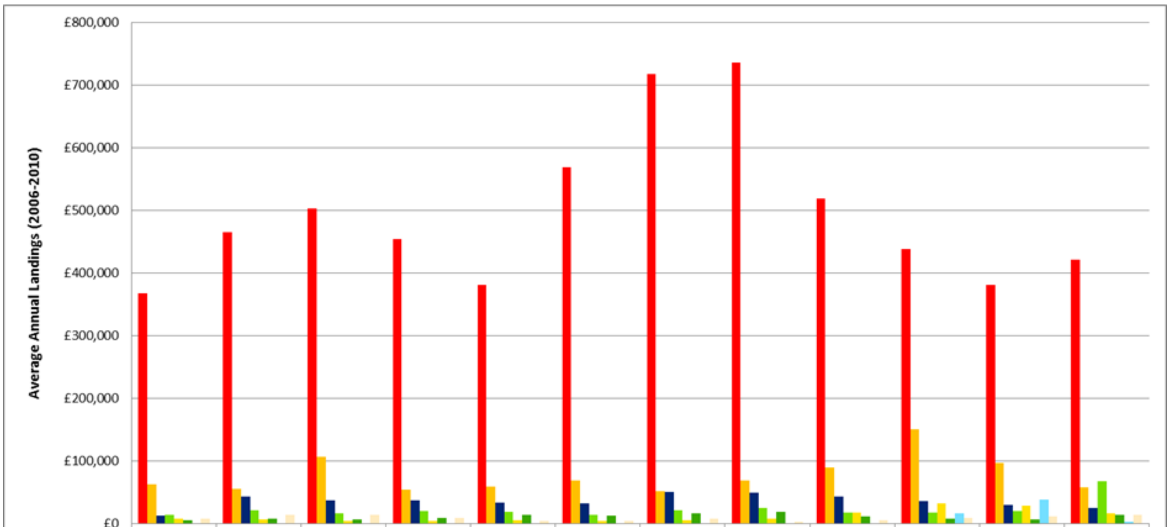


Figure 5.21 Annual (Average 2006-2010) Seasonality of Velvet Crab in ICES Rectangle 40E3 (Source: MMO)



	January	Feburary	March	April	May	June	July	August	September	October	November	December
Lobsters	£7,838	£10,965	£19,667	£41,709	£39,109	£44,655	£45,220	£50,336	£30,352	£18,529	£11,672	£19,262

Figure 5.22 Annual (Average 2006-2010) Seasonality of Lobster in ICES Rectangle 40E3 (Source: MMO)



	January	Feburary	March	April	May	June	July	August	September	October	November	December
Nephrops	£367,255	£464,928	£503,358	£454,480	£380,880	£569,229	£717,587	£736,831	£519,547	£438,934	£380,984	£421,784
Scallops	£62,395	£54,919	£106,171	£54,164	£58,385	£67,939	£51,930	£68,932	£89,717	£150,489	£96,460	£57,233
Razor Clam	£12,350	£43,017	£36,719	£36,512	£32,702	£31,413	£50,292	£49,512	£42,894	£35,346	£29,239	£24,730
Velvet Crab	£13,733	£21,096	£15,863	£19,410	£18,237	£12,971	£20,996	£24,173	£16,990	£17,503	£20,044	£67,268
Edible Crab	£7,225	£5,668	£4,186	£3,683	£4,619	£4,378	£5,124	£7,390	£17,296	£32,072	£28,145	£15,963
Lobsters	£4,485	£7,059	£6,394	£8,752	£13,121	£12,923	£16,443	£18,695	£10,587	£6,956	£6,173	£13,907
Herring	£0	£0	£0	£0	£0	£0	£0	£0	£0	£16,432	£38,465	£2,935
Other Species	£6,941	£13,300	£13,679	£8,568	£3,825	£3,245	£6,875	£3,104	£4,791	£8,076	£11,358	£12,974

Figure 5.23 Annual (Average 2006-2010) Seasonality of Species in ICES Rectangle 40E4 (Source: MMO)

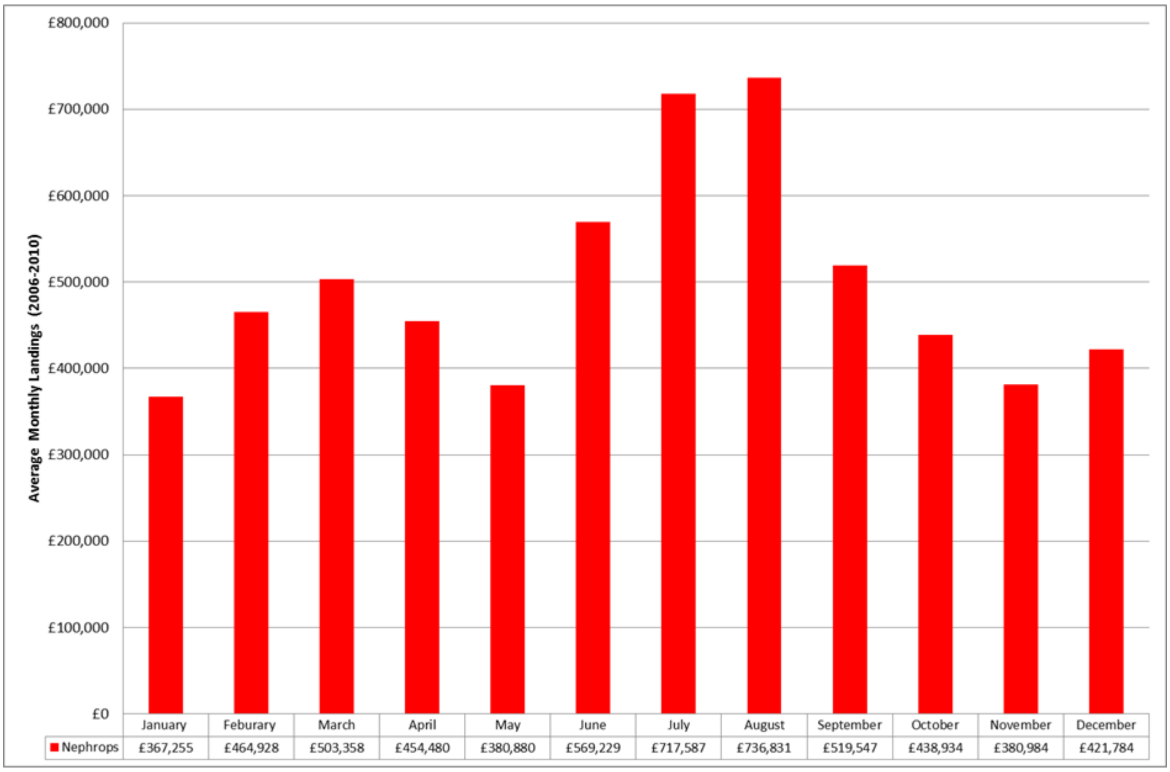


Figure 5.24 Annual (Average 2006-2010) Seasonality of Nephrops in ICES Rectangle 40E4 (Source: MMO)

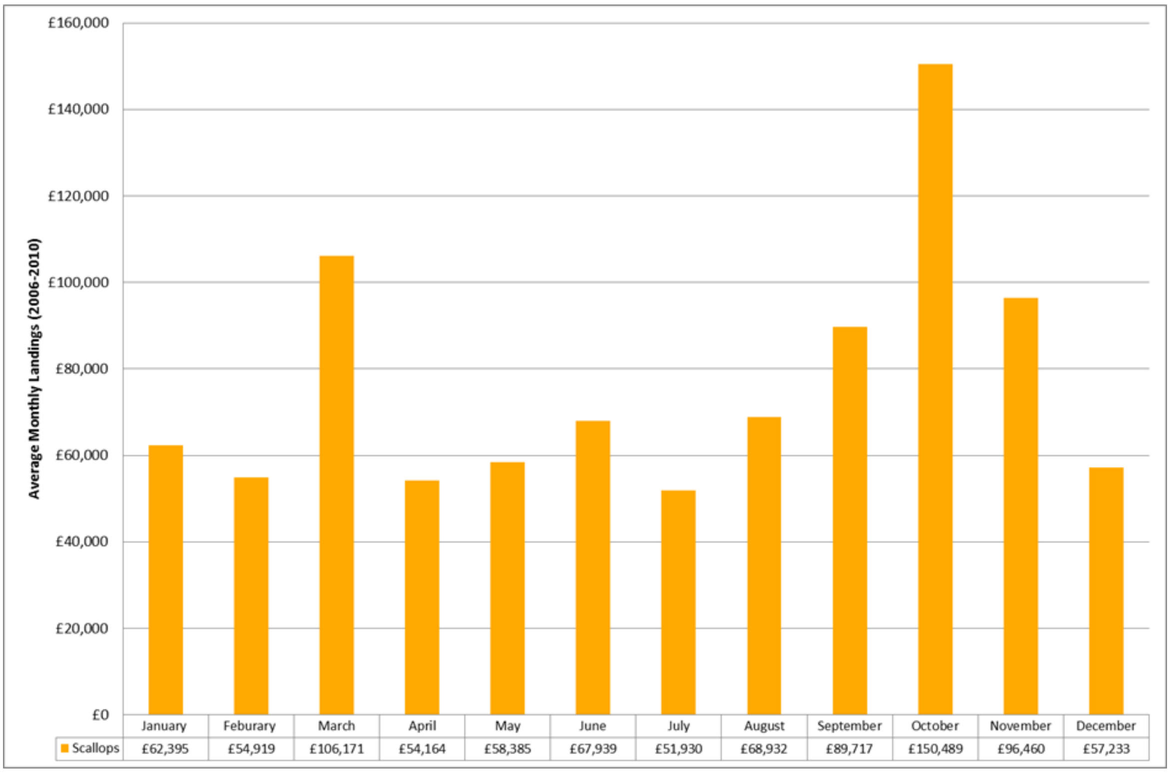


Figure 5.25 Annual (Average 2006-2010) Seasonality of Scallops in ICES Rectangle 40E4 (Source: MMO)

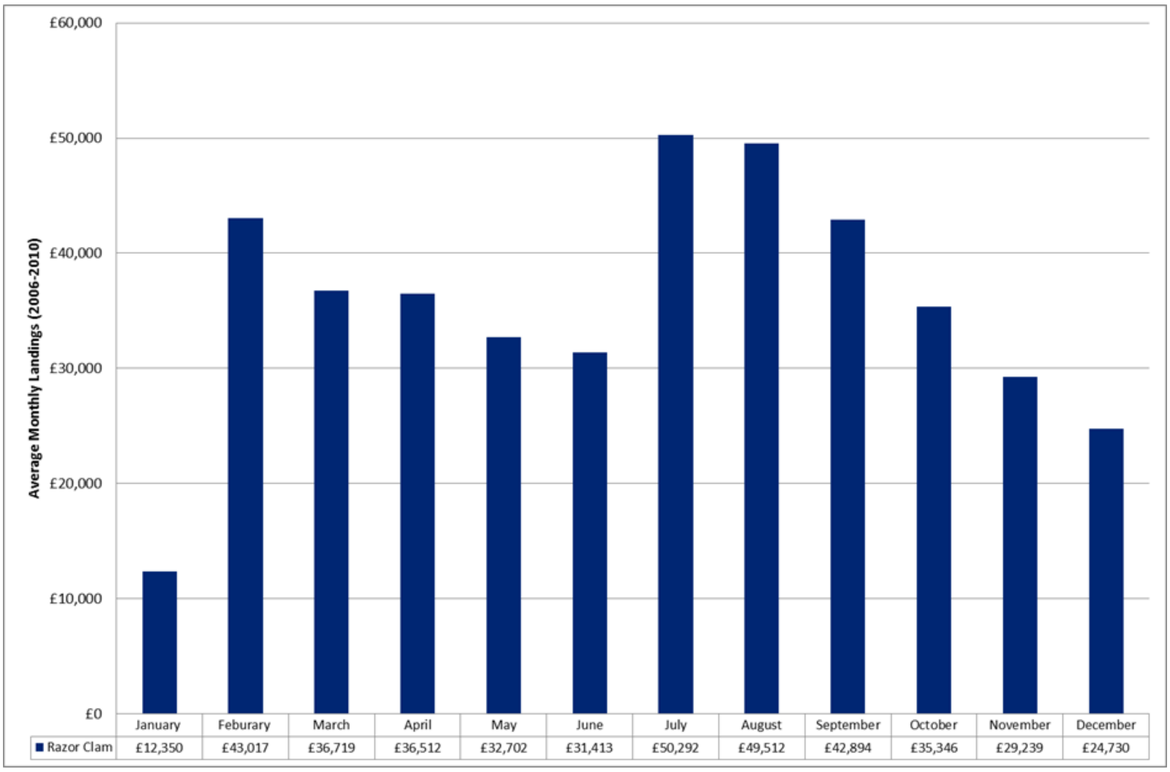


Figure 5.26 Annual (Average 2006-2010) Seasonality of Razor Clams in ICES Rectangle 40E4 (Source: MMO)

5.1.4 Landings Values by Port

Table 5.1 and Table 5.2 show the 20 ports by landings values from the local study area and the proportion of each port's total income they represent.

Table 5.1 shows that highest percentage of landings values from 40E3 are into Port Ellen (34.2%) and Port Askaig on Islay (26.6%) and represent a significant proportion of respective total landings values (89.1% and 97.5%). Lower values from 40E3 are also landed into Rathmullan (N. Ireland) and Oban (8.3% and 7.7%, respectively). These landings constitute almost a third of total landings into Rathmullan (27.6%) but less than 5% (4.6%) of the port total into Oban. Landings into Portnahaven (1.0%) and Bruichladdich, also on Islay (0.8%) contribute minimally to total landings values for 40E3, yet represent over 97% of respective port totals in both cases (97.2% and 98.5%).

Table 5.1 Top 20 Ports by Value (Average 2006-2010) from ICES Rectangle 40E3 (Source: MMO)

Port	Average Annual Landings Values (£) in the Local Study Area	% of Average Annual Value in the Local Study Area	Total Average Annual Port Value	% of Total Annual Port Value that the Local Study Area represents
Port Ellen	£770,874	34.2%	£864,848	89.1%
Port Askaig	£600,160	26.6%	£615,804	97.5%
Islay	£258,740	11.5%	£271,768	95.2%
Rathmullan	£187,563	8.3%	£679,265	27.6%
Oban	£174,746	7.7%	£3,772,677	4.6%
Campbeltown	£45,385	2.0%	£3,671,552	1.2%
Killybegs	£43,962	1.9%	£1,911,743	2.3%
Tayinloan	£34,253	1.5%	£979,820	3.5%
West Loch Tarbert	£34,002	1.5%	£1,097,307	3.1%
Portnahaven	£23,572	1.0%	£24,243	97.2%
Bruichladdich	£16,968	0.8%	£17,227	98.5%
Troon and Saltcoats	£15,491	0.7%	£864,848	1.8%
Girvan	£13,990	0.6%	£679,265	2.1%
Mallaig	£11,981	0.5%	£8,442,936	0.1%
Craighouse	£5,848	0.3%	£10,979	53.3%
Crinan	£4,616	0.2%	£932,186	0.5%
Jura	£3,932	0.2%	£10,250	38.4%
Kirkcudbright	£2,620	0.1%	£3,333,768	0.1%
Tayvallich	£1,722	0.1%	£469,898	0.4%
Scrabster	£1,134	0.1%	£26,775,247	0.0%

Table 5.2 shows that landings values from 40E4 are highest into Tarbert (30.2%), West Loch Tarbert (12.2%) and Tayinloan (10.2%) representing 94.3%, 89% and 83.2% of each ports total value, respectively. West Loch Tarbert and Tayinloan are located on the western side of the Kintyre peninsula (Sound of Jura). Clyde Sea ports (east of the Kintyre) of Campbeltown (9.0%), Troon and Saltcoats (8.0%) and Carradale (8.0%) record more moderate values with landings from 40E4 representing 19.5%, 20.5%, and 82.1% of respective annual port value.

Table 5.2 Top 20 Ports by Value (Average 2006-2010) from ICES Rectangle 40E4 (Source: MMO)

Port	Average Annual Landings Values (£) in the Local Study Area	% of Average Annual Value in the Local Study Area	Total Average Annual Port Value	% of Total Annual Port Value that the Local Study Area represents
Tarbert	£2,414,625	30.2%	£2,561,398	94.3
West Loch Tarbert	£976,531	12.2%	£1,097,307	89.0
Tayinloan	£815,598	10.2%	£979,820	83.2
Campbeltown	£715,977	9.0%	£3,671,552	19.5
Troon and Saltcoats	£642,651	8.0%	£3,133,033	20.5
Carradale	£638,495	8.0%	£777,372	82.1
Tayvallich	£329,024	4.1%	£469,898	70.0
Oban	£245,511	3.1%	£3,772,677	6.5
Bute	£208,720	2.6%	£301,586	69.2
Troon	£185,447	2.3%	£861,516	21.5
Crinan	£137,981	1.7%	£932,186	14.8
Largs and Greenock	£98,912	1.2%	£585,893	16.9
Ardrishaig	£78,731	1.0%	£108,222	72.7
Ardrossan	£57,439	0.7%	£85,118	67.5
Dunoon	£55,587	0.7%	£67,417	82.5
Rothesay	£45,522	0.6%	£53,804	84.6
Largs	£41,262	0.5%	£78,726	52.4
Ardglass	£39,829	0.5%	£6,482,796	0.6
Gigha	£34,861	0.4%	£36,994	94.2
Port Ellen	£33,703	0.4%	£864,848	3.9

5.2 Effort (Days at Sea)

Figure 5.27 shows the average annual effort in the regional study area by method. Patterns correspond to those recorded for landings values. For example, in 39E4 and 40E4 where *Nephrops* dominate landings, demersal otter trawlers record high effort levels. Creels also record relatively high effort in 40E4 where they represent a significant proportion of Nephrops landings. The proportion of effort in 40E4 by boat dredges and hand fishing reflects landings values of scallops and razor clams, respectively. Days at sea recorded in the north east of the area by creel, demersal otter trawls (including *Nephrops* trawls) and boat dredges represent similar proportions of total effort to values recorded for edible crab, *Nephrops* and scallops, respectively. In the local study area (40E3) effort distribution follows the order creels> boat dredges > demersal otter trawls; mirroring respective landings values of edible crab, scallop and *Nephrops*.

Figure 5.28 shows the average annual effort applied by vessel category in the regional study area. Broadly, the distribution of effort corresponds to the landings values: the majority of effort is by the under- 15m fleet, with the highest level of effort being in the south east of the study area. It is of note that landings values for the over-15m fleet are proportionally slightly higher than effort levels compared to the smaller category vessels.

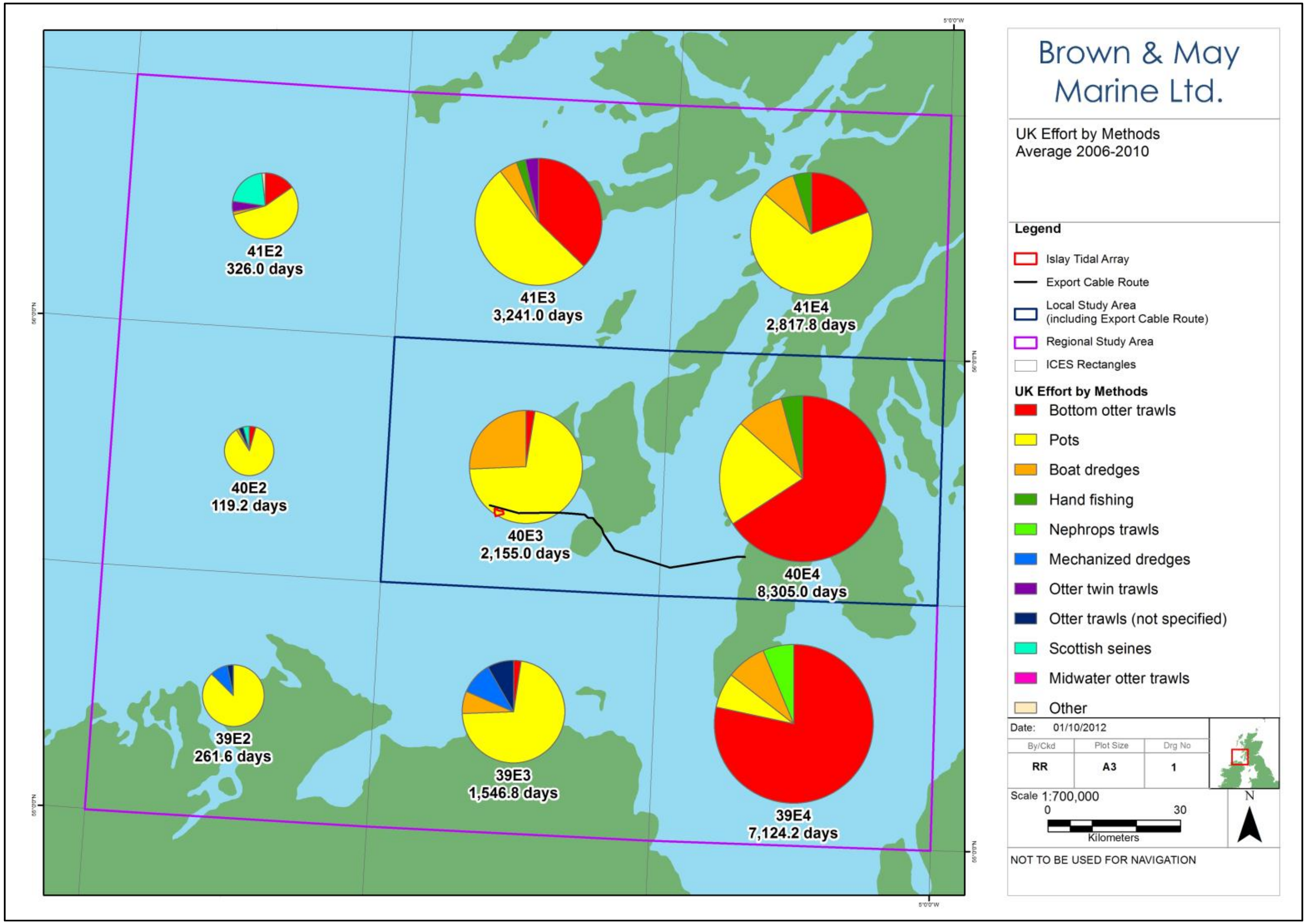


Figure 5.27 Effort (Days at Sea) by Fishing Method in the Regional Study Area (Average 2006-2010) (Source: MMO)

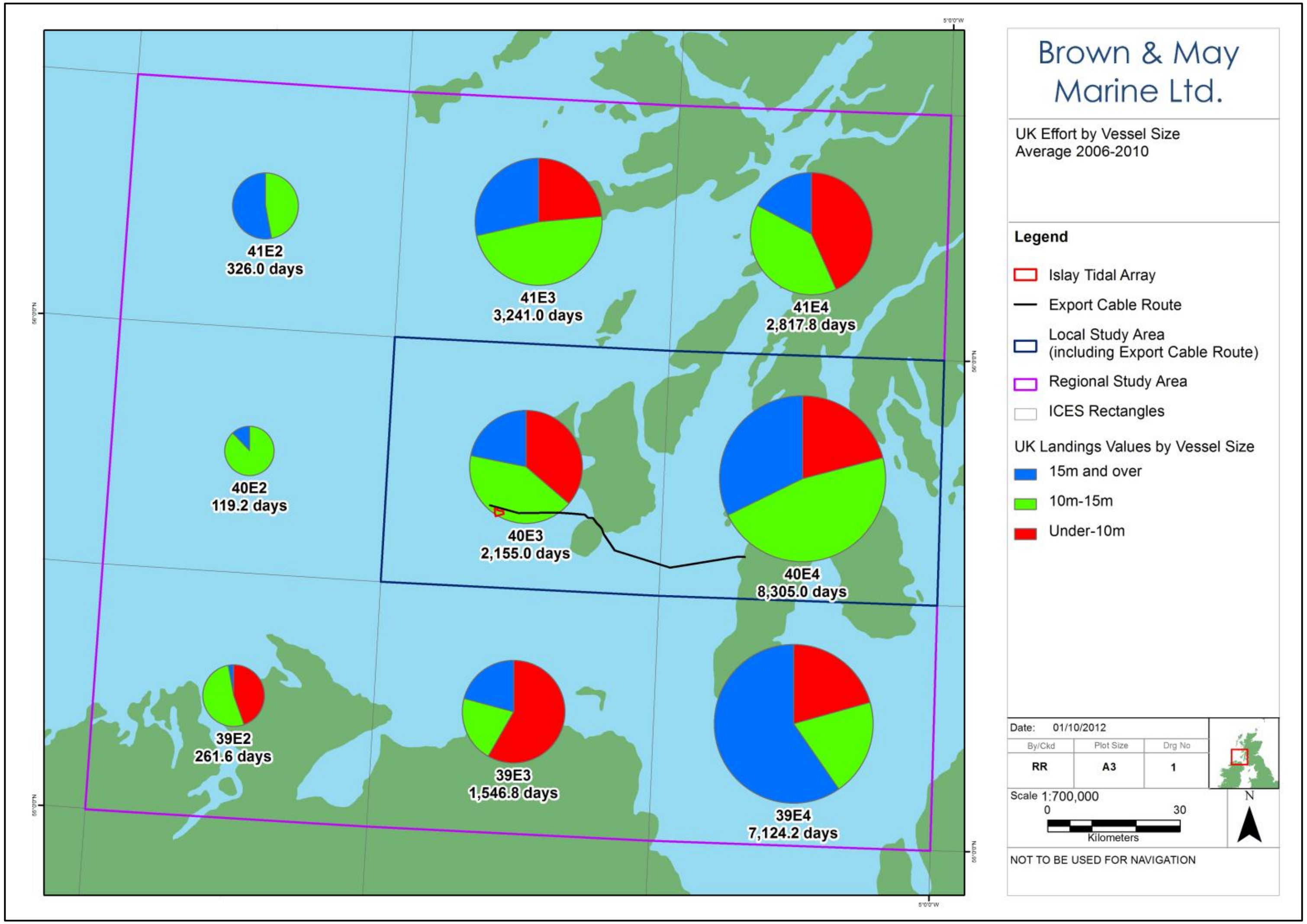


Figure 5.28 Effort (Days at Sea) by Vessel Category in the Regional Study Area (Average 2006-2010) (Source: MMO)

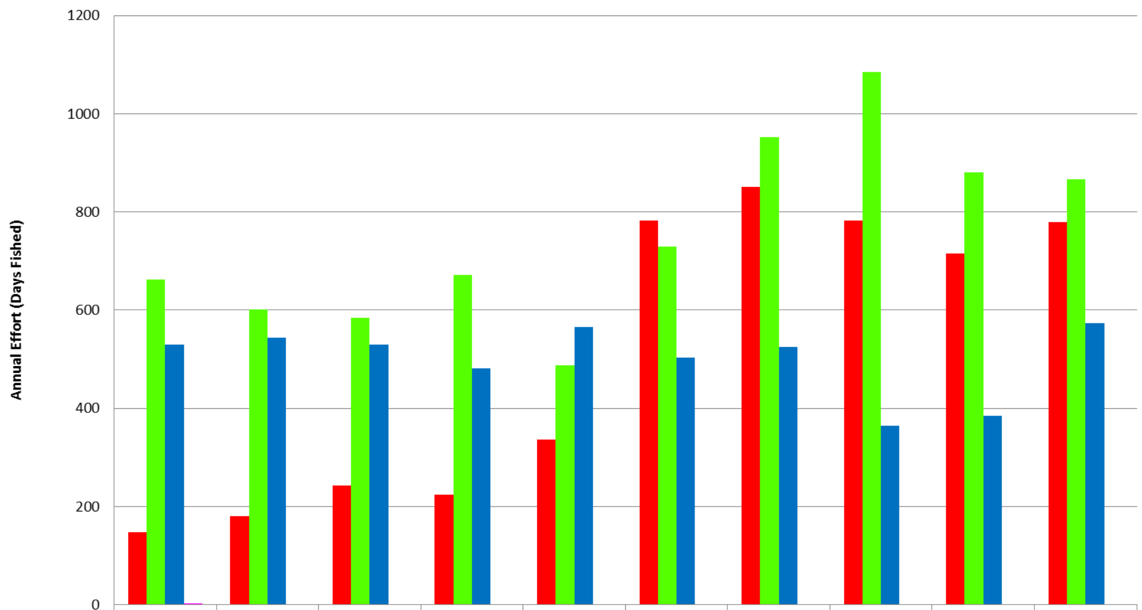
5.2.1 Local Study Area (ICES Rectangles 40E3 and 40E4)

Figure 5.29 demonstrates the annual variation in effort in ICES rectangle 40E3. With the exception of low values recorded in 2008 (365 days) and 2009 (384 days), effort by the over-15m fleet has remained above 480 days per year. Effort recorded by the 10-15m category was in excess of 580 days from 2001 to 2004, falling in 2005 (487 days) before increasing to a maximum of 1085 days in 2008, with subsequent declines recorded in 2009 (881 days) and 2010 (867 days). The under-10m fleet recorded relatively low effort of less than 250 days from 2001-2004 subsequently doubling from 2005 (336) to 2006 (782). This increase was likely a result of the introduction of recorded landings in the under-10m fleet. Effort by the under-10m fleet in all remaining years has been in excess of 715 days. Non UK vessels record only negligible effort throughout the period for which data is presented.

The annual distribution of effort in 40E4 is shown in Figure 5.30. Overall effort is considerably higher than in 40E3. Effort recorded by the over-15m fleet peaked in 2002 (4,512 days) declining to 2,345 in 2006, subsequently increasing in each year until 2010 (2,935 days). Since 2005, effort by the 10-15m sector has been higher than that recorded by other fleets reaching a maximum of 1,965 effort days in 2010. Activity by the under-10m fleet is considerably lower than other categories throughout the time series, but recorded a sharp increase of 516 days from 2004 (907 days) to 2005 (1,423 days). Again, this probably reflects the introduction of recorded landings in the under-10m fleet. The peak of effort in the under 10m fleet occurred in 2006 (1,994 days), declining in 2007 (1,559 days) and 2008 (1,473 days) slight increases were subsequently recorded in 2009 (1,705) and 2010 (1,965). No effort has been recorded by non UK vessels over the 10 years for which data is presented.

Average annual seasonality of effort in 40E3 is shown in Figure 5.31. The lowest effort in all sectors is recorded during January and February. On average, the greater proportion of effort is by the 10-15m fleet which is highest during June (162 days) and August (171 days). Effort in the under-10m and over-15m sectors is broadly similar; days at sea increase steadily from January onwards and are highest from April – August. Peaks in effort are recorded in both categories during August (under-10m fleet, 102 days; over-15m fleet, 115 days). Throughout this period the pattern of effort is more consistent by the under-10m fleet. Effort by the over-15m fleet exhibits some seasonal variability broadly following the seasonal patterns of scallops and *Nephrops* landings.

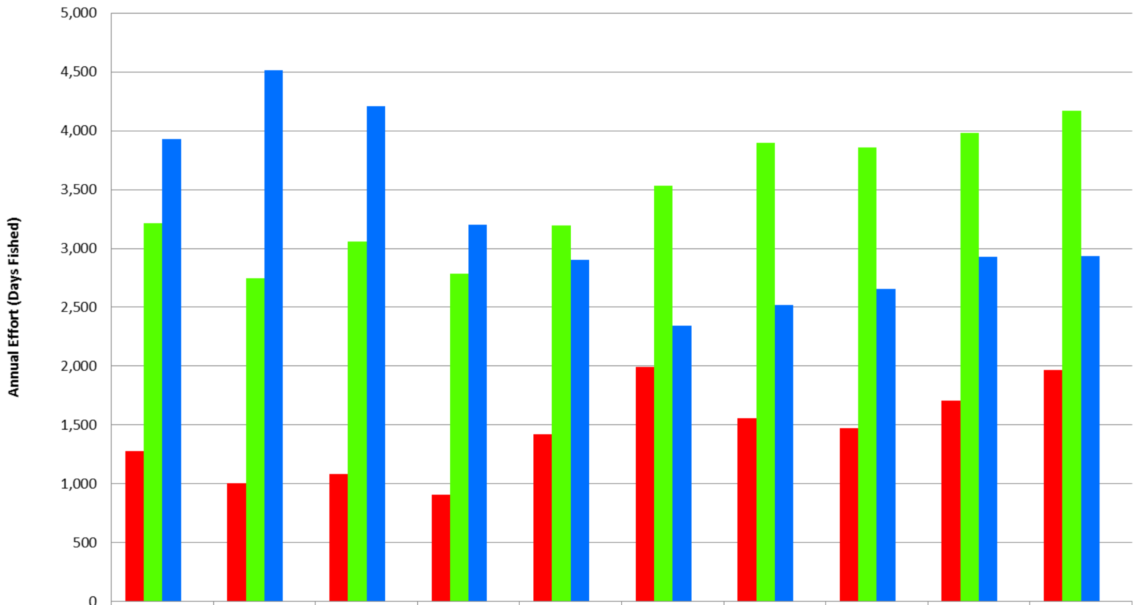
Seasonal effort patterns in 40E4 are shown in Figure 5.32. Effort in the 10-15m fleet closely tracks the pattern of *Nephrops* landings values, with peaks observed in March (331 days) and July (392 days). Effort recorded by the over-15m shows broadly similar patterns although values are considerably higher during March (298.8 days), than during the August (251.4 days)and September (250 days). Effort in the under-10m fleet also follows a similar distribution to that recorded for *Nephrops* landings values, which reflects the effort that vessels operating creels direct at this fishery.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U10m	147	181	243	224	336	782	851	782	715	779
10m-15m	662	602	584	672	487	730	953	1085	881	867
15m and over	530	544	530	482	566	503	525	365	384	573
Non-UK	3	1	0	0	0	0	0	0	0	1

Year

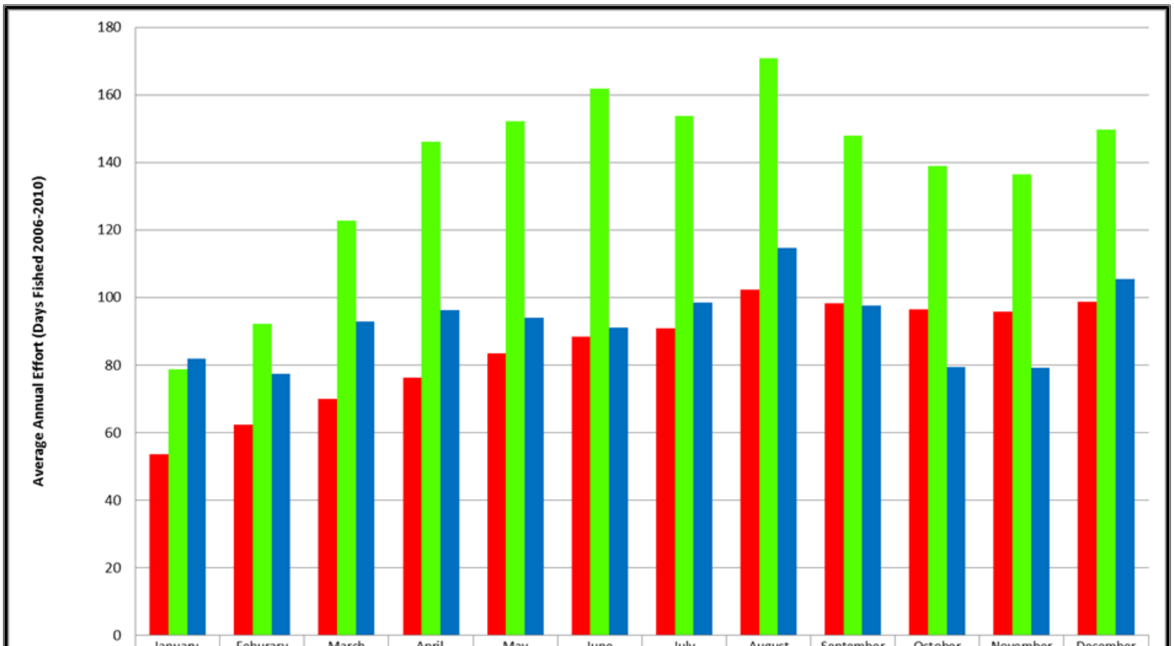
Figure 5.29 Annual Variation of Effort (Days Fished) by Vessel Category in ICES Rectangle 40E3 (Source: MMO)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U10m	1,281	1,003	1,082	907	1,423	1,994	1,559	1,473	1,705	1,965
10m-15m	3,212	2,749	3,057	2,787	3,193	3,532	3,899	3,857	3,984	4,170
15m and over	3,928	4,512	4,210	3,202	2,903	2,345	2,522	2,658	2,927	2,935
Non-UK	0	0	4	0	0	0	0	0	0	0

Year

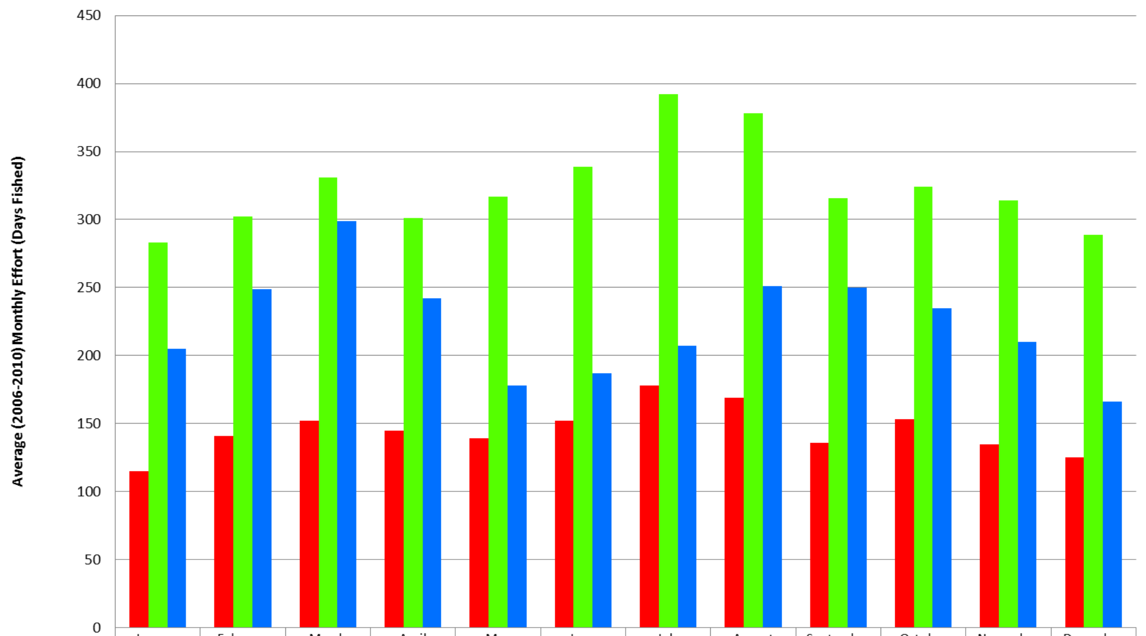
Figure 5.30 Annual Variations of Effort (Days Fished) by Vessel Category in ICES Rectangle 40E4 (Source: MMO)



	January	Feburary	March	April	May	June	July	August	September	October	November	December
U10m	54	62	70	76	83	88	91	102	98	96	96	99
10m-15m	79	92	123	146	152	162	154	171	148	139	136	150
15m and over	82	77	93	96	94	91	98	115	98	79	79	105

Month

Figure 5.31 Average Annual (2006-2010) Seasonality of Effort (Days Fished) by Vessel Category in ICES Rectangle 40E3 (Source: MMO)



	January	Feburary	March	April	May	June	July	August	September	October	November	December
U10m	115	141	152	145	139	152	178	169	136	153	135	125
10m-15m	283	302	331	301	317	339	392	378	316	324	314	289
15m and over	205	249	299	242	178	187	207	251	250	235	210	166

Month

Figure 5.32 Average Annual (2006-2010) Seasonality of Effort (Days Fished) by Vessel Category in ICES Rectangle 40E4 (Source: MMO)

Table 5.3 and Table 5.4 list the top 20 ports by effort applied in 40E3 and 40E4, respectively, and the percentage this represents to each ports total annual effort.

Similar to landings values, the majority of effort applied in 40E3 is by vessels landing into Port Ellen (46.8%), Portaskaig (26.5%), and Islay (7.3%). In all cases, effort applied in 40E3 represents a significant proportion of total effort from these ports (86.9%, 93.4%, and 59.3%, respectively). As previously, average annual effort applied in 40E3 from Portnahaven and Bruichladdich is low, but nonetheless contributes significantly to respective average effort totals for both (96.6% and 91.1%, respectively).

Table 5.3 Top 20 Ports by Effort (Days Fished, Average 2006-2010) in ICES Rectangle 40E3 (Source: MMO)

Port	Average Annual Effort in 40E3 (Days Fished, 2006-2010)	% of Average Annual Effort in 40E3	Total Average Annual Port Effort (Days Fished, 2006-2010)	% of Total Annual Port Effort that 40E3 represents
Port Ellen	1009.6	46.8%	1162.4	86.9%
Portaskaig	571.2	26.5%	611.6	93.4%
Islay	157.2	7.3%	265	59.3%
Rathmullen	105.4	4.9%	421.8	25.0%
Oban	66.8	3.1%	3884.6	1.7%
Portnahaven	33.8	1.6%	35	96.6%
Bruichladdich	30.6	1.4%	33.6	91.1%
Tayinloan	27.2	1.3%	869	3.1%%
Killybegs	25.6	1.2%	593.6	4.3%
Campbeltown	24.4	1.1%	3989.4	0.6%
West Loch Tarbert	22.8	1.1%	1081.8	2.1%
Craighouse	15.0	0.7%	36.2	41.4%
Troon and Saltcoats	14.8	0.7%	3952.2	0.4%
Jura	13.8	0.6%	60.2	22.9%
Girvan	10.8	0.5%	1346.6	0.8%
Mallaig	6.8	0.3%	8169.6	0.1%
Crinan	5.2	0.2%	771.4	0.7%
Tayvallich	2.8	0.1%	505.4	0.6%
Kirkcudbright	1.8	0.1%	1323.4	0.1%
Bowmore	1.2	0.1%	1.2	100.0%

In rectangle 40E4, the distribution of effort by port of landing broadly follows that described by landings values: the highest effort comes from vessels landing into Tarbert (33.6%); lower effort is recorded those landing into Carradale (9.7%), West Loch Tarbert (9.4%) Campbeltown (8.6%) Tayinloan, (7.8%) and Troon and Saltcoats (7.5%).

The proportion of effort which 40E4 contributes to the annual port totals is more variable, representing over 80% of the total in larger ports such as Tarbert, Carradale, West Loch Tarbert, Tayinloan and Tayvallich (93.8%; 86.2%; 86.6%; 84.5% and 80.4%, respectively). In larger ports, such as Campbeltown and Troon and Saltcoats, where combined annual effort is high, activity in 40E4 constitutes a smaller proportion (21.2% and 20.5%, respectively). Vessels from ports such as

Ardrishaig (1.4%) and Rothesay (1.3 %,) contribute minimally to effort in 40E4, although in both cases this represents over 85% of total annual effort (86.6% and 91.1%, respectively).

Table 5.4 Top 20 Ports by Effort (Days Fished, Average 2006-2010) in ICES Rectangle 40E4 (Source: MMO)

Port	Average annual effort (days fished) in the export cable area (40E4)	% of average annual Effort in the export cable area (40E4)	Total average annual port effort (Days Fished)	% of Total annual port effort that the export cable area represents
Tarbert	2789.6	33.6%	2972.8	93.8
Carradale	802.8	9.7%	931.8	86.2
West Loch Tarbert	777.8	9.4%	898.6	86.6
Campbeltown	712.6	8.6%	3364.6	21.2
Tayinloan	649.0	7.8%	767.8	84.5
Troon and Saltcoats	626.0	7.5%	3048	20.5
Tayvallich	349.6	4.2%	435	80.4
Bute	330.2	4.0%	552	59.8
Troon	174.4	2.1%	829.6	21.0
Largs and Greenock	154.8	1.9%	928.6	16.7
Oban	135.2	1.6%	3099.6	4.4
Crinan	125.4	1.5%	605.4	20.7
Ardrishaig	113.4	1.4%	131	86.6
Rothesay	106.4	1.3%	116.8	91.1
Largs	60.6	0.7%	120.6	50.2
Ardrossan	51.6	0.6%	101	51.1
Port Ellen	38.2	0.5%	1093.2	3.5
Jura	33.8	0.4%	48.6	69.5
Gigha	31.8	0.4%	33.8	94.1
Kyles Of Bute	29.0	0.3%	29.6	98.0

Table 5.5 and Table 5.6 shows the effort by each vessel category at each port from 2001-2010, in rectangles 40E3 and 40E4, respectively.

In 40E3, the highest effort from by the under-10m fleet is recorded by vessels landing into Port Ellen with particularly high numbers of days at sea recorded during 2006 (504) and 2007 (553). Effort by vessels landings into Port Askaig has increased yearly since 2003 and was highest in 2010 (289 days). During 2001 and 2002, all effort by the under-10m fleet was by vessels landing into Islay, but has been lower than Port Ellen and Port Askaig since. Effort by under-10m vessels landing into ports outside Islay such as Jura, Craighouse and Campbeltown is much lower.

Effort by the 10-15m fleet is again greatest from vessels landing into Port Ellen and has remained above 300 days since 2004. As with the under-10m fleet, effort by vessels landing into Islay was highest during 2001 (587 days) and 2002 (519 days) but has generally declined since. Effort by vessels landing into Port Askaig has increased significantly since 2006 (115 days) with the highest effort by vessels landing into the port recorded in 2009 (472 days).

Similar to other categories, effort recorded by the over-15m fleet is highest by vessels landing into Port Ellen with a peak of 299 days recorded in 2010. Vessels landing into Islay recorded high effort during 2001 (302 days), 2002 (196 days) and 2003 (128 days). Much lower effort has been recorded in subsequent years. In contrast to other vessel categories, proportionally more effort is recorded by vessels landing into ports outside of Islay. For example, vessels landing into Oban record relatively consistent effort in 40E3 with a peak recorded in 2010 (299 days). Effort by vessels landing into Rathmullen (N.I) was particularly high in 2005 (140 days) and 2007 (206 days). Low effort has been consistently recorded by vessels landing into Tayinloan with the highest number of days recorded in 2010 (49 days). Non UK vessels landing into Troon and Saltcoats, Kilkeel (N.I) and Mallaig record negligible effort in 40E3.

Table 5.5 Annual Effort (Days Fished) by Port and Vessel Category in ICES Rectangle 40E3 (Source: MMO)

Port and Vessel Category	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U10m										
Port Ellen	0	0	47	96	176	504	553	392	344	359
Port Askaig	0	0	75	77	68	221	182	254	268	289
Islay	144	171	90	37	49	36	73	90	69	92
Jura	0	0	0	0	6	4	33	26	0	0
Craighouse	0	0	0	0	0	0	0	13	26	26
Campbeltown	0	0	17	10	3	2	1	3	0	0
Other Ports	3	10	14	4	34	15	9	4	8	13
Total	**147**	**181**	**243**	**224**	**336**	**782**	**851**	**782**	**715**	**779**
10m-15m										
Port Ellen	0	20	198	387	389	359	382	459	319	383
Islay	587	519	263	69	43	177	146	79	14	0
Port Askaig	0	0	33	73	8	115	320	418	472	300
Rathmullen	0	0	0	51	0	7	37	46	0	49
Portnahaven	0	0	0	0	0	0	0	17	58	93
Bruichladdich	0	0	8	0	2	35	54	39	10	8
Crinan	27	9	17	3	5	3	1	0	0	0
Bute	13	3	24	6	0	0	0	3	0	0
Jura	18	4	4	8	7	3	2	0	0	1
West Loch Tarbert	0	0	12	7	9	6	0	7	0	2
Tayinloan	10	2	0	3	10	3	0	8	3	3
Other Ports	7	45	25	65	14	22	11	9	5	28
Total	**662**	**602**	**584**	**672**	**487**	**730**	**953**	**1085**	**881**	**867**
15m and over										
Port Ellen	0	20	77	252	222	142	231	139	183	299
Islay	302	196	128	2	0	2	5	0	1	2
Oban	27	108	72	28	58	28	26	73	62	121
Rathmullen	0	0	41	30	140	81	206	95	6	0
Tayinloan	25	12	42	49	44	27	14	6	22	49
Troon and Saltcoats	7	20	69	13	3	11	21	11	27	0
West Loch Tarbert	20	12	23	18	19	17	0	10	13	50
Campbeltown	8	5	13	14	27	20	8	13	38	28
Killybegs	0	0	0	29	13	114	0	0	0	0
Greencastle	65	38	32	0	0	0	0	3	0	0

Mallaig	19	13	9	8	4	29	2	0	1	0
Crinan	45	3	1	7	6	9	4	4	0	1
Other Ports	12	117	23	32	30	23	8	11	31	23
Total	**530**	**544**	**530**	**482**	**566**	**503**	**525**	**365**	**384**	**573**
Non-UK										
Troon and Saltcoats	3	0	0	0	0	0	0	0	0	0
Kilkeel	0	1	0	0	0	0	0	0	0	0
Mallaig	0	0	0	0	0	0	0	0	0	1
Total	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Grand Total	**1342**	**1328**	**1357**	**1378**	**1389**	**2015**	**2329**	**2232**	**1980**	**2220**

In 40E4, under-10m vessels landing into ports located to east of the Kintyre peninsula tend to record the highest effort in 40E4. Vessels landing into Tarbert record the highest effort, which has remained over 400 days throughout the 10 year period for which data is presented. Vessels landing into Bute (Isle of Bute) also record high effort in 40E4 which peaked in 2005 (452 days), with effort then declining markedly in 2009 (46 days) and 2010 (0 days). Vessels landing into Carradale (south east Kintyre) recorded a maximum of 502 days in 2001 but the level of effort was considerably lower in all subsequent years. Vessels landing into West Loch Tarbert (west Kintyre) have recorded consistent effort over the 10 year period, which has increased significantly since 2006 (197 days); particularly high effort was recorded in 2010 (363 days).

In the 10-15m category, vessels landing into Tarbert record consistently high effort in 40E4, which increased from 1438 days in 2007 to a maximum of 1849 in 2010. Although relatively consistent over the period for which data is presented, effort recorded by vessels landing into Carradale and Campbeltown is considerably lower with respective peaks occurring in 2007 (637 days) and 2004 (453 days). To the west of Kintyre relatively high, consistent effort is recorded by vessels landing into Tayvallich and West loch Tarbert with respective maximum effort occurring in 2007 (325 days) and 2009 (338 days).

On the east of the Kintyre peninsula, the highest effort by the over-15m fleet is recorded by vessels landing into Tarbert (north east Kintyre) and Campbeltown (south east Kintyre). Effort by vessels landing into both ports is relatively consistent though slightly higher into Tarbert. The maximum effort recorded effort occurred in 2002 (1247 days) for vessels landing into Tarbert and 2001 (822 days). To the west of Kintyre, vessels landing into Tayinloan and West Loch Tarbert record the highest effort levels in 40E4. Effort by vessels landing into Tayinloan was generally higher from 2001-2004 with a peak recorded in 2002 (752 days). The opposite is true for Tayinloan, where effort by vessels landing into the port have increased almost yearly, recording a maximum of 614 days in 2010.

Table 5.6 Annual Effort (Days Fished) by Port and Vessel Category in ICES Rectangle 40E4 (Source: MMO)

Port and Vessel Category	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U10m										
Tarbert	429	521	512	400	399	612	532	592	462	365
Bute	142	150	147	120	452	355	403	232	46	0
Carradale	502	73	22	47	98	195	97	35	64	105
Ardrishaig	21	152	177	156	174	206	117	115	45	50
West Loch Tarbert	16	12	16	42	3	197	192	103	197	363
Largs and Greenock	0	0	0	0	5	8	40	103	304	169
Tayinloan	30	6	41	24	18	81	80	58	83	118
Tayvallich	41	4	19	0	111	153	24	12	0	0
Campbeltown	8	31	34	98	114	57	6	4	3	1
Troon and Saltcoats	0	0	67	0	11	3	11	78	110	0
Rothesay	0	0	0	0	0	0	0	12	68	111
Largs	0	0	0	0	0	0	0	0	0	176
Crinan	31	23	21	5	16	54	1	8	12	3
Gigha	29	13	14	0	5	4	17	6	29	37
Kyles Of Bute	0	0	0	0	0	0	0	12	55	78
Dunoon	0	0	0	0	0	0	0	1	54	75
Other Ports	32	18	12	15	17	69	39	102	173	314
Total	**1281**	**1003**	**1082**	**907**	**1423**	**1994**	**1559**	**1473**	**1705**	**1965**
10m-15m										
Tarbert	1231	1182	1225	1044	1311	1415	1438	1629	1751	1849
Carradale	419	255	264	266	400	321	637	423	450	298
Campbeltown	228	346	440	453	293	265	285	291	287	394
Troon and Saltcoats	7	37	256	209	299	504	645	562	349	8
Tayvallich	241	271	211	237	275	304	325	311	293	309
West Loch Tarbert	89	36	112	202	231	314	198	184	338	228
Bute	412	167	225	214	235	214	198	183	11	0
Crinan	44	66	94	56	62	71	33	66	32	102
Tayinloan	182	82	17	26	15	28	55	43	70	67
Troon	0	0	0	0	0	0	0	0	31	414
Oban	150	132	107	4	1	9	1	12	7	20
Jura	62	55	48	27	39	53	39	29	4	4
Rothesay	0	0	0	0	0	0	0	32	207	102
Largs and Greenock	71	89	42	22	2	5	31	14	17	25
Largs	0	0	0	0	0	0	0	0	0	124
Ardrossan	0	0	0	0	0	0	0	9	37	71
Other Ports	76	31	16	27	30	29	14	69	100	155
Total	**3212**	**2749**	**3057**	**2787**	**3193**	**3532**	**3899**	**3857**	**3984**	**4170**
15m and over										
Tarbert	948	1247	1177	850	891	566	700	687	654	696
Campbeltown	822	703	558	373	307	241	481	394	462	392
West Loch Tarbert	648	752	638	576	336	281	210	344	391	349
Tayinloan	267	267	331	352	358	503	384	523	538	614

Carradale	331	636	592	327	367	323	333	211	239	283
Troon and Saltcoats	388	396	348	234	310	178	135	291	253	3
Crinan	256	196	192	209	127	72	53	23	61	36
Oban	78	135	211	136	95	78	117	116	129	71
Troon	0	0	0	0	0	0	0	0	29	363
Tayvallich	41	27	52	26	12	6	0	4	0	7
Girvan	31	21	6	9	13	23	3	7	19	25
Port Ellen	3	5	3	33	19	25	23	7	17	9
Ardrossan	0	0	0	0	0	0	0	5	81	55
Gigha	5	5	17	14	20	11	19	19	10	1
Portavogie	30	9	10	18	19	8	11	3	5	5
Largs and Greenock	4	14	21	12	0	3	29	1	21	4
Other Ports	76	99	54	33	29	27	24	23	18	22
Total	**3928**	**4512**	**4210**	**3202**	**2903**	**2345**	**2522**	**2658**	**2927**	**2935**
Non-UK										
Milford Haven	0	0	4	0	0	0	0	0	0	0
Total	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Grand Total	**8421**	**8264**	**8353**	**6896**	**7519**	**7871**	**7980**	**7988**	**8616**	**9070**

6.0 Fisheries Surveillance Sightings

Figure 6.1 and Figure 6.2 give the positions of vessels identified by fisheries surveillance officers in the regional study area, by method and nationality respectively. Vessels of all lengths and nationality are recorded.

Demersal trawlers, which represent 64% of all observations, are most frequent in areas where *Nephrops* constitute a significant proportion of landings values (39E4, 40E4 and 41E3). Vessels operating creels (15% of total observations) are principally recorded in eastern and central areas where landings of edible crab, velvet crab and lobster are high, but also occur frequently in the north of the sound of Jura (40E4) and the north east of the region (41E4). Landings of crab and lobster are relatively low in these areas, indicative of the increased importance of the *Nephrops* creel fishery in these areas. Sightings of scallop dredgers represent a smaller proportion of sightings (6%) and are highest in central and eastern areas. Sightings of vessels operating pelagic trawls, gill nets, drift nets and long lines represent 7% of all vessel observations combined.

In terms of country of registration, 96% of vessels are of UK origin; based on landings data the majority of these are Scottish with a smaller proportion of visiting Northern Irish vessels. Vessels registered in the Republic of Ireland constitute 3% of observations. Sightings of other non UK vessels are comparatively low.

With reference to the development and its associated export cable the majority of sightings to the west of the site (40E3) are creel vessels. Vessel sightings along the cable route (40E3 and 40E4) are principally scallop dredgers, creelers and demersal trawlers. Sightings along the western section of the cable route (40E3) are less frequent than those recorded in the east and are represented by mainly by creelers and scallop dredgers. Higher densities of demersal trawlers are recorded in the central area of the cable route (Sound of Jura; 40E4); scallop dredgers and creelers are prevalent in coastal areas west of the Kintyre peninsula.

Although no direct vessel observations have been recorded within the site boundary, this may be due to the low fly over frequency of surveillance aircraft (see section 3.2.2). During consultation it was stated that the area may be periodically targeted with creels when tidal and weather conditions permit (pers. comm. creel fishermen, September 2012).

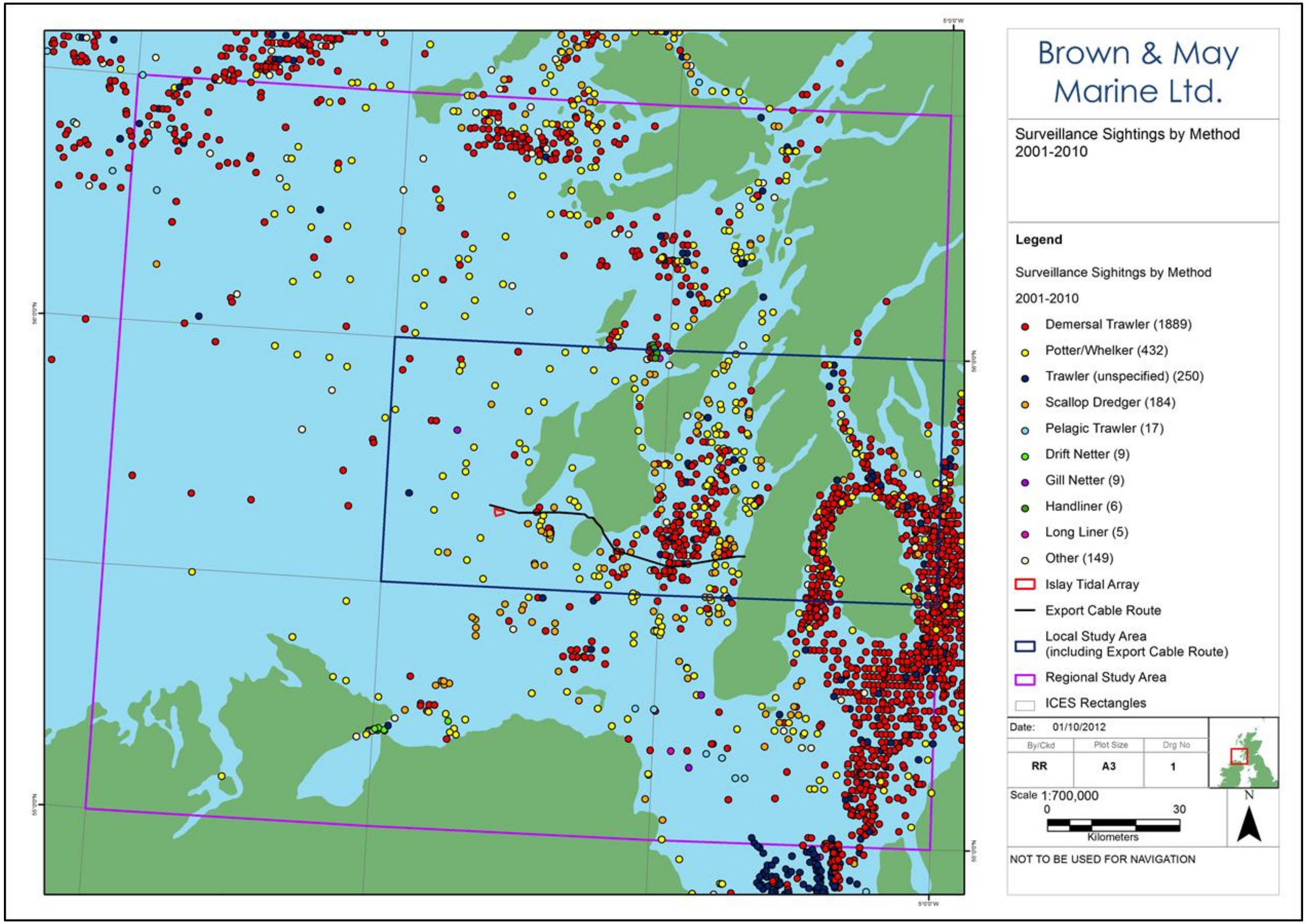


Figure 6.1 Surveillance Sightings (2001-2010) by Method in the Regional Study Area (Source: MMO)

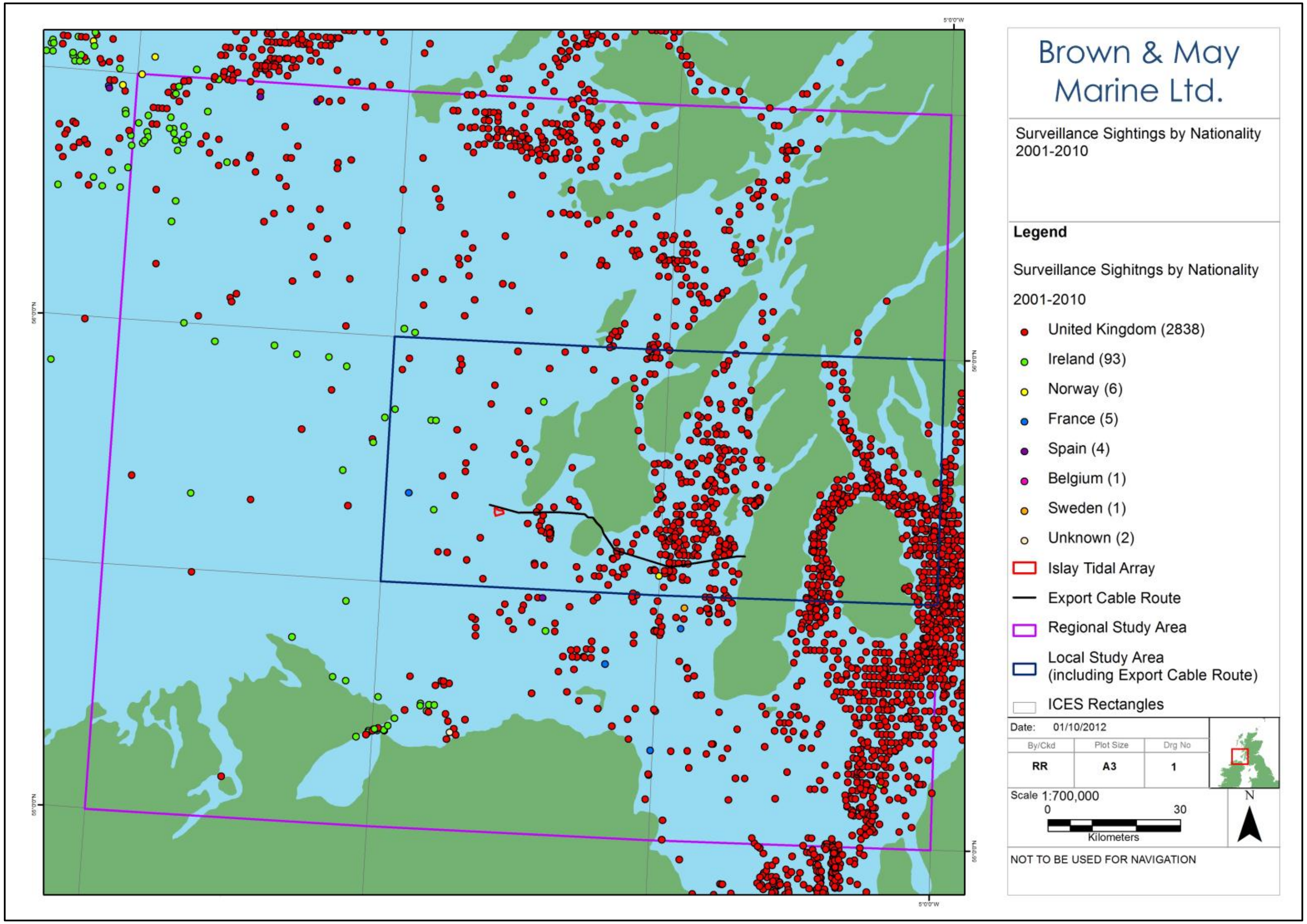


Figure 6.2 Surveillance Sightings (2001-2010) by Nationality in the Regional Study Area (Source: MMO)

7.0 MMO UK Satellite Tracking (VMS) Data

UK satellite data were provided by the MMO in comma separated variable (CSV) format. The data is not separated by method due to concerns over data protection and has been cross-referenced with the landings and effort data to provide values in a 0.05° by 0.05° grid format.

As outlined previously, VMS satellite data are only representative of the activity of vessels over-15 metres in length. Based on analysis of effort and landings data, a significant proportion of activity recorded in the regional study area is by vessels under 15m. This is particularly true of the local study area where effort by vessels under-15m represents 75% and 68% of effort in 40E3, and 40E4, respectively. It is therefore recognised that activity by these fleets will not be represented by VMS data sets.

7.1 National Overview

Figure 7.1 and Figure 7.2 show the average satellite (VMS) density by value and effort (hours fished), respectively, of all UK vessels over-15 metres (2007 to 2010) within the national study area. Areas of the highest density are located in offshore areas to the north east, north and north west. High activity is also recorded closer inshore along the majority of the west coast. Within the regional study area considerable disparity is evident in terms of activity between western and eastern areas: VMS densities in the east are considerably higher both in terms of both value and effort. This is particularly marked within the south east of the region.

7.2 Regional Study Area

7.2.1 2007-2010 Data

Figure 7.3 and Figure 7.4 show the average satellite (VMS) density by value and effort (hours fished), respectively, of all UK vessels over-15 metres (2007 to 2010) within the regional study area. Both effort and value are considerably higher in eastern areas, with rectangles located to the south (39E4) and east (40E4) recording the highest densities, particularly in terms of effort. Both central northern (41E3) and southern (39E3) rectangles also exhibit localised patches of relatively high density. Relatively low levels of activity are recorded in western parts of the study area.

Within the local study area, VMS densities inside and in the immediate vicinity of the tidal array are low in terms of value and effort (£2,500 and 500 hours, respectively). The export cable transects areas of relatively high value landings (£ 10,000-25,000) and effort (5,000 -10,000 hours) immediately south of the Rhinns of Islay. To the east of Islay in the Sound of Jura the export cable route passes through several areas where moderate and high VMS landings (£10,000-£50,000) and effort (10,000-50,000 hours) densities are recorded.

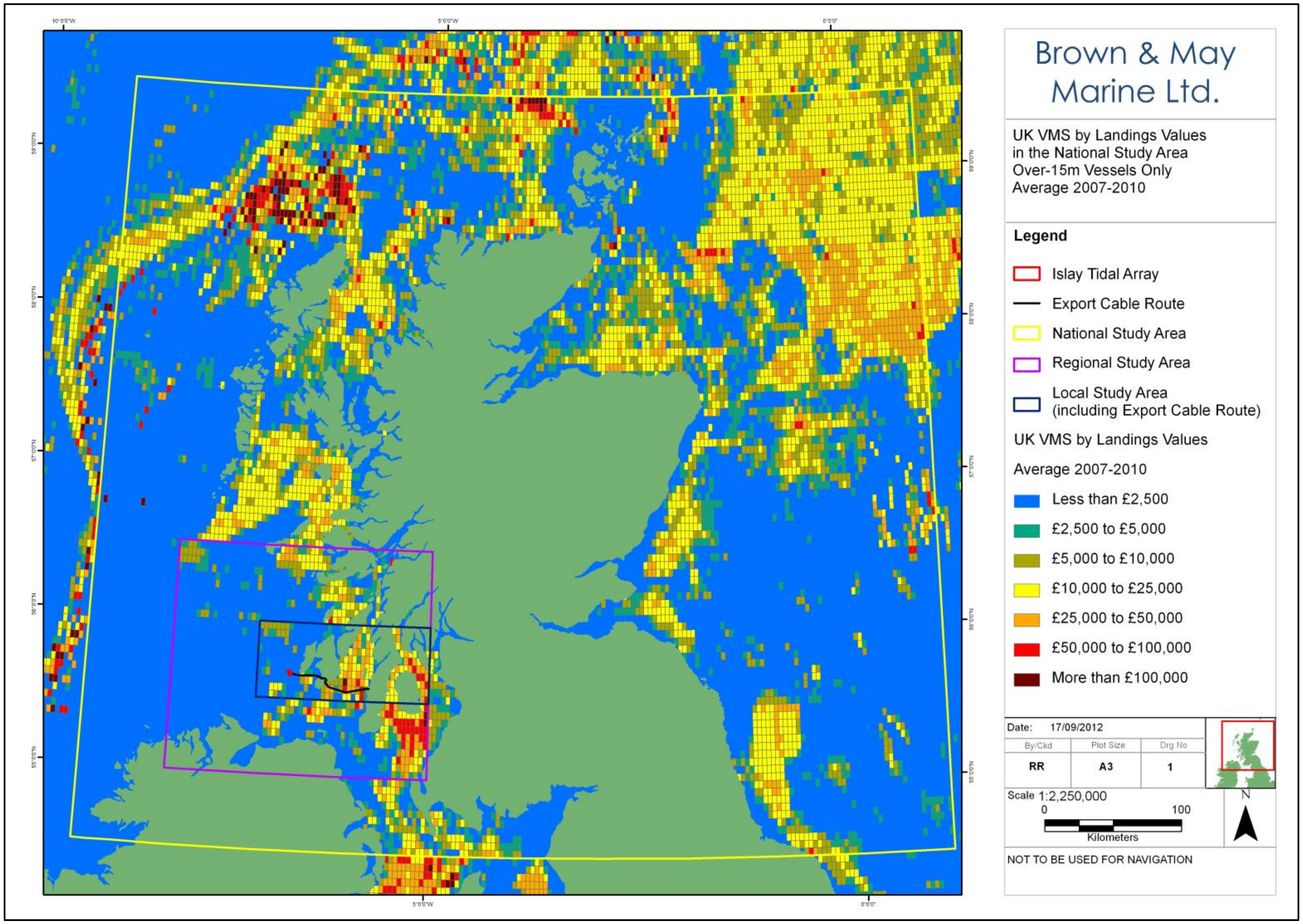


Figure 7.1 VMS Density by Value (Average 2007-2010) in the National Study Area (Source: MMO)

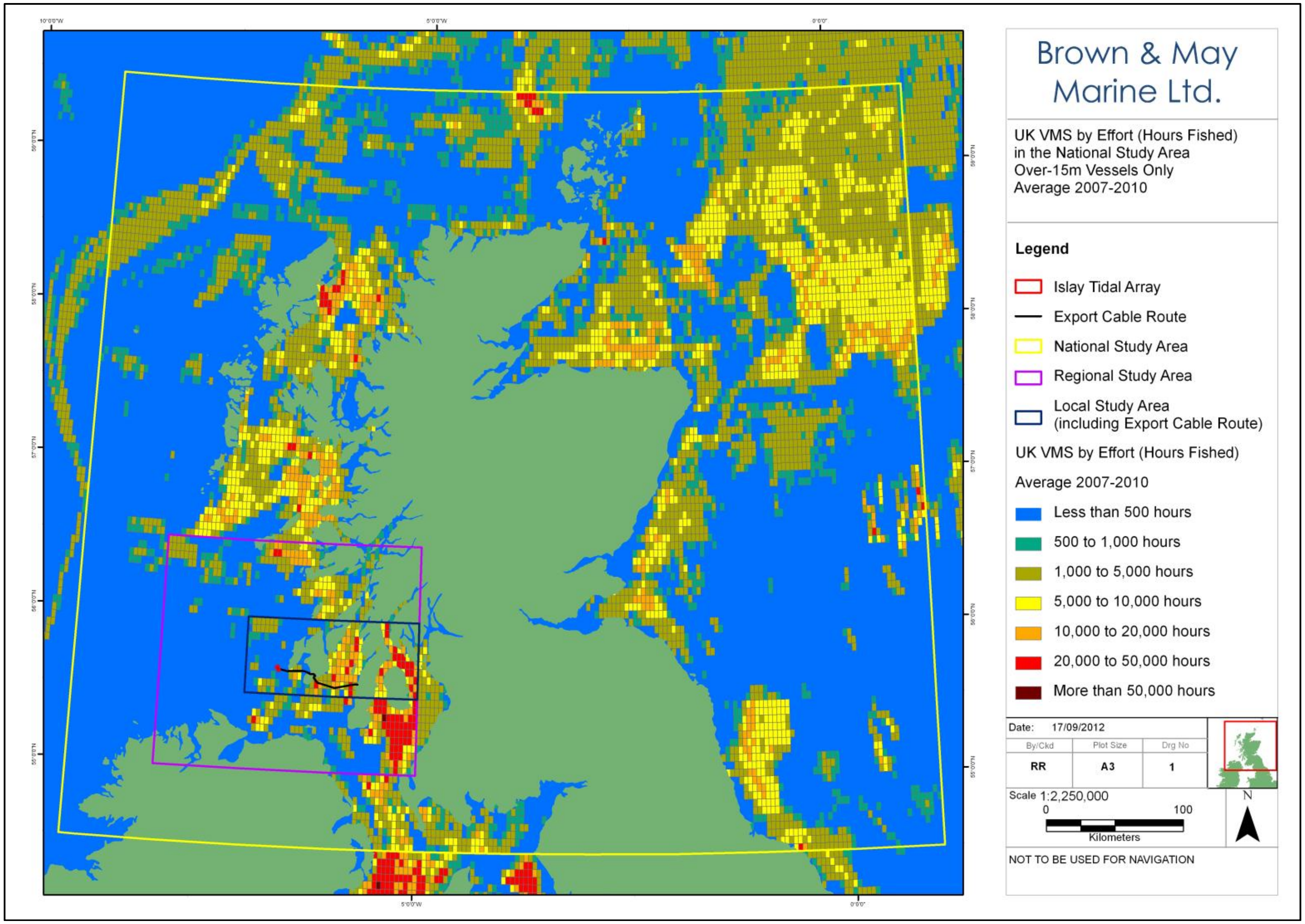


Figure 7.2 VMS Density by Effort (Average 2006-2010) in the National Study Area (Source: MMO)

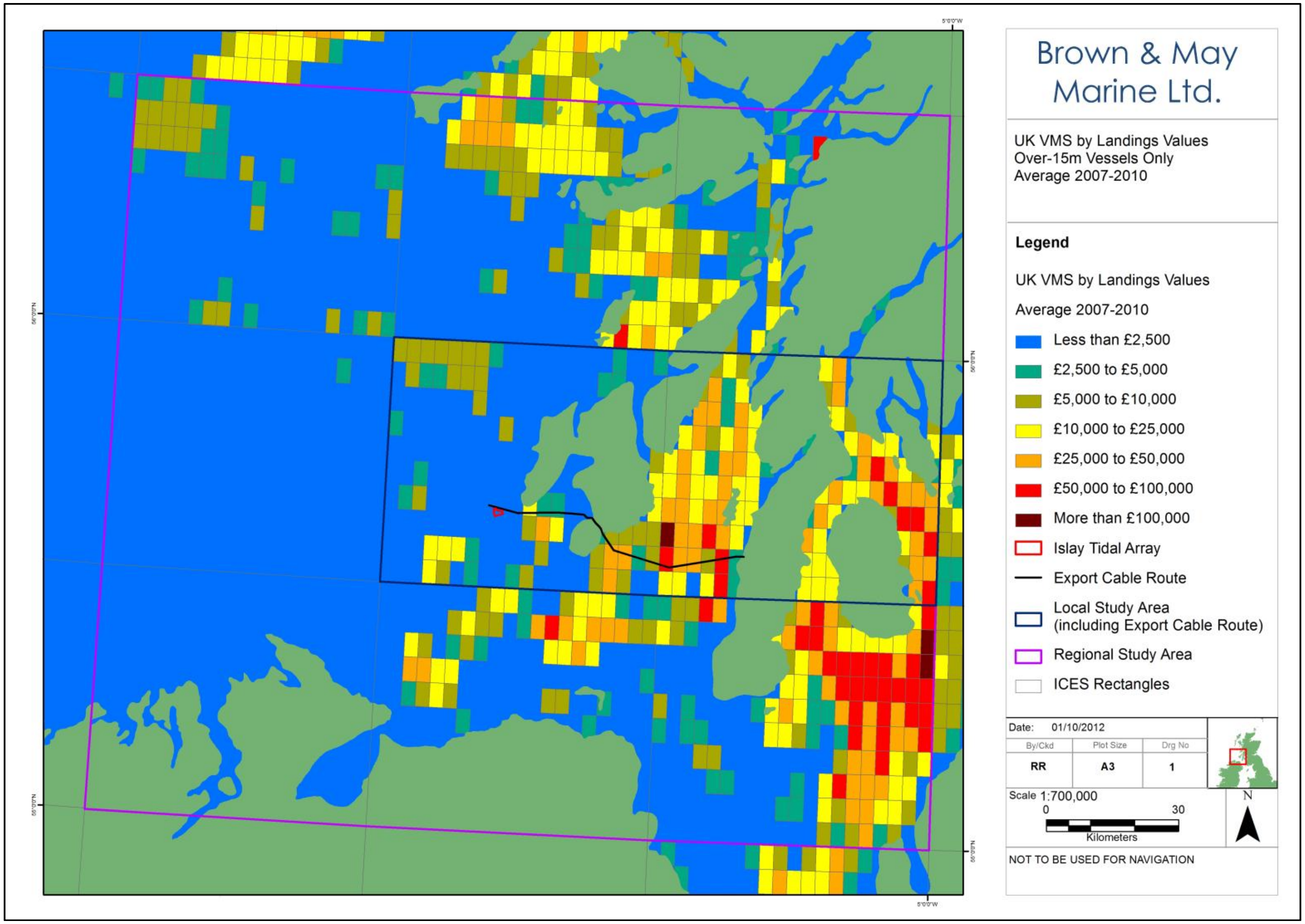


Figure 7.3 VMS Density by Value (Average 2007-2010) in the Regional Study Area (Source: MMO)

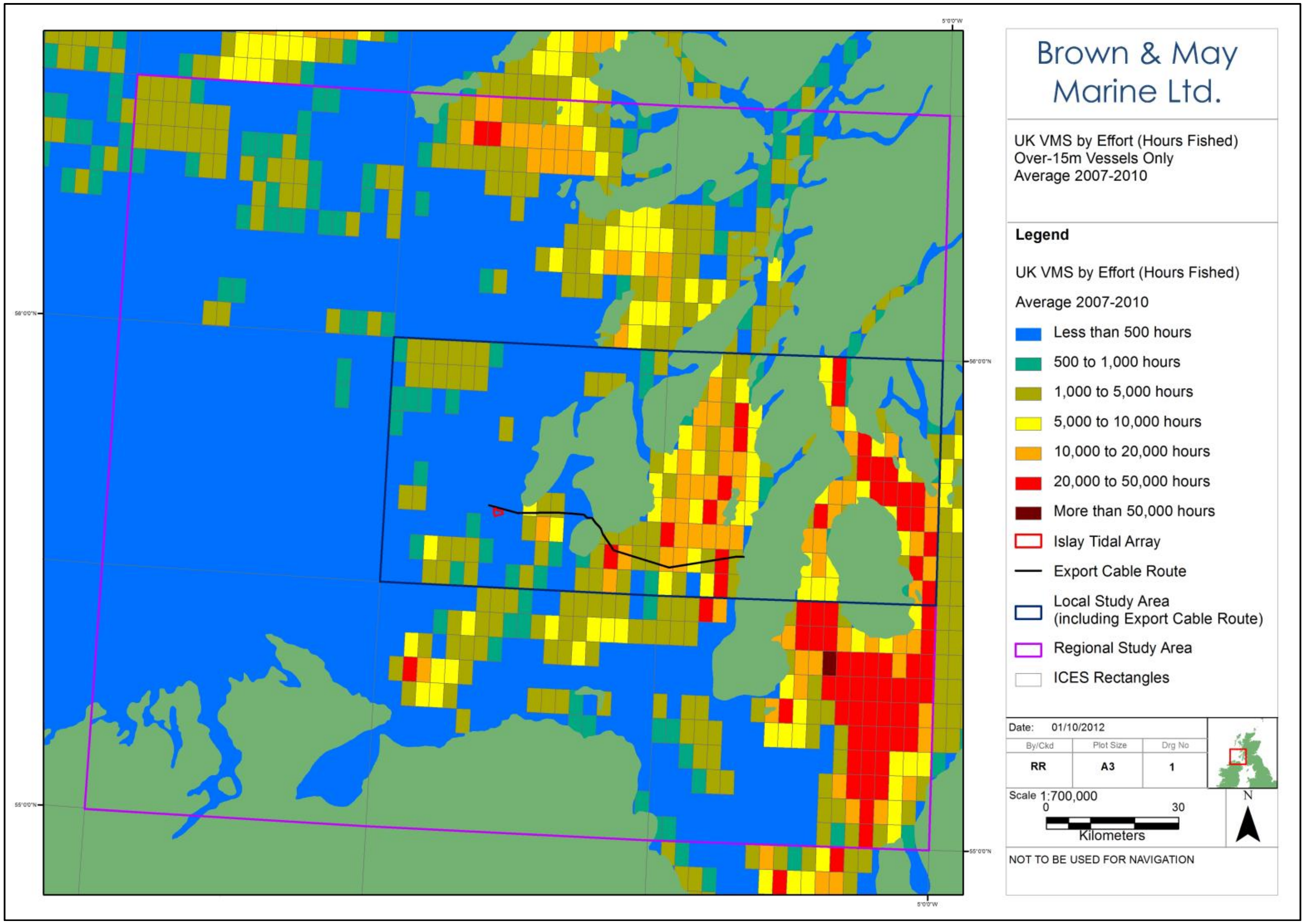


Figure 7.4 VMS Density by Effort (Average 2006-2010) in the Regional Study Area (Source: MMO)

8.0 Marine Scotland Data Analysis

As previously stated, the following charts have been produced by MSS and provided to BMM to assist the establishment of a comprehensive commercial fisheries baseline in the Islay area. As with the MMO VMS data, there are limitations associated with the interpretation of this data set (see section 3.3); principally that it is representative only of the over-15m fleet.

Figure 8.1 shows the distribution of commercial fisheries in the Islay area based on VMS data from vessels over-15m in length for 2011 only. As identified by previous analysis of VMS and surveillance data the highest intensity grounds are located to the east of the region, dominated by vessels targeting *Nephrops* and scallops.

Differences in the distribution of scallop and *Nephrops* grounds are clearly evident. Scallop grounds are principally located in coastal areas of the Sound of Jura, and south of Portnahaven across the mouth of Loch Indaal. The most intensively fished scallop grounds are situated within the Sound of Jura. Lower intensity grounds are located immediately north of Islay and along the west coast of Jura. Localised areas of scallop dredging activity are also located in areas of the North Channel and to the west of the development in the Malin Sea. The most intensively fished *Nephrops* grounds are located in the central areas of the Sound of Jura with some overlap with scallop grounds close to the Islay cable landfall. Low level pelagic activity is recorded on both sides of the cable route in the Sound Of Jura.

In 2011, activity by the over-15m fleet in the immediate area of the development was minimal, with a higher level of activity recorded along the export cable route. The planned route transects scallop grounds south east of the Rhinns of Islay and in the Sound of Jura also passing through areas of high *Nephrops* activity in the latter area.

Figure 8.2 to Figure 8.4 show the distribution of grounds by relative average value (2007-2011) of scallop, Nephrops (demersal trawl gear only) and edible crab fisheries, respectively.

The highest value scallop landings originate from grounds located along west, central and eastern areas of the export cable route south of the Rhinns of Islay, and in the North Channel and Sound of Jura. Grounds located in the latter two areas record the highest value scallop values in the area. Moderate values are recorded immediately north and north east of Islay (Figure 8.2).

The central area of the grounds situated in the sound of Jura record the highest value landings of *Nephrops*, located immediately north of the export cable route. The export cable route itself passes through an area of moderate-high value in the southern area of these grounds. More moderate values are recorded with increasing distance north and toward inshore areas. Grounds to the north east of Islay also record moderate-high values (Figure 8.3).

Landings values from the edible crab fishery are recorded exclusively in the north west with low levels recorded elsewhere. It should however be considered that a significant proportion of vessels using creels to target crab are under-15m in length and will therefore not be represented within this data set (Figure 8.4).

Figure 8.5 to Figure 8.9 illustrate landing value distributions of fishing activities not identified as a being of significant commercial importance in the MMO data set: *Nephrops* creels, mobile demersal gear, static demersal gear (long lines, gill nets and drift nets) and pelagic trawl gear, mobile demersal gear, and squid fisheries (mobile gear), respectively. It should be noted, however, that a number of vessels operating creels and demersal static gear will be under-15m and will therefore not be represented by this data set.

Landings from the *Nephrops* creel fishery are low in the vicinity of the development area. Two areas recording low-moderate values are situated immediately north of the cable route and south west of the cable landfall south east of Islay in the Sound of Jura (Figure 8.5).

Landings by demersal static gear methods are generally low, with two localised areas in the sound of Jura and west of Kintyre showing low-moderate value landings (Figure 8.6).

Vessels operating mobile demersal (excluding *Nephrops*) gear also record low overall landings values, with areas of slightly increased value to the south east and north west of the area (Figure 8.7). Low value landings of squid are recorded to the west of the Kintyre peninsula only (Figure 8.8).

Pelagic trawls record a relatively low level of activity (Figure 8.9). Analysis of MMO data indicates that this fishery is targeted by a small Scottish and Northern Irish pair trawling fleet which record a low number of landings in to either Tarbert or Ardglass during October, November or December. Vessels are reported to be over-15m in length and this data set will therefore be representative of their activity.

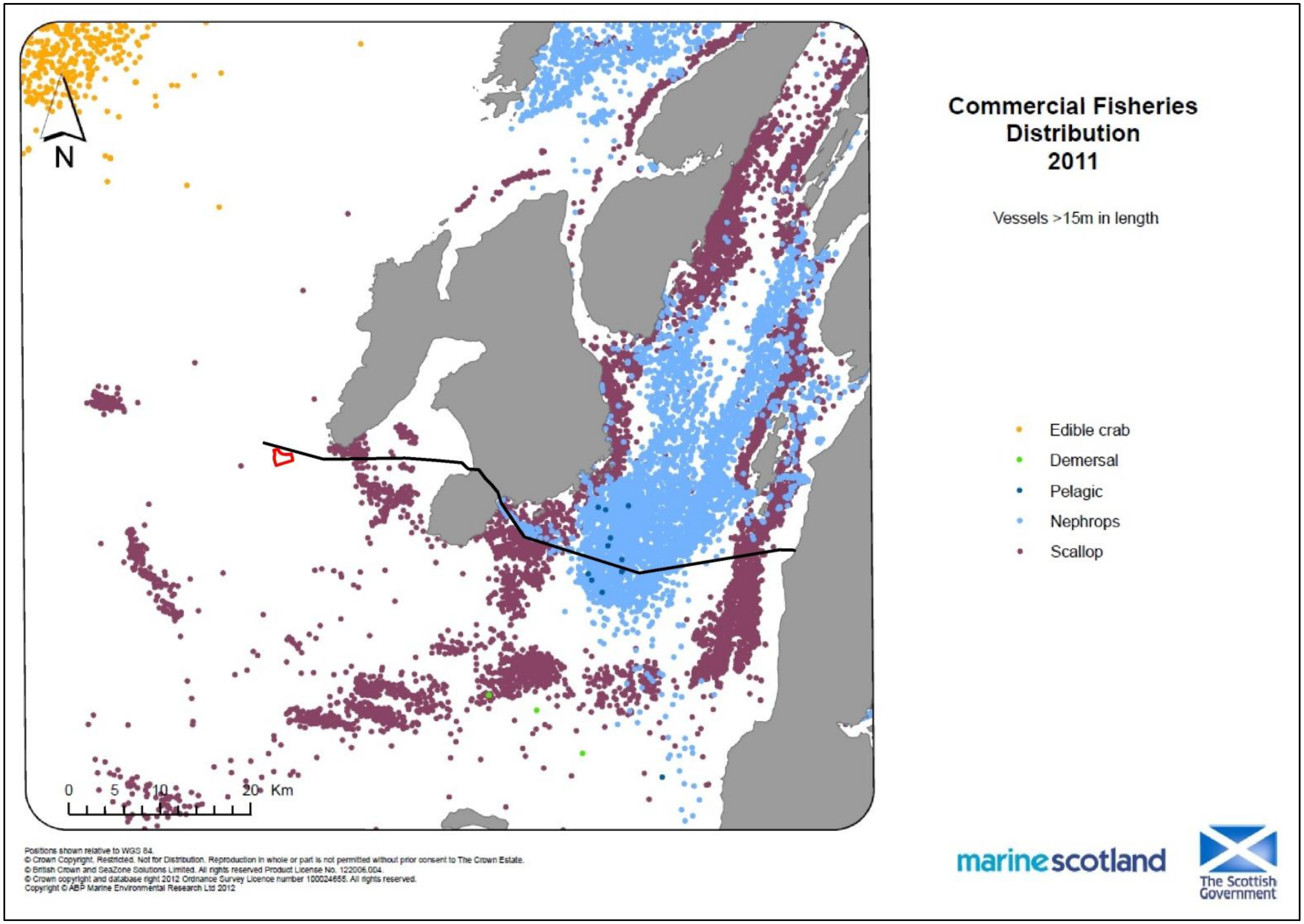


Figure 8.1 Commercial Fisheries Distribution in the Islay Area, 2011 (Source: Marine Scotland)

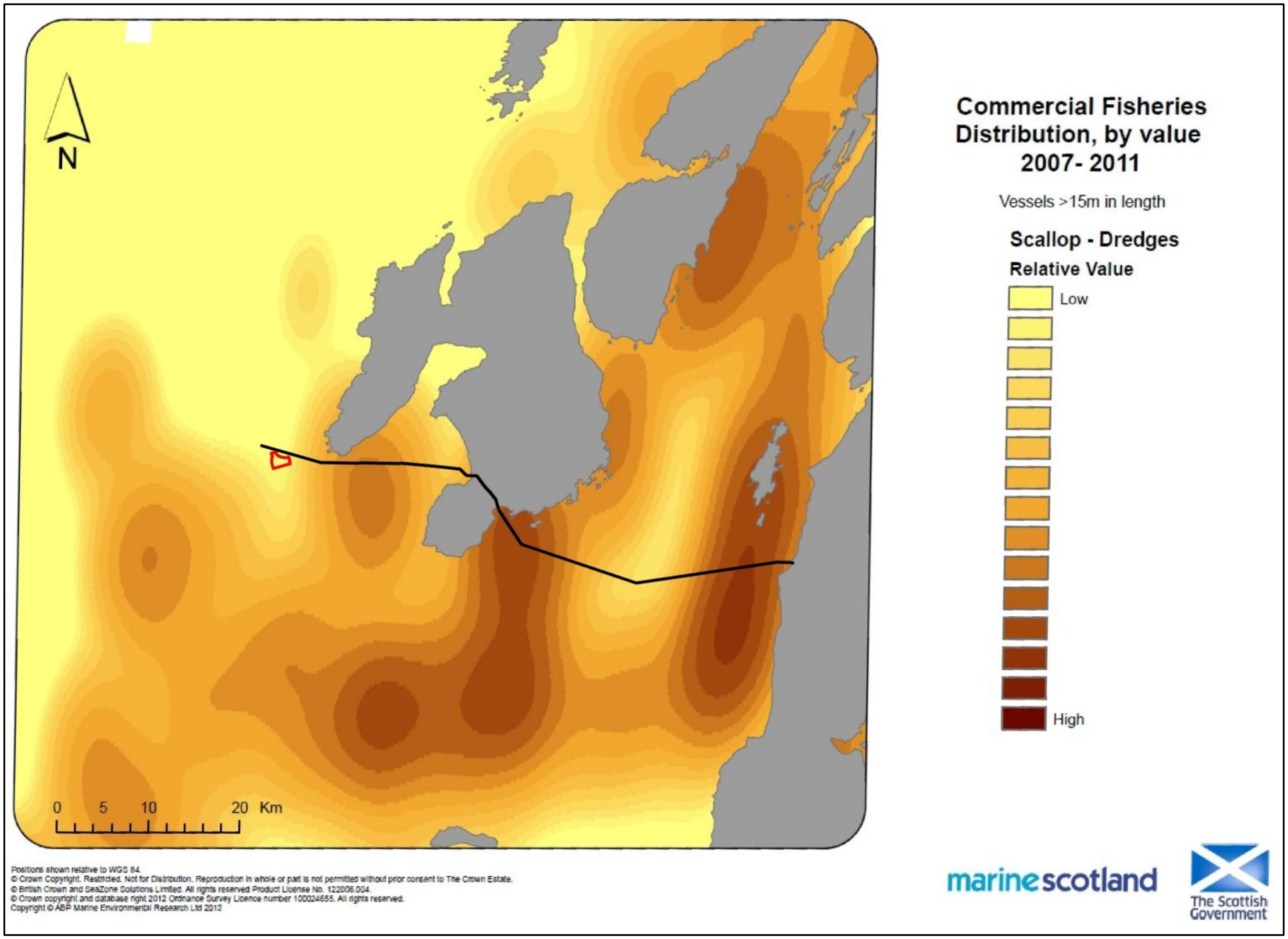


Figure 8.2 Distribution of Scallop Dredge fishery by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

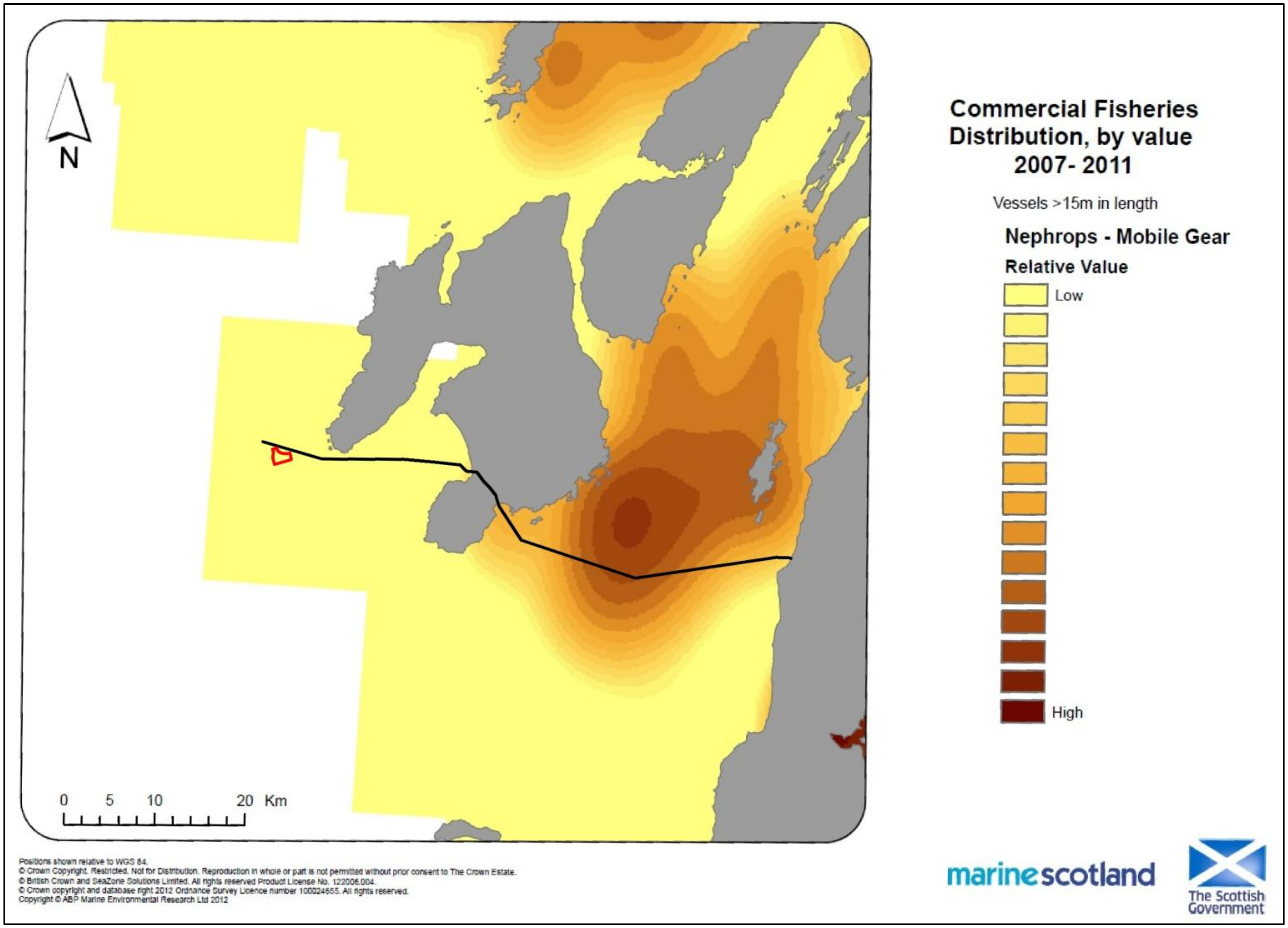


Figure 8.3 Distribution of *Nephrops* Demersal Trawl Fishery by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

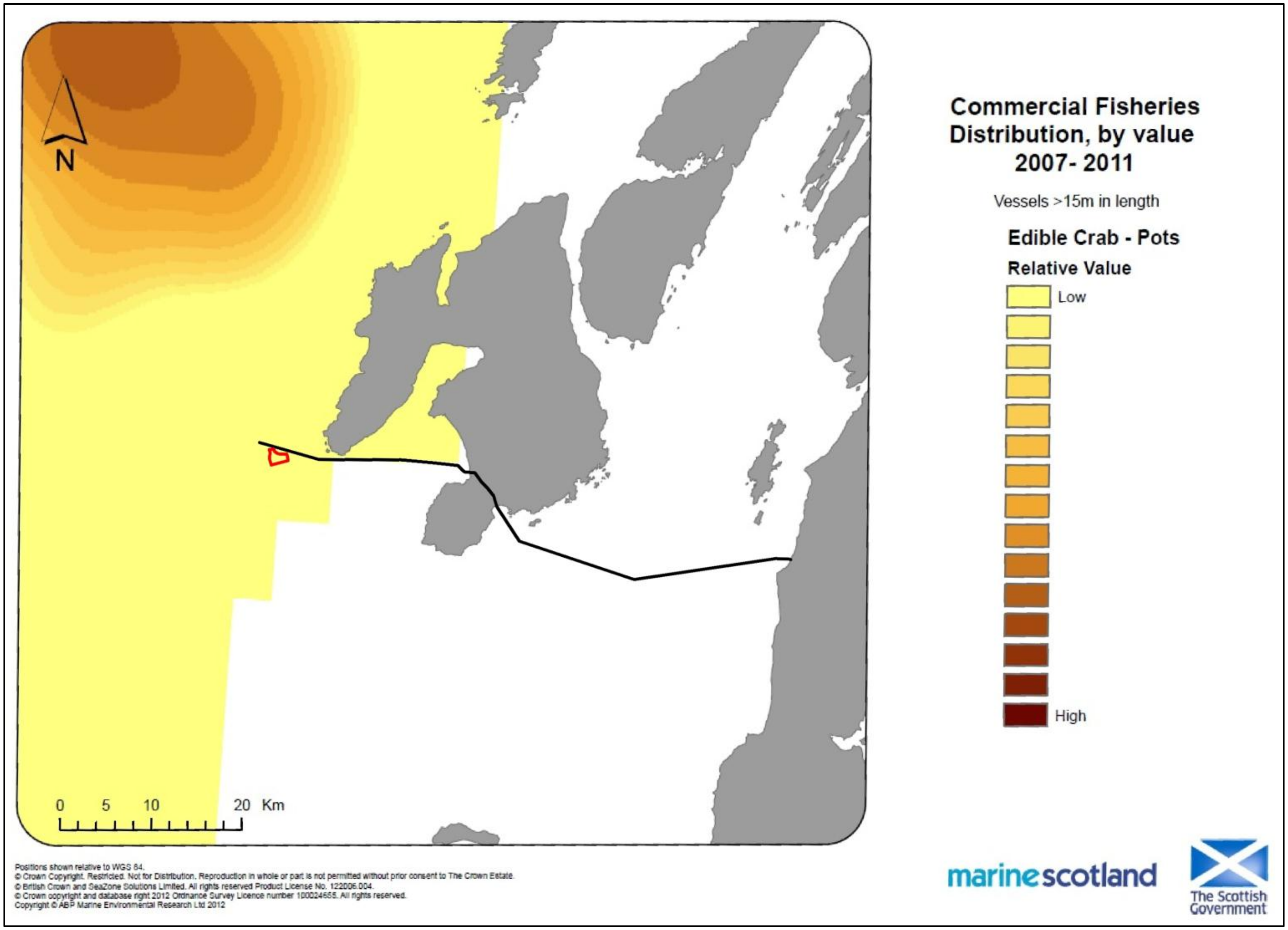


Figure 8.4 Distribution of the Edible Crab Fishery by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

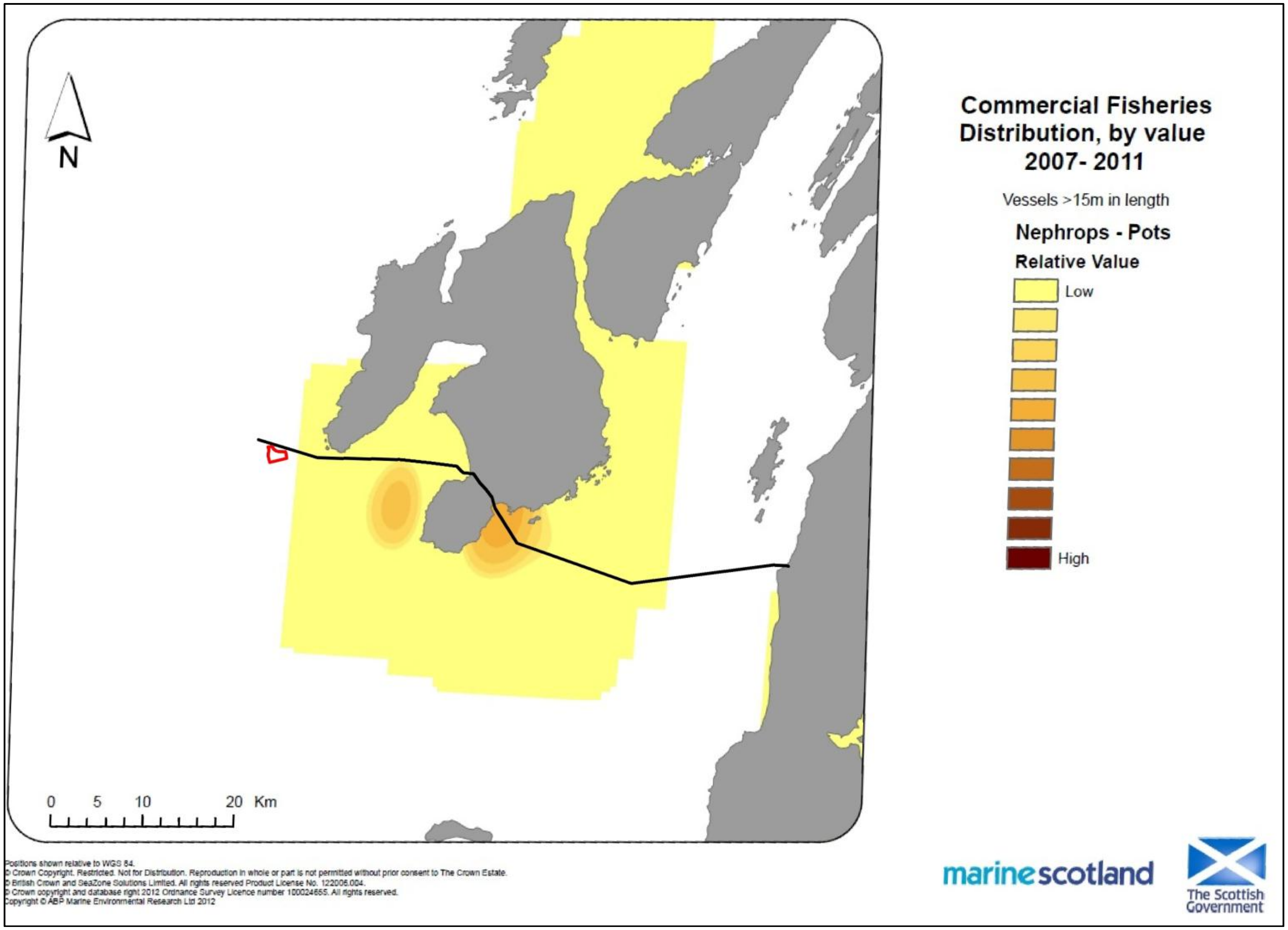


Figure 8.5 Distribution of *Nephrops* Creel Fishery by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

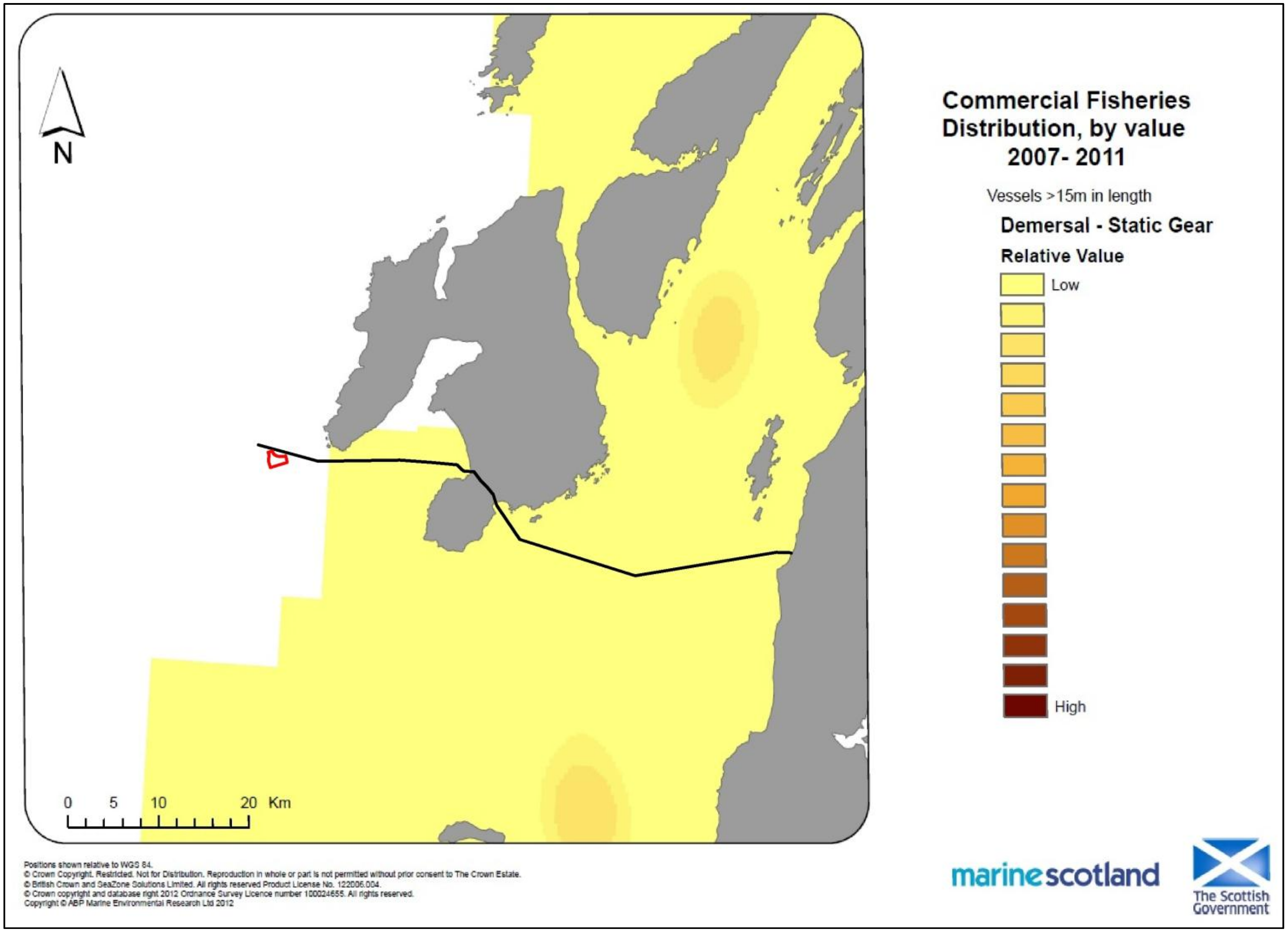


Figure 8.6 Distribution of Demersal Static Gear Fishery by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

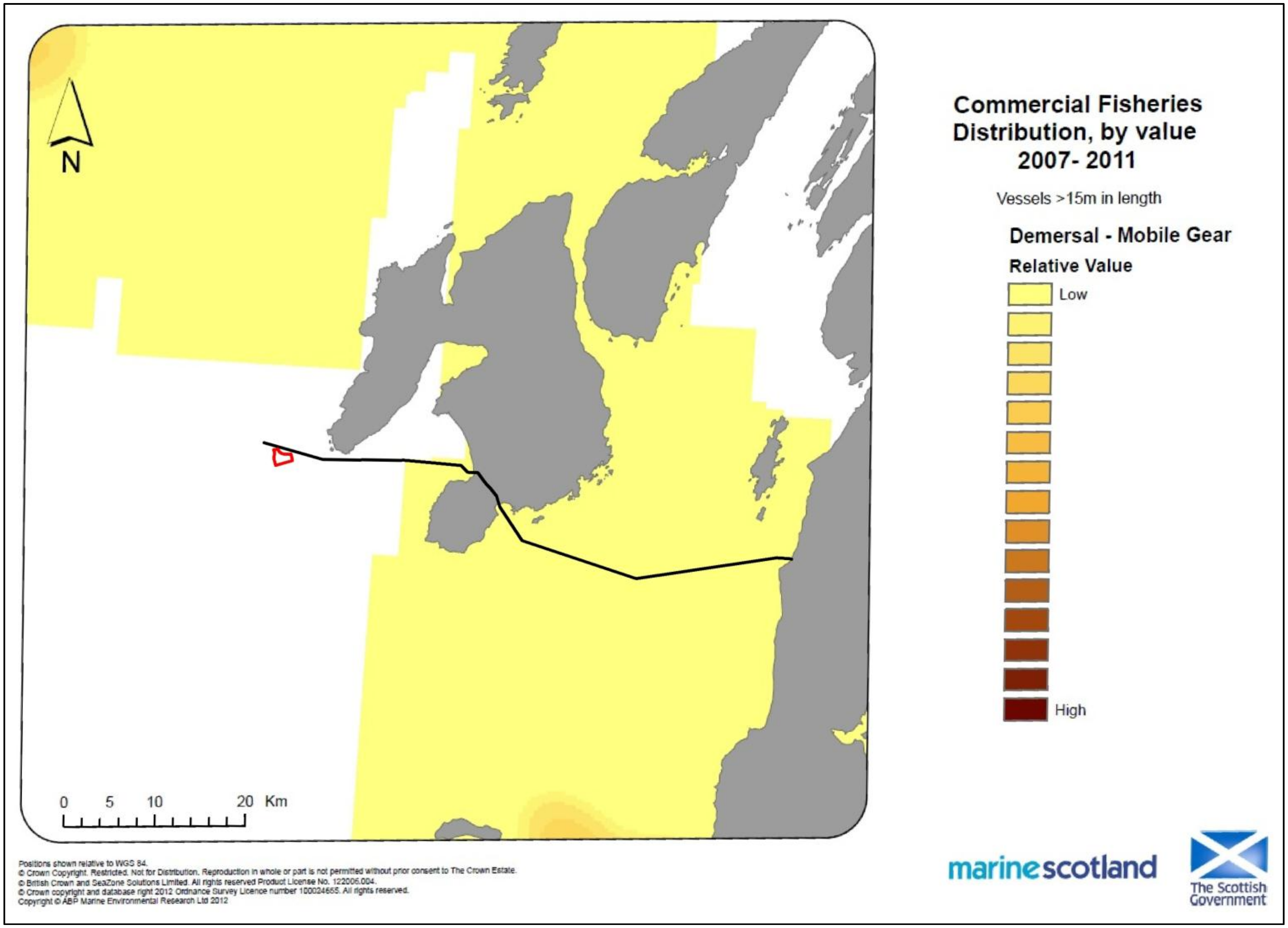


Figure 8.7 Distribution of Demersal Trawl Fishery (excluding *Nephrops*) by Value (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

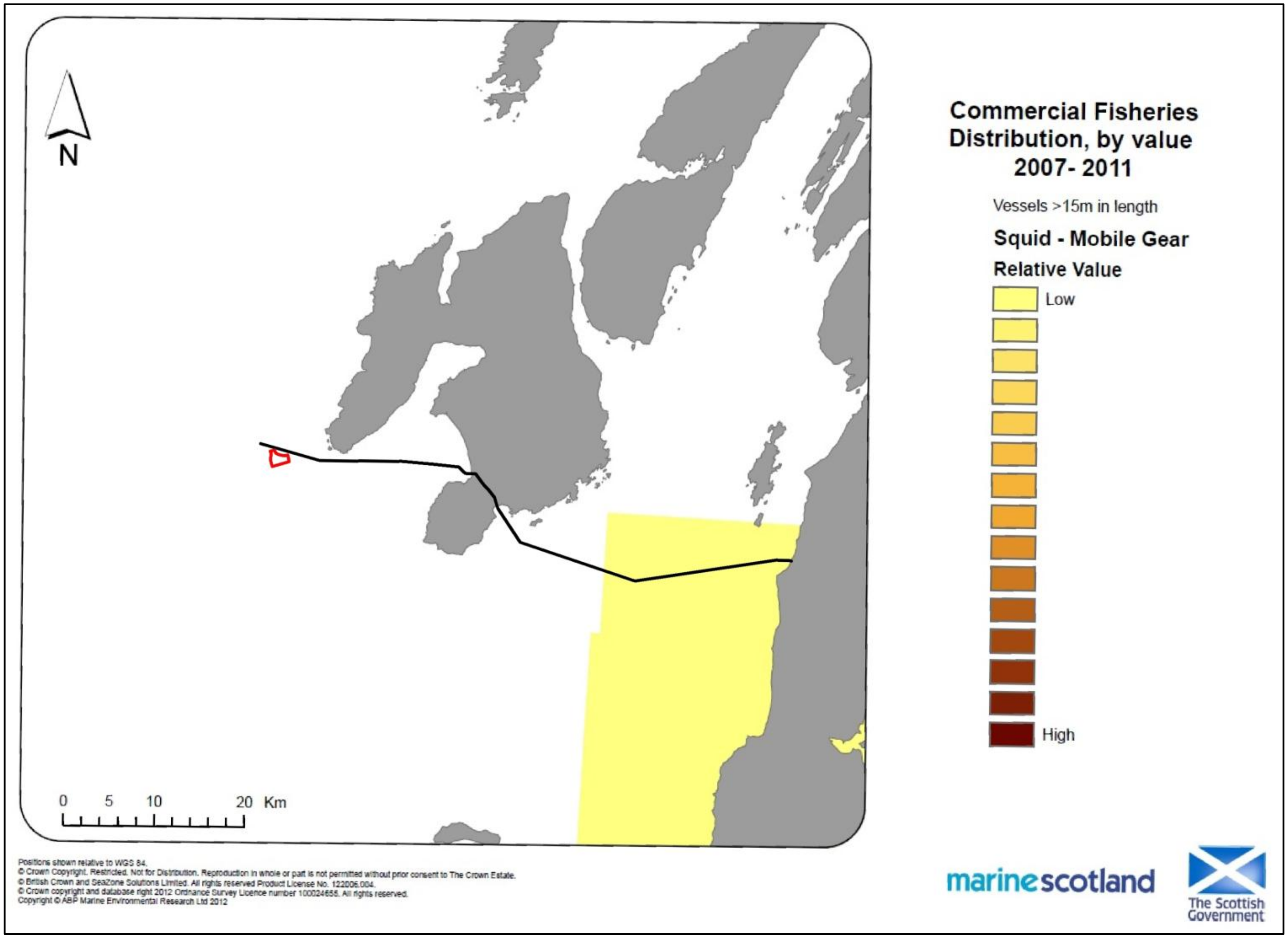


Figure 8.8 Distribution of Mobile Squid Gear (excluding *Nephrops*) Fisheries (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

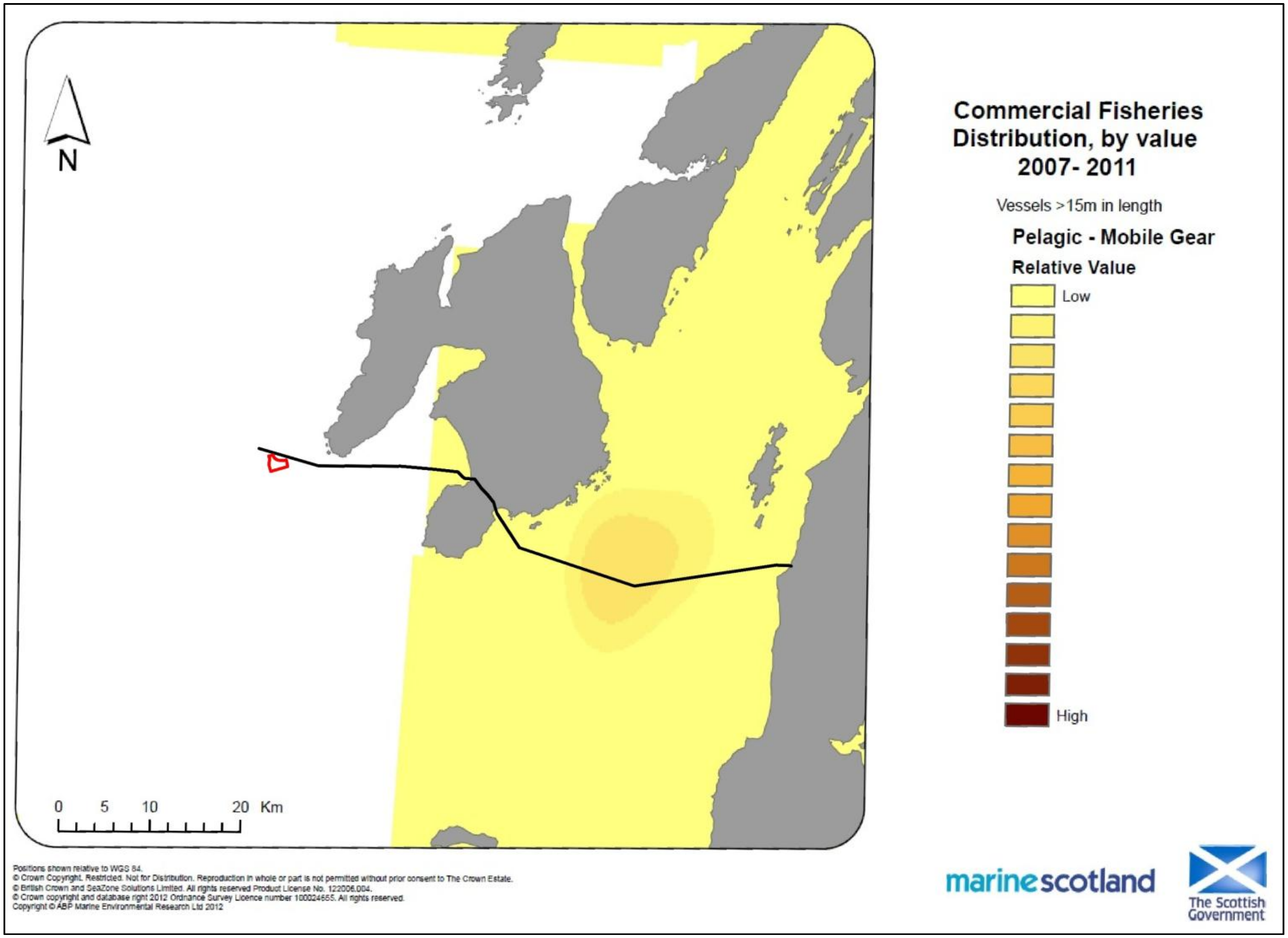


Figure 8.9 Distribution of Pelagic Trawl Fisheries (Average 2007-2011) in the Islay Area (Source: Marine Scotland)

9.0 Fishing Methods and Operating Practices

The three principal fishing activities identified to operate in the area of the proposed Islay Offshore Wind Farm site are as follows:

- Potting (creeling) for edible and velvet crab, lobster and Nephrops
- Scallop dredging
- Demersal otter trawling (principally targeting Nephrops)

Additional fisheries which are of lesser importance but have been identified in the regional study area are:

- Mid water pair trawling for herring
- Hand fishing for razor clams

9.1 Scallop Dredging

The principle species targeted by dredge in the area of the development and export cable route is king scallops. Dependent on vessel size, engine power and winch capacity, scallop vessels tow 1 or 2 steel beams, onto which an array of dredges is attached. Small vessels tow single beams with 4-6 dredges from the stern; larger vessels typically tow two beams 6-10m in length with 6-10 dredges per beam. The beam is fitted with solid rubber wheels at each end to aid passage over the seabed. Within Scottish waters the largest vessels may operate up to 14 dredges per side outside of 12nm. There are currently no limits restricting the number of dredges per side in English waters outside 12nm (i.e. they could operate more than 14 dredges per side).

Figure 9.1 Scallop Vessel operating Five Dredges per side (source: BMM)

The principal dredge employed is the spring loaded 'Newhaven' type as shown in Figure 9.2. Each dredge is fitted with a sprung tooth bar, which rakes the buried scallops from the substrate into a bag constructed from heavy chain rings[9]. Teeth are up to 11cm long and penetrate the substrate to a maximum of 20cm. A dredge, with fitted tooth bar and chain bag, will typically weigh between 120 and 140 kg.

The average tow duration for scallop dredges is approximately 2 hours at speeds between 2-4 knots. Warp length to water depth ratios during operation are usually 3:1. Gear specifications a scallop vessel known to target grounds on the west coast of Scotland are provided in Table 9.1.

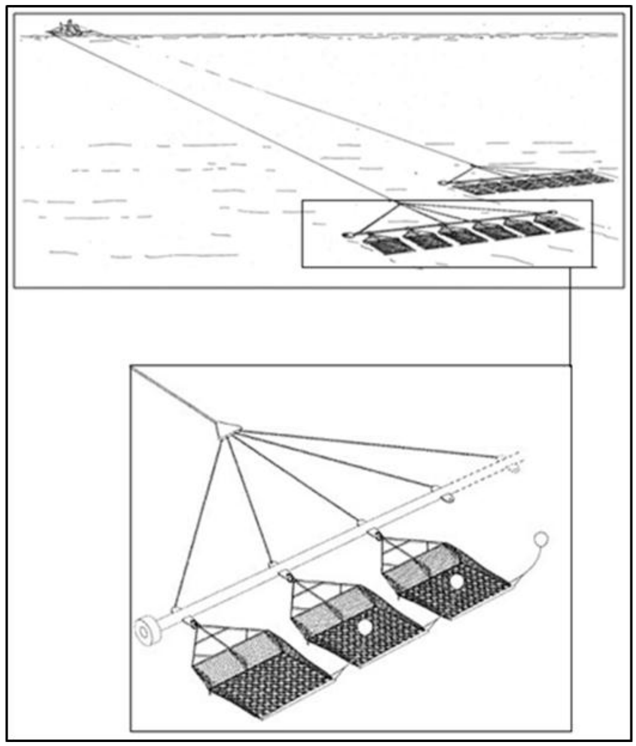


Figure 9.2 Scallop Gear Configuration and Newhaven Dredge Array

[9] Beukers-Stewart, B.D. and Beukers-Stewart, J.S. (2008) Principles for the Management of Inshore Scallop Fisheries around the United Kingdom. *Environmental Department, University of York report to CCW/SNH/NE.*

Table 9.1 Vessel and Gear Specifications for Scallop Dredger SC.1.

Fishing vessel	Vessel SC.1
Home port	Annan
Length	18.7
Main engine power	500hp
Fishing association	Scallop Association (SA)
Typical fishing trip duration	1-3 days
Typical distance steamed per trip	1-30 nm
Seasonality of activity	Scallops – all year
Average number of days fishing per year	200 days per year
Number of beams per side	1
Number of dredges per beam	8
Estimated total gear width	9m each side
Average towing speed	2.3 knots
Average towing duration	1 hour
Average tow length	2.5nm

9.1.1 Fishing Patterns and Practices

King scallops inhabit a range of depths from below the MLWM to in excess of 100m with preferred substrate typically comprising sand, gravel and mud, often interspersed with larger stones and rocks[10]. Scallops are the second most valuable shellfish species in Scottish waters and landings represent around 50% of the UK total[3]. Scallops are targeted all year round, with fleet activity generally highest during the second quarter[5]. Earlier analyses of MMO data sets indicate this seasonal pattern is true of the local study area where landings values are highest from April- July.

Commercial fishing for scallops was developed in the Firth of Clyde area (partially located in the eastern portions of 39E4 and 40E4) during the 1930s. Expansion of the fishery occurred during the 1960s in response to increased demand from continental Europe and additional fisheries were developed in other west coast areas such as West of Kintyre[11].

In Scotland, stocks are managed by geographical location and are broken down in to the following areas: North West, Orkney, Shetland, North East, East coast, Irish Sea, Clyde, and West of Kintyre. The regional study area encompasses the whole of the West of Kintyre stock and a small area of the Clyde stock. Both areas contribute significantly to scallop landings at the national level.

A significant proportion of the scallop fleet is considered 'nomadic', with vessels fishing grounds for a period before moving to other areas. Grounds are left for sufficient time (for example, around 18 months) to allow sufficient stock recovery before being targeted again. The areas fished depend on the productivity of each scallop ground and the changes in stock levels and regulations. Nomadic vessels are often large and operate the maximum number of permitted dredges outside the 12nm limit (14 per side). It was reported during consultation that larger vessels operating outside of the Firth of Clyde (e.g. West of Kintyre grounds) may remove dredges in order to allow them to target grounds inside the 6 and 12nm limits (pers. comm. scallop fisherman, 2012).

[10] Keltz, S. and Bailey, N. (2010) Fish and Shellfish Stocks 2010. *Marine Scotland Report.*

[11] McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review

The operational extent of smaller vessels tends to be more restricted by virtue of their size. Smaller local vessels tend to focus fishing activity on grounds located in the Firth of Clyde and West of Kintyre fisheries although they may also visit grounds in the Irish Sea during when closures are not in force (pers comm. scallop fisherman, 2012).

As described previously, the scallop fishery is not subject to catch and effort quotas, being managed principally by limits on dredge numbers and minimum landings sizes. A number of other management strategies have been implemented at smaller spatial scales in response to concerns over conservation and stock sustainability. For example, the Irish Sea king scallop fishery is closed from 1st of June to the 31st of October, inclusive. Significant increases in scalloping effort in the Cardigan Bay resulted in additional closures of large areas of the fishery in 2010. Further vessel and gear restrictions apply to vessels targeting scallops in territorial waters of the Isle of Man. In addition to limitations of effective gear width (which essentially restricts the number of dredges), further restrictions were applied to vessel engine power. These restrictions excluded all vessels with an engine capacity of over 221Kw from IOM territorial waters, unless they had fished the area for a minimum of fifty days 18 months prior to the ban (November 2010).

Such restrictions may have further implications for both fleets and stocks. For example, the Cardigan Bay closures resulted in vessel displacement increasing effort in other areas. Similarly, vessel power restrictions in Isle of Man waters resulted in the Scottish Government extending the seasonal closure of grounds in nearby Luce Bay. This extension was implemented in response to an anticipated increase in effort directed at stocks within the area[12]. At the time of writing the Irish Sea and Cardigan Bay closures are reported to have increased effort directed at grounds in the Sound of Jura and Firth of Clyde with up to 14 vessels targeting grounds south of Islay (pers. comm. scallop fisherman, 2012).

9.1.2 Scallop Vessels

As previously stated there are a number of local vessels with home ports based on the mainland and Islay which target grounds in the Sound of Jura and Firth of Clyde. The following information has been provided through the CFA, Campeltown DFO and individual skippers and vessel owners. Table 9.2 lists five vessels which target scallops and have home ports on the mainland, one of which is currently operating out of the Island of Gigha located west of Kintyre (pers. comm. scallop fisherman, 2012). The two vessels operating out of Carradale frequently target grounds to the west of Kintyre (pers. comm. Campbeltown DFO, 2012). One of these vessels is under-15m in length and will therefore not be represented by VMS data sets.

There are currently five scallop vessels based at Port Ellen on Islay (pers. comm. Campbeltown DFO), two of which are under-15m in length (pers. comm. Campbeltown DFO, 2012).

A number of scallop vessels from other Scottish ports and up to three visiting vessels from the Isle of Man may also periodically target grounds in the study area (pers. comm. IOM fishing industry representative, 2012). Including local and visiting vessels up to 15 vessels may target scallop grounds in the study area at any one time (pers. comm. scallop fisherman and scallop industry representative, 2012). As previously stated, a higher number of vessels are expected to occur during periods when closures are in force in the Irish Sea (pers. comm. scallop fisherman, 2012)

[12] Ross, D. (2010) Scallop-dredging row leaves Scots boats nowhere to fish. *The Herald Scotland*, 18/11/10.

Table 9.2 Scallop dredgers with Home Ports on the Mainland

Vessel number	Length (m)	Home port
Vessel Bz	15.18	Campbeltown
Vessel Ca	14.94	Carradale
Vessel Cb	16.15	Carradale
Vessel Cd	16.95	Oban
Vessel Ce	>15m	Oban (currently operating out of Ghiga)

Table 9.3 Scallop Dredgers with Home Ports on Islay

Fishing vessel	Length (m)	Home port
Vessel Cm	>10m	Port Ellen
Vessel Cn	11.5	Port Ellen
Vessel Co	13	Port Ellen
Vessel Cp	14.95	Port Ellen
Vessel Cq	15.35	Port Ellen

9.1.3 Scallop Fishing Grounds

The charts below have been produced using information provided by individual fishermen on paper charts. Areas indicated do not show discrete grounds fished by individual vessels but rather their general location relevant to the development and export cable route.

Figure 9.3 illustrates the general location of scallop grounds relevant to the tidal development and associated cable route. The cable route passes through scallop grounds south of the cable landfall at Port Ellen and west of Kintyre as previously shown in VMS data sets.

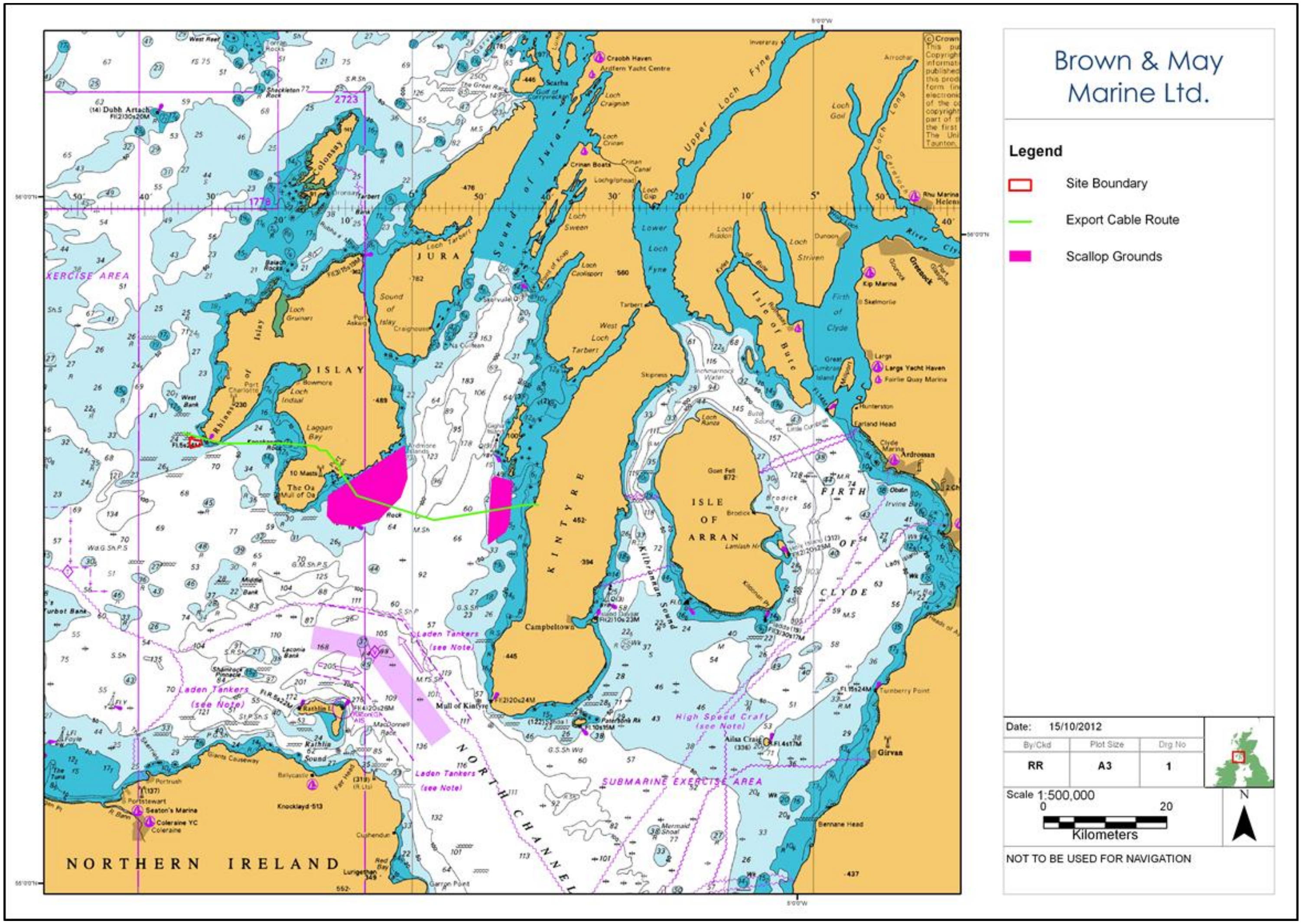


Figure 9.3 Scallop Grounds within the area of the West Islay Tidal Development and associated Cable Route

9.2 Demersal Otter Trawling for *Nephrops* and Whitefish

Demersal otter trawling currently represents the most common commercial fishing method in Scottish waters employed by full time vessels. Figure 9.4 shows the type of vessel which may target *Nephrops* grounds in the study area.

Figure 9.4 A *Nephrops* Trawler (source: IntraFish)

The basic configuration of a single rig demersal otter trawl is shown in Figure 9.5. The horizontal spread of the net is maintained by a combination of hydrodynamic and ground sheer forces effected by heavy steel trawl doors ('otter boards'), which penetrate the substrate to a maximum of 30cm, dependent on substrate hardness[13]. Floats on the headline maintain the opening of the net in the vertical plane, the height of which may vary dependent on target species. A weighted groundline ensures continued contact of the trawl mouth with the substrate. Groundline type will differ in response to the ground being fished. Over rough ground, durable rubber 'rockhopper' discs aid passage over the seabed reducing the risk of fastening and net damage. Over clean ground a weighted fibre rope ('grassrope') may be employed. The otter boards and sweeps have the effect of retaining the fish in the path of the oncoming net, which are then guided in to the mouth of the net by the wings. The top panel prevents the catch escaping over the top of the net, which on tiring drift down the net to be retained in the cod end.[14]

[13] Linnane, A., Ball, B., Munday, B., van Marlen, B., Bergman, M. and Fonteyne, R. (2000) A review of potential techniques to reduce the environmental impact of demersal trawls. Irish Fisheries Investigations (New Series). No. 7

[14] Galbraith, R.D and Rice, A (2004). An introduction to commercial fishing gear and methods used in Scotland. Scottish fisheries information pamphlet No.25

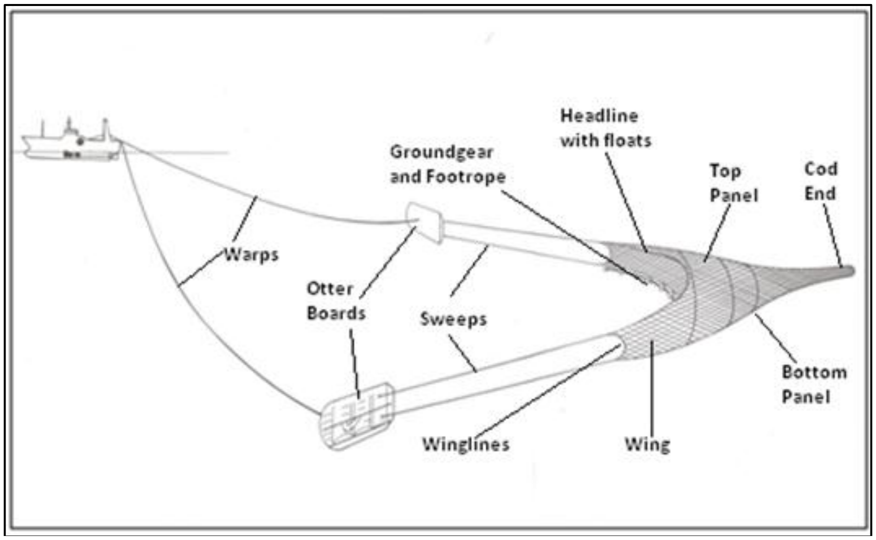


Figure 9.5 Single net Demersal Otter Trawl

An increasing number of vessels operate a system known as 'twin rigging'. The method operates on the same basic principles as those described for a single rig demersal otter trawl with the addition of an extra net as shown in Figure 9.6. The spread of the outer wings of the nets are maintained by the otter boards (a), with the inner wings attached to a heavy central weight known as a 'clump' weight (c), towed on a third central warp (b). Twin rig gear is more commonly used to target *Nephrops* but is also employed in whitefish fisheries. Warp length to water depth ratio are typically 3:1. Towing speed varies in response to the target species; vessels targeting mobile whitefish species will tow the gear at higher speeds than those targeting less mobile species such as *Nephrops*.

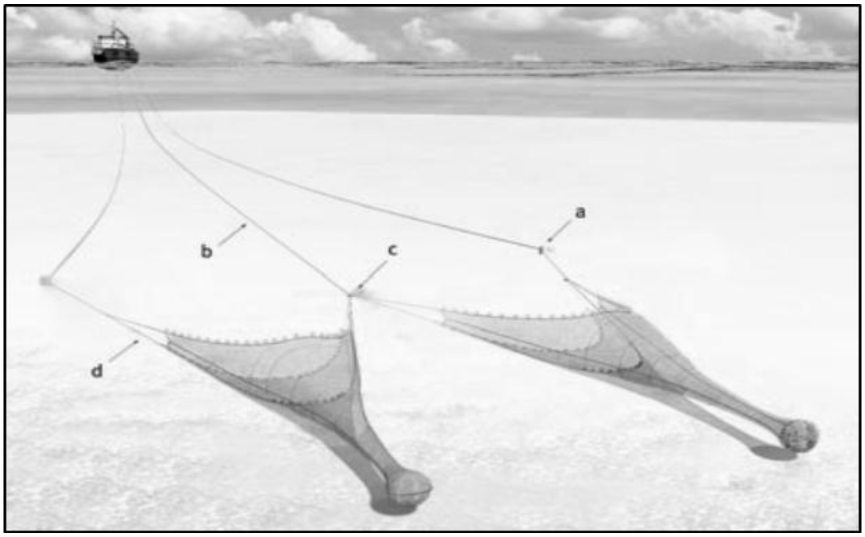


Figure 9.6 Demersal Twin Rig Trawling

Two vessels may undertake demersal pair trawling towing a single net between them, with one warp towed by each vessel. The use of two vessels eliminates the need for trawl doors to maintain the spread of the net. Instead, lengths (200-400m) of heavy chain and/or warp keep the gear in contact with the substrate. The net is generally rigged the same as for a single vessel but can be considerably larger. As the workload is effectively halved, small vessels of relatively low horsepower are able to tow large gear between them.

The gear specifications for a Northern Irish *Nephrops* vessel operating twin rig gear and targeting grounds in the Sound of Jura are provided in Table 9.4.

Table 9.4 Vessel and Gear Specifications for vessel N.I.1 a twin rig *Nephrops* trawler

Fishing vessel	Vessel N.I.1
Fishing Association	ANIFPO
Home port	Kilkeel
Length	18.4 m
Drive type	Hydraulic
Number of trawl winch drums	3
Length of warp on each drum	366m
Braking type	Band

Wire type	6 x 9 + 1
Warp diameter	16mm
Length of warp paid out relative to depth	2.5:1
Trawl door length	6.6ft
Trawl door height	4.6ft
Trawl door weight	260kg
Trawl door angle of attack	30 -36°
Distance between doors	50 fathoms
Number of bridles per side	1 (four in total)
Bridle length	50 fathoms
Ground line type	Rubber discs over soft ground
Grounds line length	120-180ft
Net type	Twin Rig Nephrops
Mesh size	80mm
Estimated headline height	3-4ft
Estimated distance between net wing ends	10m
Clump weight type	Chain
Clump weight	860kg
Maximum spread of gear	60 fathoms

9.2.1 Fishing Patterns and Practices

9.2.1.1 *Nephrops* Fishery

Nephrops are the highest value species landed in Scottish waters and are an important resource to a large proportion of the country's demersal fleet. The fishery is the largest in Europe and Scottish vessels are allocated the majority of the TAC[15]. The most extensive fishery is the Fladen Ground, located offshore, north east of the Moray Firth. The west coast fisheries situated in the North Minch, South Minch and Clyde (including Sound Of Jura) areas are also important, with particularly high landings values recorded from the latter areas[9]. Visiting vessels from the east coast *Nephrops* fleet do not tend to target the sound of Jura and Clyde grounds (pers. comm. *Nephrops* fishermen, 2012), fishing further north in the Minches and operating mainly from Mallaig and Ullapool[16]. Areas of both the Clyde (39E3, 40E4) and South Minch (41E3) grounds are located within the regional study area.

The majority of the demersal fleet operating in areas such as the Firth of Clyde and Sound of Jura are almost entirely dependent on *Nephrops,* which are targeted all year round (pers. comm. *Nephrops* fisherman, 2012)[17]. On a national scale the majority of *Nephrops* landings originate from vessels operating demersal otter trawl gear, although the creel fishery is of increased importance on the west coast[16]. This is true in parts of the regional study area such as ICES rectangle 41E4 (South Minch), and 40E4 (Sound of Jura/ Firth of Clyde), where creels account for significant proportions of Nephrops landings and effort values.

The ecology and life cycle of *Nephrops* influence both the location of grounds and catch composition. As a burrowing species *Nephrops* distribution is dictated by the occurrence of suitable mud, muddy sand and sandy mud substrates. The most productive grounds are therefore found where these substrates exist. Population density and individual size may also vary in response to substrate type; coarser sediments may support larger *Nephrops* but in lower numbers compared to finer sediments. This pattern is reported in the Firth of Clyde and Sound of Jura (regional study area) where grounds are characterised by abundant stocks of low individual mean size.[16] *Nephrops* are generally more active in low light levels, resulting in higher catch rates during darkness and at dawn and dusk, though this may vary in response to water depth and clarity[14]. Catches also tend to comprise a higher proportion of males due to a tendency for females to remain in their burrows while bearing eggs.[18]

Historically, bycatch of species such as cod, haddock and whiting were high in *Nephrops* fisheries as a result of the limited selectivity of gear and the tendency of the species to share similar grounds. As described previously a number of technical measures designed to improve gear selectivity and reduce bycatch of these species were introduced under the long term Cod Recovery Programme in 2008 and 2009. The first requirement of *Nephrops* trawlers was to use a large (120mm) square mesh panel (SMP) implemented as part of the Scottish Conservation Credits scheme. EU emergency measures aimed at reducing gadoid bycatch increased the mesh size in the cod end of the net from 70mm to 80mm in 2009[16].

Generally, vessels operating twin rigs utilise large 200mm SMPs, with 100mm cod end meshes. Whilst the majority of vessels operating in the Clyde and Sound of Jura utilise twin rigs, SMPs are usually 160mm due

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[15] Keltz, S. and Bailey, N. (2010) Fish and Shellfish Stocks 2010. Marine Scotland Report.

[16] Fishing News (3.8.2012). Fraserburgh gears up for busier last five months of challenging year.

[17] McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review

[18] ICES Advice June 2012, *Nephrops* in Division VIa

to the smaller average size of *Nephrops* on these grounds[12]. From October 1st 2012 all west coast vessels will be required to fit 200mm SMPs[19]. Although these measures have the effect of reducing the volume of catch, individuals are generally of a larger average size and quality is increased[11]. The Clyde *Nephrops* fleet now operate trawls with low headline height, a voluntary measure aimed at further reducing small fish by catch[20]. Swedish gate gear has also been trialled in the area, but has been met with mixed responses from the industry. This is due to associated handling difficulties when shooting and hauling the gear and significant reductions in the smaller size classes of *Nephrops* which are a feature of these fisheries.

Recent UWTV surveys of *Nephrops* stocks in the South Minch, Firth of Clyde and Sound of Jura indicate high population densities in all three areas. These have remained relatively stable since 1995 (1997 in the South Minch) and all fisheries currently have high productivity. In previous years the management advice based on these surveys has indicated levels of effort and harvest rates in these fisheries were sustainable. Despite high productivity the most recent report issued by ICES (June 2012), suggests stocks in the Clyde fishery are currently close to be exploited in excess of the maximum sustainable yield (MSY)[14].

9.2.1.2 Whitefish Fishery

Historically, whitefish species such as cod, haddock, whiting, saithe and hake represented important demersal fisheries on the west coast of Scotland. In areas such as the Firth of Clyde, landings of demersal whitefish rose rapidly during the early 1960's following the repeal of a ban on trawling outside of the 3nm limit. Landings reached a peak in 1973 before showing signs of decline. In response, grounds inside the 3nm limit were opened to demersal trawling in an attempt to maintain the longevity of the fishery. Despite this change in legislation demersal landings continued to dwindle until the early 2000s when the directed fishery effectively ceased[21].

The stock collapses and introduction of whitefish TACs under the CFP resulted in quota restrictions during the 1980s, further driving transition to a demersal fishery dominated almost entirely by *Nephrops*. Despite *Nephrops* being the target species, the fishery is mixed and as such species such as cod, haddock and whiting are also exploited. Recent research indicates that the increase in effort directed at *Nephrops* corresponded with the collapse of whitefish stocks[22]. It has been contended however that this study has oversimplified stock changes. This is because discards data which can form an important part of total demersal catch are unaccounted for and landings data alone are insufficient to support such a hypothesis[23]. As described previously, the Firth of Clyde has been a designated Cod Recovery Zone since 2001 and the wider regional area is subject to the gear regulations outlined in section 4.6 under the long term Cod Management Plan. In addition, a zero TAC for cod was allocated to Area VIa in 2012.

9.2.2 Nephrops Vessels

As stated previously, the local demersal fleet depends almost entirely on the *Nephrops* fisheries present in the Firth of Clyde and Sound of Jura. Based on information provided by the CFA and Campbeltown DFO there are currently 51 vessels with home ports on the mainland which target grounds in either or both of

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19 Fishing News 7th September 2012. *Clyde Fishermen determined to fight ban on gear.*

20 Fishing News 13th July, 2012. *Campbeltown services diverse prawn fleet.*

21 McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review

22 Thurstan RH, Roberts CM (2010). Ecological Meltdown in the Firth of Clyde, Scotland: Two Centuries of Change in a Coastal Marine Ecosystem. PLoSONE 5(7): e11767. doi:10.1371/journal.pone.0011767

23 McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: *Clyde Ecosystem Review*

these areas. A list of vessels and respective home ports is provided in Table 9.5. It should be noted that the exact length is not known for those vessels listed as either less than or greater than 10m in length. It should also be considered that that to some degree the operational range of smaller vessels will be limited by their size and they are therefore likely to target grounds closer to respective home ports (pers. comm. Campbeltown DFO). This will apply to vessels with home ports such as Troon, Greenock, Largs, Milport and Rothesay which are located on the eastern side of the Firth of Clyde. Larger vessels have the potential to target grounds in both the Firth of Clyde and Sound of Jura

Table 9.5 Vessels targeting *Nephrops* in the Study Area

Fishing vessel	Length (m)	Home port
Vessel Aa	11.39	Campbeltown
Vessel Ab	15.6	Campbeltown
Vessel Ac	16.79	Campbeltown
Vessel Ad	23.9	Campbeltown
Vessel Ae	16.85	Campbeltown
Vessel Af	16.6	Campbeltown
Vessel Ag	16.49	Campbeltown
Vessel Ah	17.07	Campbeltown
Vessel Ai	>15	Campbeltown
Vessel Aj	>15	Campbeltown
Vessel Ak	15.67	Campbeltown
Vessel Al	14.13	Carradale
Vessel Am	19.92	Carradale
Vessel An	10.9	Carradale
Vessel Ao	>10	Carradale
Vessel Ap	9.95	Carradale
Vessel Aq	10.89	Greenock
Vessel As	10.17	Greenock
Vessel At	9.9	Largs
Vessel Au	9.92	Millport
Vessel Av	9.1	Portincaple
Vessel Aw	9.9	Rothesay
Vessel Ay	10.1	Rothesay
Vessel Az	9.28	Rothesay
Vessel Ba	8.4	Rothesay
Vessel Bb	10.0	Rothesay
Vessel Bc	16.95	Tarbert
Vessel Bd	15.46	Tarbert
Vessel Be	13.84	Tarbert
Vessel Bf	16.27	Tarbert
Vessel Bg	11.25	Tarbert
Vessel Bh	13.84	Tarbert
Vessel Bi	17.01	Tarbert
Vessel Bj	12.16	Tarbert
Vessel Bk	17.07	Tarbert
Vessel Bl	12.98	Tarbert
Vessel Bm	11.08	Tarbert
Vessel Bn	12.0	Tayvallich
Vessel Bo	13.67	Troon

Fishing vessel	Length (m)	Home port
Vessel Bp	12.0	Troon
Vessel Bq	10.0	Troon
Vessel Br	9.9	Troon
Vessel Bs	13.47	Troon
Vessel Bt	15.69	Troon
Vessel Bu	18.53	Troon
Vessel Bv	12.75	Troon
Vessel Bw	16.92	Troon
Vessel Bx	16.51	Troon
Vessel By	9.93	Troon
Vessel Bz	17.71	Troon
Vessel Ca	14.6	Troon

Up to 40 visiting Northern Irish vessels may target grounds in the Firth of Clyde during the spring and summer (pers. comm. Campbeltown DFO). Information gathered during consultation indicates that seven Northern Irish *Nephrops* vessels regularly target grounds in the Sound of Jura using both single and twin-rig gear. Vessels N.I. 1 and 2 periodically target grounds in the sound of Jura and other west coast grounds between April and October. Vessels N.I. 4-7 target the Firth of Clyde *Nephrops* fishery during the week before moving into the Sound of Jura when the Clyde weekend closure is operational (pers. comm. ANIFPO, 2012). Unlike a number of other N.I. vessels that target these grounds during the spring and summer, vessels N.I. 4-7 operate in the Firth of Clyde and Sound of Jura principally during September to December. All of these vessels are over-15m in length and will therefore be represented by VMS data. Details of those vessels known to target *Nephrops* in the Sound of Jura are provided in Table 9.6.

Table 9.6 List of Northern Irish Vessels Targeting *Nephrops* in the Sound of Jura

Fishing vessel	Length (m)	Gear	Home port
Vessel N.I.1	18.2	Twin Rig	Killkeel
Vessel N.I.2	18.4	Twin Rig	Killkeel
Vessel N.I.3	18.2	Single Rig	Annalong
Vessel N.I.4	21.3	Single Rig	Portavogie
Vessel N.I 5	20.3	Single Rig	Portavogie
Vessel N.I 6	19.3	Single Rig	Portavogie
Vessel N.I.7	20.2	Twin Rig	Portavogie

9.2.3 *Nephrops* grounds

The general location of Nephrops grounds in relation to the export cable route are shown in Figure 9.7. Whilst this information was provided by the skipper of a vessel operating twin rig *Nephrops* gear it was also noted during consultation that *Nephrops* creel and trawl grounds overlap in some areas. As previously indicated by VMS data the cable route transects *Nephrops* grounds in the central areas of the Sound of Jura.

The location of *Nephrops* grounds targeted by five visiting vessels from Northern Ireland is shown in Figure 9.8. It should be noted that the depiction of these grounds is based on VMS data provided during consultation and therefore gives an accurate representation of targeted areas. Grounds fished are in a similar area to those targeted by Scottish vessels and are crossed by the export cable route. Additional grounds are located north of Colonsay.

9.2.4 Squid Grounds

Although legislation under the Cod Recovery Plan currently prevents a directed squid fishery in the study area (see section 10.2.4) grounds where squid are caught were indicated during consultation. Figure 9.9 shows grounds located close to the cable route in areas to the south east of Islay and west of Kintyre. It was stated during consultation that this fishery is seasonally restricted to the autumn months (pers. comm. *Nephrops* fisherman, 2012

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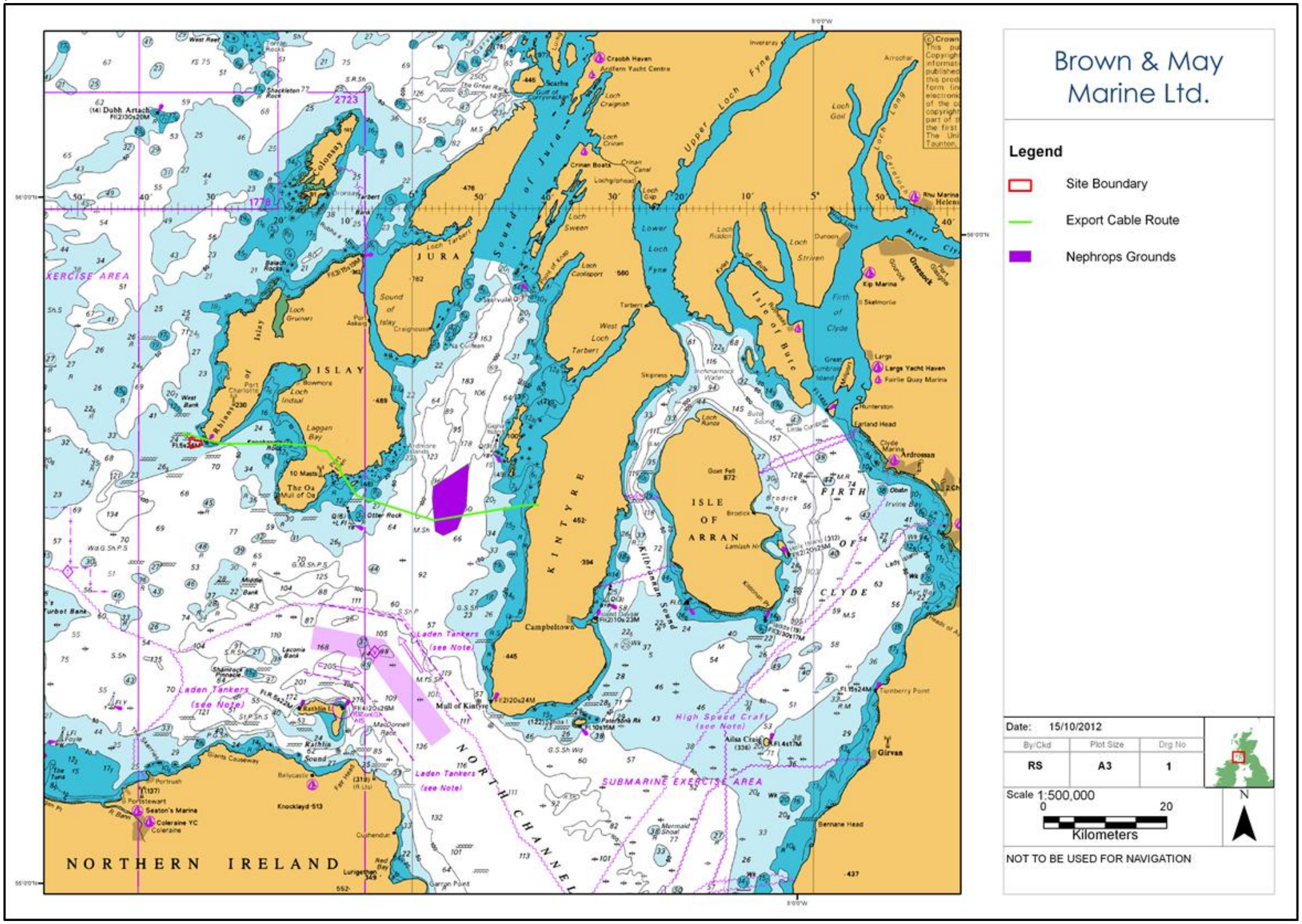

Figure 9.7 *Nephrops* Grounds within the area of the West Islay Tidal Development and associated Cable Route

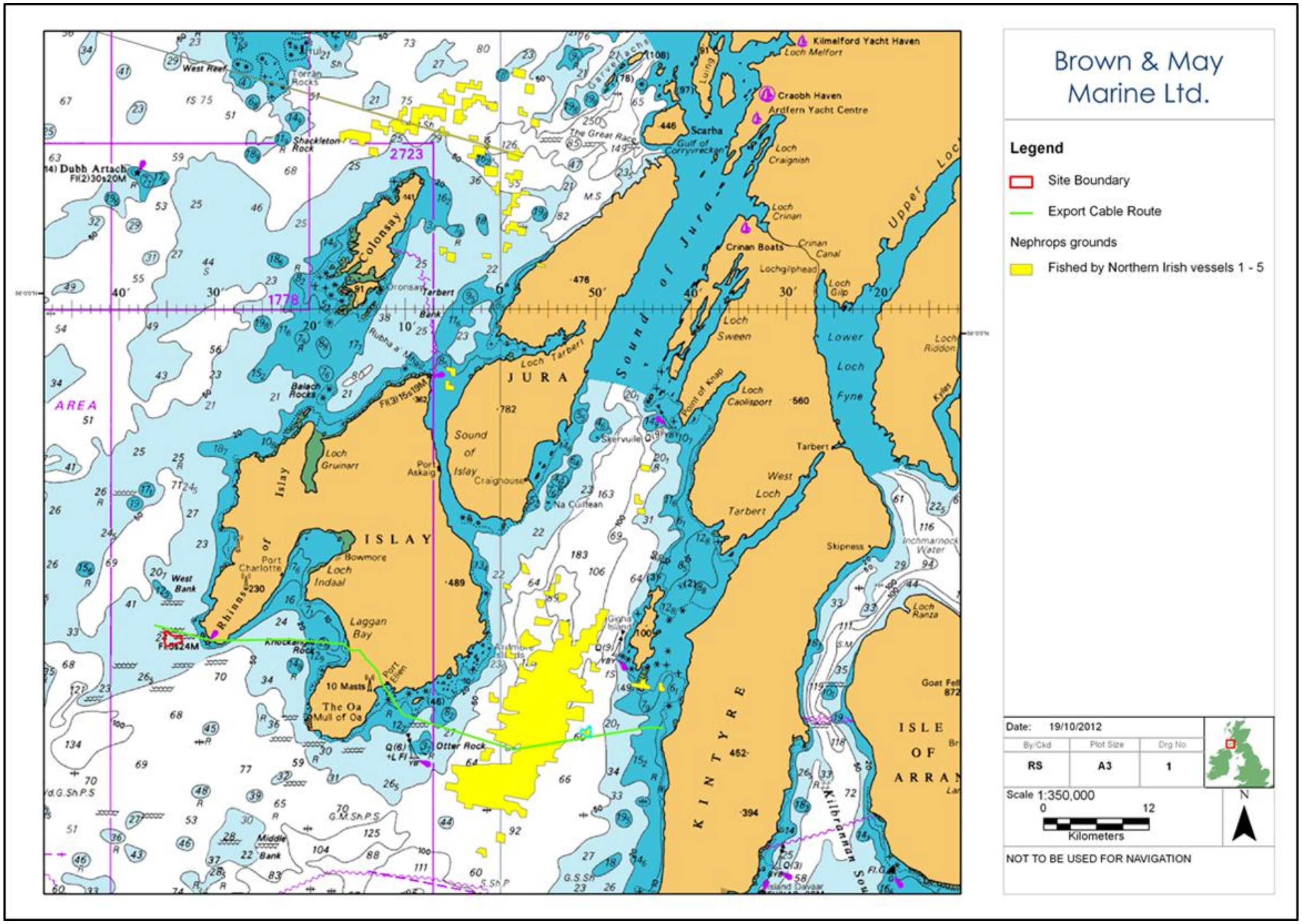

Figure 9.8 ***Nephrops*** **Grounds Targeted by Northern Irish Vessels within the area of the West Islay Tidal Development and associated Cable Route**

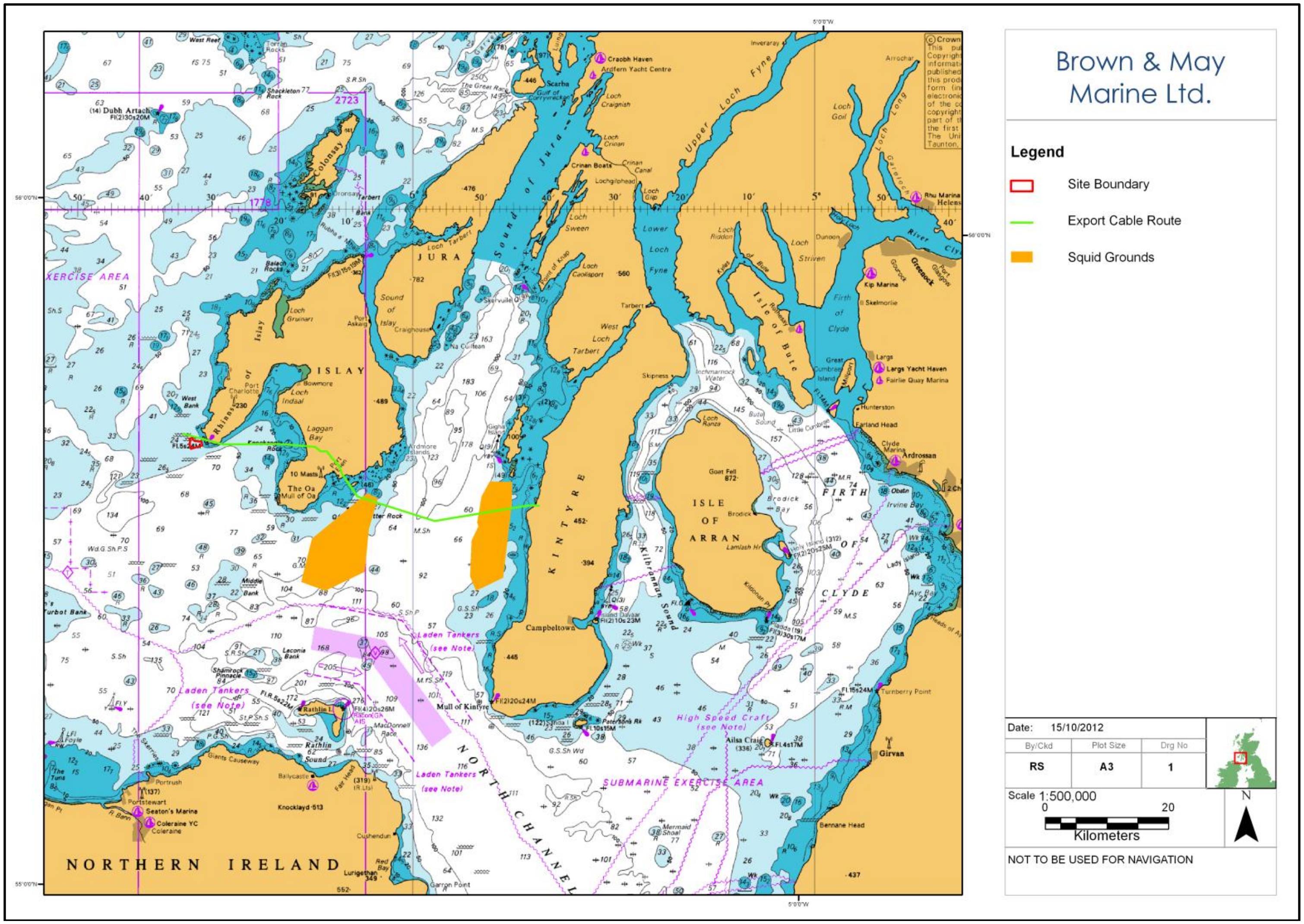

Figure 9.9 Squid Grounds within the area of the West Islay Tidal Development and associated Cable Route

9.3 Potting (Creeling)

Pots, (creels in Scotland), are static traps commonly baited with low value fish such as mackerel, herring, and dogfish. A number of creels are set on a main line anchored to the seabed and marked with a 'dahn' at either end. A set of pots is known as a 'string' or 'fleet', and is left to soak for anywhere between 24hrs to three days or more, depending on the productivity of grounds and weather conditions which may prevent the gear being hauled. Creels are the principal method used to target active scavenging crustaceans such as brown crab, velvet crab, and lobster. As described previously the method is also increasingly used to target *Nephrops* in the regional study as alternative to demersal trawls. A creel vessel with 'vivier' (on board live catch storage) capacity is shown in Figure 9.10. The configuration of a fleet of and the type of creel typically used (a parlour pot) are shown in Figure 9.11. Vessel specifications for a creel vessel operating from Islay are provided in

Up to 40 visiting Northern Irish vessels may target grounds in the Firth of Clyde during the spring and summer (pers. comm. Campbeltown DFO). Information gathered during consultation indicates that seven Northern Irish *Nephrops* vessels regularly target grounds in the Sound of Jura using both single and twin-rig gear. Vessels N.I. 1 and 2 periodically target grounds in the sound of Jura and other west coast grounds between April and October. Vessels N.I. 4-7 target the Firth of Clyde *Nephrops* fishery during the week before moving into the Sound of Jura when the Clyde weekend closure is operational (pers. comm. ANIFPO, 2012). Unlike a number of other N.I. vessels that target these grounds during the spring and summer, vessels N.I. 4-7 operate in the Firth of Clyde and Sound of Jura principally during September to December. All of these vessels are over-15m in length and will therefore be represented by VMS data. Details of those vessels known to target *Nephrops* in the Sound of Jura are provided in Table 9.6.

Table 9.6.

Figure 9.10 Creel Vessel with Vivier Capacity

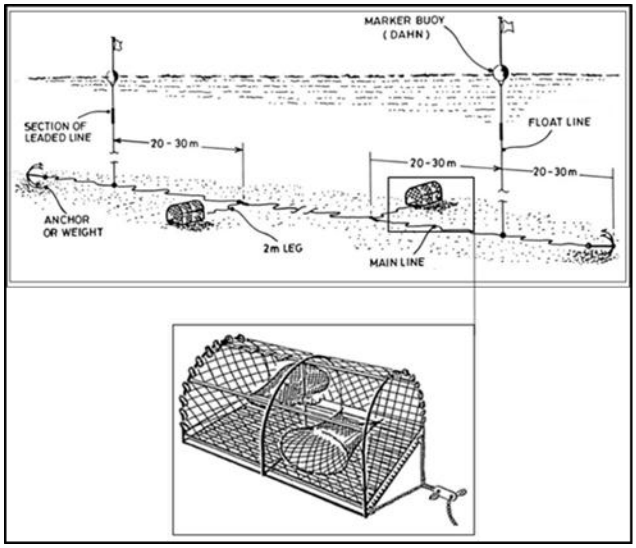

Figure 9.11 Fleet of Creels and an example of a 'Parlour' Pot

Table 9.7 Vessel and Gear Specifications for Vessel CR1 a Creel Vessel Operating from Islay

Fishing vessel	Vessel CR1
Home port	Unspecified Islay Port
Length	11.6
Main engine power	177hp
Typical fishing trip duration	12 to 14 hours
No. of creels hauled per-day	500
No of creels per fleet	30-50
Seasonality of activity	Creels for edible crabs, lobster and velvet crabs – all year

9.3.1 Fishing Patterns and Practices

Landings of brown crab, velvet crab, and lobster are not subject to TAC and quota restrictions, although minimum landings sizes are enforced and vessels targeting these species commercially must hold a shellfish entitlement license. On the west coast, effort directed at brown crab is restricted by EU measures (in the form of kilo watt (kw) days) for vessels over 15m. Landings from the west coast, including the South Minch area (in which part of the study area is located) account for a significant proportion of Scotland's total landings of brown crab, velvet crab and lobster, much of which is exported live to southern European markets.

The majority of catch from the creel fishery is delivered to market live. A lack of quota restrictions and lower operating costs compared to other methods make creeling a viable prospect for a range of vessels. Part time, seasonal participation by small vessels setting low numbers of creels is common, particularly during the summer months. Full time commercial operations vary from smaller day boats hauling 500-700 creels, to larger (over 15m) long range 'super crabbers' with vivier capacity. These vessels have increased offshore capability and may haul 1200 -3000 creels a day. The operational range of smaller vessels is generally limited to inshore areas by virtue of their size and weather conditions. During trips of short duration crustaceans such as brown crab and lobster can be stored in fish boxes while at sea and then transferred to 'keep' boxes on permanent moorings until landing. Larger, 'vivier' vessels have purpose built tanks on board to keep high volumes of catch at optimum condition for longer time periods.

Grounds located in the immediate vicinity of the West Islay Tidal Farm are generally targeted during the spring and summer when tidal and weather conditions are suitable (pers. comm. creel fisherman 2012). Areas inside Loch Indaal may also be targeted in the autumn and winter along with areas along the cable route in the Sound of Jura and close to the landfall at Mausdale (pers. comm. creel fisherman, 2012). In the autumn and winter inshore grounds are accessed as shelter is provided by the lea of the land (pers comm. creel fisherman 2012). If gear is to be left to soak for long time periods which will cover both spring and neap tides then it will generally be left in deeper areas to minimise the potential for damage and loss which is likely to occur over shallower, harder ground (pers. comm., creel fisherman 2012). The targeting of inshore areas may also be increased to reduce conflict with mobile gears such as scallop dredging and demersal trawling where grounds overlap. This may however be limited to some extent by communication between local skippers (pers. comm. creel fisherman, 2012).

The brown crab fishery records highest landings during the third and fourth quarters of the year, whilst the peak of velvet crab landings tend occur from July-November[9]. The lobster fishery is most prolific from April-September. Previous analyses of MMO fisheries statistics indicate seasonal patterns are similar in the local study area.

Spiny lobster (known locally as crawfish or crayfish) is also captured in creels in the study area though landings of the species are much lower than those of edible crab and lobster. In the past the species was targeted specifically using gillnets although this method of capture was prohibited in 2009 (pers comm., creel fisherman, 2012).

9.3.1.1 Creel Vessels

A list of vessels operating creels with ports on the mainland is provided in Table 9.8. As with smaller vessels targeting *Nephrops* with demersal gear those operating creels are more likely to target grounds closer to home ports. There are currently approximately 20 vessels of under -10m in length which operate out of ports of Islay and approximately four over 10m (pers. comm. Campbeltown DFO, 2012). As previously stated vessels operating from ports on Kintyre and Islay may target grounds in the vicinity of the West Islay Tidal Farm in suitable conditions. Grounds in Loch Indaal are also targeted, along with those located along the cable route and close to the cable landfall at Mausdale.

Table 9.8 Vessels Operating Creels with Home Ports on the Mainland

Fishing vessel	Length (m)	Home port
Vessel Cb	9.9	Campbeltown
Vessel Cc	9.5	Campbeltown
Vessel Cd	9.5	Campbeltown
Vessel Ce	<10	Campbeltown
Vessel Cf	<10	Campbeltown
Vessel Cg	<10	Campbeltown
Vessel Ch	12.1	Oban
Vessel Cj	11.2	Tarbert
Vessel Ck	11	Tarbert
Vessel Cl	>10	Tarbert
Vessel Cm	<10	Tarbert
Vessel Cn	<10	Tarbert
Vessel Co	<10	Tarbert

Vessel Cp	<10	Tarbert
Vessel Ci	7.07	Tarbert
Vessel Ck	>10	Tayvallich
Vessel Cl	>10	Tayvallich
Vessel Cm	<10	Tayvallich
Vessel Cn	<10	Tayvallich
Vessel Co	<10	Tayvallich

9.3.2 Creel Grounds

Figure 9.12 shows the extent of creel grounds in relation to the development and export cable route. The black arrows at the western extent of the cable indicate an area of increased seasonal activity in loch Indaal. This area is targeted from October through to Christmas due the presence of female brown crab which are heavier during this time of year when first sale value is also increased (pers. comm. creel fisherman, 2012). The area of west of Kintyre is targeted by vessels operating creels for mixed species including *Nephrops*. It was noted during consultation that trawling for Nephrops does not generally occur in this area. Localised lobster grounds are shown south of the export cable landfall at Muasdale.

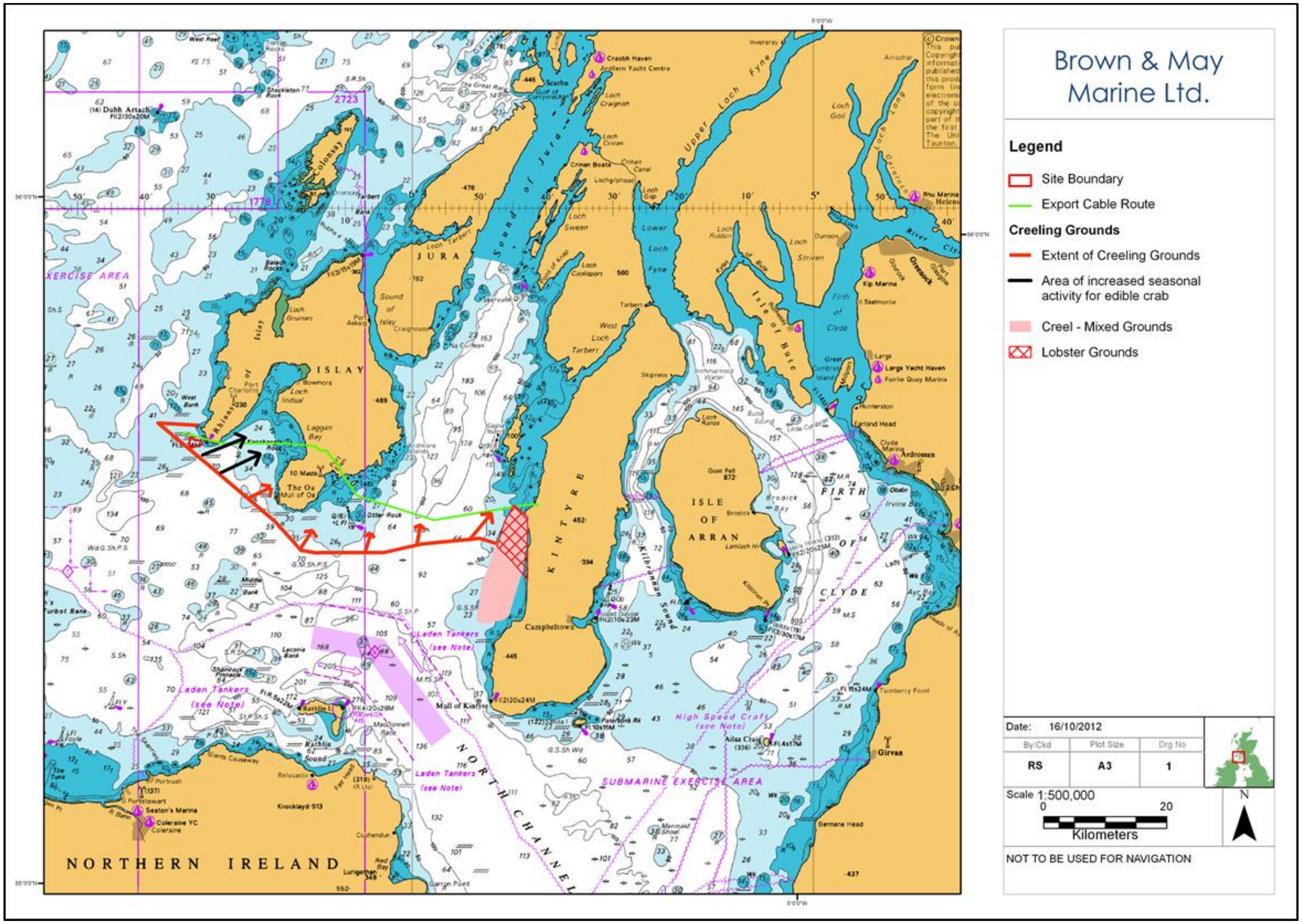

Figure 9.12 Creel Grounds in within the Area of the West Islay Tidal Development and associated Cable Route

9.4 Pelagic Trawling (single and pair)

Vessels targeting pelagic species such as herring, mackerel and sprat employ trawls designed and rigged to work at the surface and mid-water where shoals are frequently located. Vessels are also able to trawl nearer to the seabed during full daylight conditions, when pelagic species form dense shoals closer to the sea floor. Mid water trawls are usually considerably larger than demersal trawls, being designed to accommodate the large catches associated with pelagic species.

The front net sections of mid-water trawls are often constructed with very large meshes (10m) or ropes which herd the shoals of fish towards the net aft sections. Mesh size decreases down the net with cod end meshes as small 16mm used when targeting sprat[24]. Nets are mainly made of nylon, which is able to cope with the stresses associated with large hauls in rough weather. Shoals are actively targeted using sonar and echo sounders with fishing depth controlled by a net sounder and altering either warp length or towing speed in response to the depth of the shoals.

Mid-water otter trawling involves a single vessel (Figure 9.13) whereby the horizontal opening of the net is controlled by otter boards which do not normally come into contact with the seabed. The doors are large and made of steel with longer vertical sides than those used for demersal trawling. Considerable horsepower is required to tow the net at an effective fishing speed.

Mid-water pair trawling involves two vessels towing a single pelagic net between them (Figure 9.14). Similar to demersal pair trawling, trawl doors are not required to maintain the lateral opening of the net; instead the net is weighted on either side by a large clump weight (midway along the bridle). Vessels are able to alternatively operate individually or as part of a pair.

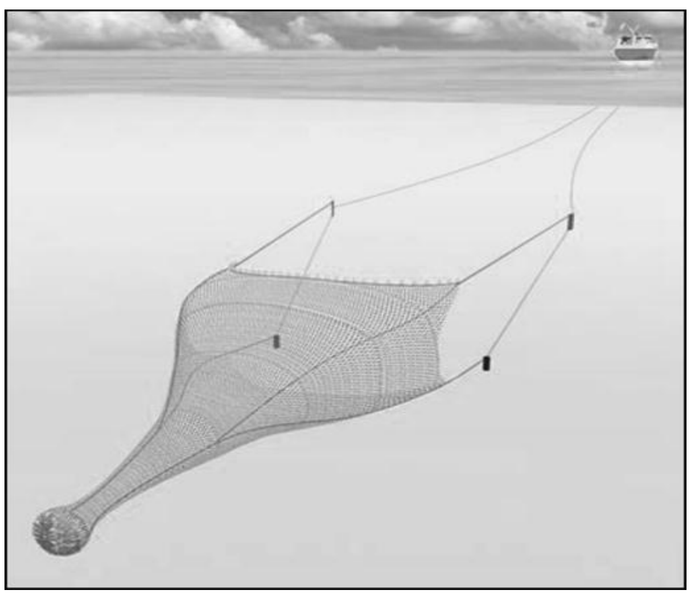

Figure 9.13 Mid Water Otter Trawling

[24] Galbraith, R.D and Rice, A (2004). An introduction to commercial fishing gear and methods used in Scotland. Scottish fisheries information pamphlet No.25

Figure 9.14 Mid Water Pair Trawling

9.4.1 Fishing Patterns and Practices

The Firth of Clyde once formed the centre of an important herring fishery. Historically, the fishery was targeted by anchored drift nets and ring netting[25]. The gradual demise of these methods occurred concomitantly with the lifting of a ban on pelagic trawling in 1962 and the onset of pair trawling in 1968 which had become the dominant method by 1973. Herring landings in the area peaked at around 14,000 tonnes in the mid-1960s after which stocks began to collapse[26].

During the 1970s herring stocks were low throughout area VIa resulting in the closure of the fishery in 1978 and introduction of TACs in 1979. During this period a decline in the Clyde spring spawning stock was observed in parallel with an increase in abundance of the autumn spawning component. Due to these complexities ICES recommended that the Clyde stock should be managed separately from the wider VIa fishery. This resulted in the allocation of small TAC of 2000 tonnes in 1979 but with closures implemented from October to April to prevent further collapse of the spring spawning stock. Management of this stock has remained separate since this date, but landings have remained low exceeding 1000 tonnes only once since 1991[27]. The following restrictions still apply to the Clyde herring fishery:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April on key spawning grounds on the Ballantrae Bank; and
- A ban on all herring fishing between 00,00 Saturday morning and 24,00 Sunday night.

Reasons for stock collapse are not fully understood but poor recruitment and high fishing mortality are both believed to have contributed. Part of the Clyde fishery is located in the local study area (40E4) in and is currently targeted by a small local fleet and Northern Irish Pair trawlers[27].

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25 Fishing News 13th July, 2012. Campeltown services diverse prawn fleet.

26 Bailey, N., F. G. Howard, and Chapman, C.J. (1986). Clyde Nephrops, biology and fisheries. Proceedings of the Royal Society of Edinburgh 90B, 501-518 *in* McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review.

27 McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review

Herring stocks outside the Firth of Clyde are part of the Malin Sea shelf complex and are managed under the area VIa (south) TAC. This fishery targeted by pelagic vessels in the 1st and 4th quarters with a short season of only a few days due to the relatively low TAC.[28]

9.5 Hand Fishing (Razor Clams)

In Scotland, the Razor clam fishery is managed only by a 100mm MLS, with no limits currently placed on landings or effort. Landings of 39 tonnes were first recorded in 1994, increasing to 200 tonnes by 1997 and had exceeded 700 tonnes by 2009[28]. Areas such as the Western Isles, Orkney and the Shetlands recorded the highest landings up until 2004, after which landings in these areas declined rapidly. Since 2004 a high proportion of landings have come from ICES rectangle 40E4, with emerging fisheries on the east coast in areas such as the Firth of Forth and Moray Firth[28]. Razor clams may be targeted by dredging methods or hand harvested by divers who typically operate out of small (under - 10m) vessels. Previous analysis of MMO landings data indicates that this is the principal method used to target razor clams in the study area.

In order to harvest razor clams by hand they must be extracted from their burrows. The simplest method involves injecting strong saline slurry into the vent hole which causes the razor clam to rapidly exit the burrow allowing it to be harvested by hand.[29] In recent years more advanced methods have been employed including water jets or compressed air to dislodge the razor clam from its burrow[27]. Use of the latter method has been reported in coastal areas around the Isle of Arran (40E4)[30]. There have been recent reports of vessels towing metal structures (such as bars) through which an electrical current is passed; causing the clams to exit their burrows which are then collected by following divers. This method is however illegal and has been banned under EU law since 1998. Specific concerns relating to illegal use of the method centre on the potential impact of electrofishing on non –target species and health and safety issues arising from the use of unregulated electrical equipment and divers[28].

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28 ICES advice, 2011. Book 5. Herring in division VIa (south) and VIIb,c.

29 Breen, M., Howell, T and Copland, P. (2011). A report on electrical fishing for razor clams (*Ensis sp.*) and its likely effects on the Marine environment. Marine Science Scotland Report.

30 Scotland Herald, 31st July, 2000. Threat to beaches from razor clam fishing.

10.0 Future Fisheries

Changes to quota and effort allocation, fishing areas and gear restrictions make predicting future fishing activity difficult and subjective. Additionally, the CFP is undergoing reform which will have an impact on the management of commercial fishing activities.

10.1 Future Activity and Regulations

10.1.1 Reform of the Common Fisheries Policy

Since 1983, the EU has primarily dictated the structure and capacity of the UK fishing fleet through the CFP. The CFP was reviewed in 2002 to ensure the sustainable exploitation of fisheries. In 2007 however, the EU Court of Auditors judged that the CFP has failed to achieve this objective and a new review was launched in 2008. Changes to the CFP were proposed in summer 2011. These included:

- Taking action against over-fishing and introduce more sustainable management of fisheries;
- Ensuring productivity of fish stocks to maximise long-term yields;
- Introducing a multi-annual plans governed by an ecosystem approach;
- Simplify rules and decentralise management;
- Introducing a system of transferable fishing concessions;
- Introducing measures that are beneficial to small-scale fisheries;
- Introducing a ban on discards;
- Introducing new marketing standards and clearer labelling;
- Introducing a better framework for aquaculture;
- Introducing EU financial assistance to support sustainability objectives;
- Maintaining up-to-date information on state of marine resources; and
- Promoting international responsibility.

In June 2012, the EU Council of Ministers for Fisheries reached a first position on the reform of the Common Fisheries Policy set out in a framework document agreed under a 'General Approach'. The key points in the preliminary position adopted by the EC are listed below :

- Discard ban – The principle is accepted, but Member States prefer an approach that is fishery-based and introduced gradually between 2014 and 2020.
- Maximum sustainable yield (MSY) – For the management of all stocks at least at MSY, the Council accepted the deadline of 2015, but added the possibility of phasing in until 2020.
- Regionalisation – The Commission's proposal was acceptable but Member States prefer a model where they would cooperate with each other on multi-annual plans to send recommendations on implementation measures to the legislator (Commission, or co-decision).
- Transferable fishing concessions (TFC) – The Council supports the application of TFC on a voluntary basis. The Council introduced the obligation for Member States to report on (over-capacity and develop an action plan to reduce overcapacity where applicable).
- Advisory Councils – The Council would like to have two additional Advisory Councils created; one for the Black Sea and one for the Outermost Regions.
- External Dimension – The Commission's proposal was endorsed and the introduction of a human rights clause in the fisheries partnerships agreements with non-EU States (third countries) was added to the approach.

10.1.2 Changes in fleet size

The current national fleet is considered to be proportionate with sustainable stock levels by those in the fishing industry and it is therefore considered that fishing practices will not alter considerably in the future. It is possible however, that reduction in quota allowance and cuts in effort could lead to a reduction in fleet size.

If future pressure stock levels are deemed to be unsustainable, it is possible that further rounds of decommissioning may be introduced, which could be voluntary or compulsory.

10.1.3 Changes in Vessel Use and Fishing Gear Configuration

Vessels have generally increased in size and power over the past twenty years, however this is considered to be incremental and in line with normal advancement. There are several factors which could have the potential to affect the fishing method or gear a vessel employs:

10.1.3.1 Increases in Fuel Costs

Increases in fuel costs have led to fishermen altering the configuration of their vessels, fishing gears and operating patterns to minimise costs. A number of fishing gear trials to assess the feasibility of modified and alternative gears are currently being undertaken.

10.1.3.2 Increased Restrictions upon certain Fishing Methods

Restrictions on specific fishing methods have led to vessels utilising different gear types or becoming multi-purpose in order to target other, less restrictive fisheries. This is most likely to be the case for demersal towed gear, which is considered to be one of the more environmentally sensitive fishing methods. Static gear methods, such as gill netting and long lining, are not considered to have such an environmental impact but can still target demersal species. It is therefore possible that use of static gear to target demersal species may increase in the future as a result of increasing restrictions on demersal towed gear.

10.2 Potential Changes to Existing Fisheries

Commercial fishing activities are not constant and patterns of fishing activity fluctuate both annually and on a longer term basis. As a result, predictions of future fishing activity are complicated. Furthermore, the proposed changes to fisheries management under the CFP reform and other related legislation will likely significantly alter future fishing practices and management.

A summary of the potential changes which may occur to the fisheries previously identified is provided below. This is based upon current knowledge of fishing patterns and practices in the study area.

10.2.1 Scallop Fishery

Marine Scotland Science recommends that in order to maintain the sustainability of scallop stocks and to effectively manage fisheries, restrictions on the number of vessels entering the scallop fleet and increases in the minimum landing size are introduced in the near future[31]. Recent assessment of scallop spawning stock biomass (SSB) and recruitment in the West of Kintyre fishery is currently low compared to historical levels. Limited sampling means that similar assessment of the Clyde stock has not been possible[24] and stock sustainability in the area therefore remains uncertain.

[31] Keltz, S. and Bailey, N. (2010) Fish and Shellfish Stocks 2010. Marine Scotland, The Scottish Government Report

As previously stated, seasonal closures are already in place in the Irish Sea and further restrictions have been implemented in the territorial waters of the Isle of Man in order to protect stocks. During consultation it was stated the Irish sea closure has the effect of increasing the numbers of visiting vessels operating in West of Kintyre and Clyde grounds during the closure period (1st of June- 31st October). Considering these trends, in addition to Marine Science Scotland advice and the low SSB observed on the West of Kintyre grounds it is possible that additional management may be implemented in order to maintain sustainability of local stocks.

As described previously, concerns over the impact of scallop dredging on benthic habitats have resulted in restricted or no access to sea areas, such as has occurred in Cardigan Bay. Furthermore, calls have recently been made to restrict scallop dredging (along with other demersal trawled gear methods) in Marine SACs. This has particular relevance to sensitive habitats (e.g. maerl beds) which are of special conservation interest in EU waters and may be interspersed within productive scallop grounds. Alterations in maerl bed habitats as a result of scallop dredging are believed to have occurred in the Clyde Sea area[32]. A combination of these factors, in addition to commitments to increase protection of marine habitats through the establishment of Marine Protected Areas (MPAs), may result in changes to the management of scallop fisheries in the future.

10.2.2 *Nephrops* Fishery

In Scottish waters in general, increased effort directed at *Nephrops* fisheries has resulted in pressure on stocks leading to declines in landings in recent years[33]. At the regional level, recent ICES assessments of abundance based on UWTV survey indicate high productivity on South Minch, Sound of Jura and Clyde grounds[34]. In addition, spawning stock biomass (SSB) in the South Minch and Clyde fisheries is currently above levels which are deemed to represent a risk of stock depletion through overfishing. SSB in the Sound of Jura is currently undefined but is unlikely to be lower than the Clyde due to comparatively reduced effort levels.

Based on SSB and total yield in each fishery ICES also advises on maximum sustainable yield (MSY). Harvest rates in the South Minch and Sound of Jura fisheries are currently below respective MSYs and stocks are therefore currently considered to be exploited sustainably. In light of this, significant changes to levels of activity in these two fisheries are not expected in the near future. In the Clyde, harvest rates are currently above the MSY leading to a recommendation that catches are reduced gradually to the MSY by 2015. Despite this, grounds fished for the last 50 years by the local fleet remain productive and the fishery is generally perceived as sustainable[33].

In light of ICES recommendations, the Scottish Government is undertaking consultation with organisations such as the CFA, seeking opinion on a proposed increase in the MLS for west coast *Nephrops* to match those applied in the North Sea[35]. The current west coast MLS is 70mm overall length, 20mm for carapace length and 32mm for tails, compared to 85 mm for overall length, 25 mm for carapace length and 46 mm for tails in North Sea Fisheries. It is has been suggested that this could increase the breeding potential of individuals, potentially rendering stocks less susceptible to over fishing and improving MSY in the longer term. Given that any such increase in the MLS would likely result in a

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32 Hall-Spencer, J.M and Moore, P.G. (2000). Scallop dredging has profound, long-term impacts on maerl habitats. ICES Journal of Marine Science: 1407-1415.

33 The Scottish Government (2010). The Future of Fisheries Management in Scotland; Edinburgh 2010.

34 ICES Advice June 2012. Book 5. *Nephrops* in the Celtic Sea and Division VIa.

35 The Scottish Government (2012) Consultation on new controls in the Nephrops and Crab and Lobster Fisheries

reduction in landings in a fishery which is characterised by *Nephrops* of a small average size, it is considered unlikely that the west coast *Nephrops* fleet will support this proposed change. In addition, grounds fished for the last 50 years by the local fleet remain productive and the fishery is generally perceived as sustainable[33].

Within the same consultation, the Scottish Government also seeks opinion on the introduction of a number of potential regulatory measures in Scottish creel fisheries within the 12nm limit. For the wider creel fishery (e.g. edible crab, velvet crab, lobster and *Nephrops*), opinion is sought on the introduction of either a blanket restriction on the number of creels operated by a single vessel or a system which allocates creel numbers on the basis of vessel size. The potential implications of these measures are discussed further in section 10.2.5. With specific reference to the *Nephrops* creel fishery questions focus on the introduction of gear restrictions aimed at improving selectivity, such as mandatory escape panels and/or increased mesh sizes. It is believed that reducing numbers of discards from the vessel (by allowing escape from the creel on the seabed) may improve stocks in the long term as discarded individuals have a high mortality rate in the *Nephrops* creel fishery[35]. The response of the *Nephrops* creel fleet is likely to depend on the perceived impact that such measures would have on landings and the rate of discards within a given fishery.

The Sustainable Inshore Fisheries Trust (SIFT) has recently called for reinstatement of the ban on trawling within 3nm in the Firth of Clyde. This would impact significantly on activity of the local demersal (*Nephrops*) fleet[36] which depends heavily on grounds within the 3nm limit[37]. Given the importance of the fishery to both local and visiting vessels it is considered unlikely that such legislation will come to pass in the near future. Were such a closure to occur, displacement of effort to adjacent grounds (e.g. Sound of Jura and South Minch) and increases the number of vessels targeting *Nephrops* with creels in the Clyde could be two potential outcomes.

10.2.3 Whitefish Fisheries

As described previously, interlinked factors such as stock collapse, introduction of TACs under the CFP, subsequent conservation measures and quota reductions saw whitefish fisheries in the study area decline from the 1970s onwards, ceasing to be viable in the early 2000s. In areas such as the Firth of Clyde and Sound of Jura landings of species such as haddock and cod are now largely the result of by catch in the *Nephrops* fishery[38]. As detailed previously, there is a zero TAC for cod in area VIa and vessels are also subject to gear restrictions aimed at limiting whitefish by catch. In light of this, viable fisheries for these species do not seem likely to occur in the near future.

Proposals have recently been made to ban demersal trawling within 3nm limit in the Firth of Clyde: previous legislation (lifted in 1973) is believed to have protected whitefish stocks by forming a refuge from trawling. It has been suggested that if such management policies were reintroduced stocks of demersal fish species could potentially return to viable levels[35]. In addition, under the Cod Recovery Plan ICES recommend that a zero catch of cod would result in the highest chance of recovery of west coast stocks. Effectively, this implies closure of all mixed demersal and *Nephrops* fisheries on the west coast. Due to the social and economic implications of such closures it is considered unlikely that they will be implemented in the near future.

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[36] Clyde fishermen determined to fight ban on gear. Fishing News 7th of September 2012.

[37] Fishing prawns in the Clyde. Fishing news 17th August 2012

[38] McIntyre, F., Fernandes, P.G. and W. R. Turrell (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review.

10.2.4 Squid Fishery

On the east coast, areas such as the Firth of Forth and Moray Firth support important fisheries for squid. These fisheries are relatively recent and are currently unregulated by quota or effort. In these areas, the fishery has become a valuable alternative for the *Nephrops* fleet in which vessels are able to reconfigure gear to target squid, particularly when *Nephrops* fishing is poor. The availability of an alternative target species also has the effect of relieving pressure on *Nephrops* stocks.

Previous analysis of Marine Scotland data indicates that landings of squid in the study area from 2007-2011 were low and confined to an area west of the Kintyre peninsula. This was not always the case: ICES division VIa (regional study area) was once an important area for squid landings in Scottish Waters, the majority of which were by catch from demersal whitefish fisheries[39]. The low landings currently observed are not necessarily indicative of the absence of viable stocks. For example, during consultation it was stated that the potential for a directed squid fishery is currently limited by gear and by catch regulations in place under the long term cod management plan (pers comm. *Nephrops* fisherman, 2012).

Squid can currently be landed by vessels using 80-120mm meshes but the catch must comprise of greater than 35% *Nephrops* by weight. In addition to the mesh size restrictions placed on the demersal fleet targeting *Nephrops* and whitefish vessels further legislation was passed in 2009 which prohibited the use of any mesh sizes less than 55mm in any vessel operating east of the French line in area VIa. There are two exceptions to this legislation which apply to pelagic fisheries as outlined below:

- no net mesh size greater than or equal to 55mm is carried on board; and
- no fish other than herring, mackerel, pilchard/sardines, sardinelles, horse mackerel, sprat, blue whiting and argentines are retained on board

This legislation effectively rules out a directed squid fishery in area VIa. The current cod recovery programme is to be reviewed in 2015. Fishermen operating in the regional study area plan to lobby the Scottish government regarding such restrictions in order to diversify their operating practices to target squid (pers comm. *Nephrops* fisherman, 2012).

10.2.5 Creel Fisheries (excluding *Nephrops*)

As discussed previously (see section 10.2.2), the Scottish Government has recently circulated a consultation document seeking opinion on a number of proposed potential changes to Scottish creel fisheries within the 12nm limit. This is in response to a belief that unregulated creel fishing is leading to some crab and lobster stocks are being fished close to, or above sustainable levels, and that a 'race to fish', is occurring where numbers of creels deployed increase in response to competition and to secure and protect grounds.

As stated previously, measures such as a blanket limit on the number of creels a single vessel can operate, (independent of size), or limits based on vessel size have both been proposed. The former measure is currently operational in the Northumberland Inshore Fisheries and Conservation Authority (IFCA) and Isle of Man creel fisheries. In addition, the introduction of Scottish crab and lobster quotas managed independently of the EU TAC system has also been suggested. It is believed that such regulations could

[39] Young, I. Pierce, G,. Dalya, H., Santosa M., Keya, L., Bailey, N., Robin J.-P. Bishop A.J, Stowassera, G., Nyegaard, M., Choa, S Raserod, M., Pereirae, J (2004). Application of depletion methods to estimate stock size in the squid *Loligo forbesi* in Scottish waters (UK). Fisheries Research 211-227.

have a number of benefits such as reducing conflict both within and between (e.g. trawl and creel) fisheries, and improve market conditions by limiting the numbers of crustaceans for sale.

With respect to gear restrictions in the crab and lobster creel fisheries, the recent consultation also seeks opinion on introducing limits on the numbers of parlour creels operated by a single vessel. Parlour creels are double chambered and capable of retaining more catch than traditional creels, with less frequent lifting of fleets required. The use of this creel type has increased in recent years, and it is believed that this may be resulting in reduced catch rates in some areas of Scotland.

In the event that responses to this consultation supported the proposed regulations, significant changes could be expected in the crab and lobster creel fisheries, particularly within the inshore fleet operating within the 12nm limit. Given that such legislation would not extend beyond territorial waters, the operating practices of larger, vivier vessels would likely be less impacted.

10.2.6 Queen Scallop Trawl Fishery

Queen scallops are a more mobile species than king scallops, actively swimming up off the seabed when disturbed which facilitates their capture with demersal trawls as well as dredges. The fishery generally operates during the summer months when the species is most active. The trawl fishery is perceived to be less environmentally damaging than the use of dredges fishery and the catch is cleaner, and therefore has a longer shelf life (pers. comm. scallop fisherman, 2012). There are productive queen scallop grounds located in the regional study area. However, similar to squid, it not currently possible for the local fleet to diversify into targeting queen scallops with demersal gear due to the mesh size restrictions and by catch composition regulations implemented under the Cod Recovery Programme (pers. comm. *Nephrops* fisherman, 2012). As with the squid fishery, fishermen plan to lobby the Scottish government when the current cod recovery programme is reviewed in 2015 (pers. comm., *Nephrops* fisherman, 2012).

10.2.7 Sandeel Fishery

An industrial sandeel fishery historically existed off the west coast of Scotland in ICES division VIa, from 1972-2004, with a peak in landings during the mid-1980s. Throughout the history of the fishery, almost all landings from were from Scottish vessels, the last of which were recorded in 2004 (566t). Since this date low landings (55t) have been recorded only once in 2007 by vessels based in the Faeroe Isles. The stock has not been assessed since 1996 and therefore no management advice is provided on SSB and MSYs. In light of this ICES recommends that no increase in catch should occur unless evidence is presented which suggests stock sustainability[40]. ICES also advise that reinstatement of the industrial fishery could result in significant bycatch of juvenile herring and other species. Considering these factors reestablishment of the fishery in the near future appears unlikely.

[40] ICES advice June 2012. Book 5 . Sandeels in the Celtic Sea and Area VIa.

11.0 Consultation List

Consultation and liaison has been ongoing, and will continue, with the following organisations and individuals:

ANIFPO

- Davey Hill

Campbeltown District Fisheries Office

- Johanna Holbrook

Clyde Fishermen's Association

- Archie McFarlane (FIR)
- Richard Johnston
- John Brown

SA

- John Hermes
- John McAllister

Tarbert Shellfish

- Donald Lawson

Isle of Man Fish Producers Organisation

- Tom Bryant – Brown

WESTISLAY TIDAL

ENERGY PARK

volume 4 // appendix 12.2 //

DPE salmon and sea trout baseline

Photograph reproduced from

The Yachtsman's Pilot Clyde to Colonsay by Martin Lawrence and Imray Laurie Norie and Wilson Ltd.

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West Islay Tidal Energy Farm

DP Marine Energy Ltd and Blue Energy Ltd

Salmon and Sea Trout Baseline

Brown & May Marine Ltd
Progress Way
Mid Suffolk Business Park
Eye
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Tel: 01379 870181
Fax: 01379 870673
Email: marine@brownmay.com

Ref	Issue	Checked	Approved	Issue Date
West Islay Tidal Farm Salmon and Sea Trout Baseline	**DRAFT1**	JL	JHM	05/11/2012
	DRAFT2	JL	JHM	22/11/2012
	FINAL	JL	JHM	26/11/2012

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1.0 Introduction

The definition of salmon under the Salmon Act 1986 includes both Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*). Both species form an important part of Scotland's natural heritage and support and maintain the existence of important commercial and recreational fisheries which contribute to the country's economy and support significant full time employment. A study commissioned by the Scottish Executive estimated that game and coarse anglers spent a total of £131m in Scotland of which 65% (£73m) corresponded to salmon and sea trout fishing (Radford et al., 2004). The value of commercial fishing is harder to estimate but has shown a general pattern of decline in recent years (Malcolm et al, 2010). Despite this, commercial salmon and sea trout fisheries have a long tradition in Scotland and are still an active and important area of the Scottish fishing industry.

Atlantic salmon is listed under Annexes II and V of the European Union's Habitat Directive and Annex III of the Bern Convention and is a priority species under the UK Biodiversity Action Plan (BAP). Sea trout is not currently protected under EU legislation but is listed as a UK BAP priority species.

For the purposes of this assessment, fisheries catch data provided by Marine Scotland Science has been analysed to provide information about the following aspects of salmon and sea trout fisheries:

- Current trends in salmon, grilse and sea trout catches in Scotland with respect to historical levels (1952 to 2011);
- The relative importance of the fishery at a national, regional and local level, based on annual average catches (2002 to 2011) by species and method; and
- The seasonality and annual variation of average catches (2002 to 2011) by species and method at the local level.

The analysis of fisheries catch data presented here is not intended as an assessment of the abundance or state of the stocks, rather as an indication of the underlying population trends and relative importance of the fisheries of salmon and sea trout by fishery region and district in Scotland. The critical time for fisheries does not necessarily represent critical times for salmon and sea trout movement and catch data is limited in terms of presenting an accurate baseline of fish populations and fish migration outside of the time of fisheries. An overview of salmon and sea trout life cycle and ecology is provided in section 4.0.

2.0 Study Area

The area of study has been defined at a local, regional and national level. The local study area focuses on the salmon fishery districts located closest to the West Islay Tidal Farm and associated cable route: the Laggan (Islay) and Ormsary (west Kintyre Peninsula) districts. It should be noted that fisheries statistics for both districts may include more than one river (see section 3.1.2). In light of the migratory behaviour of salmon and sea trout the importance of respective fisheries are also briefly described briefly at the regional and national levels. The regional area is defined by the West Coast salmon fishery region, whilst the national study area is defined by salmon fishery regions throughout Scotland.

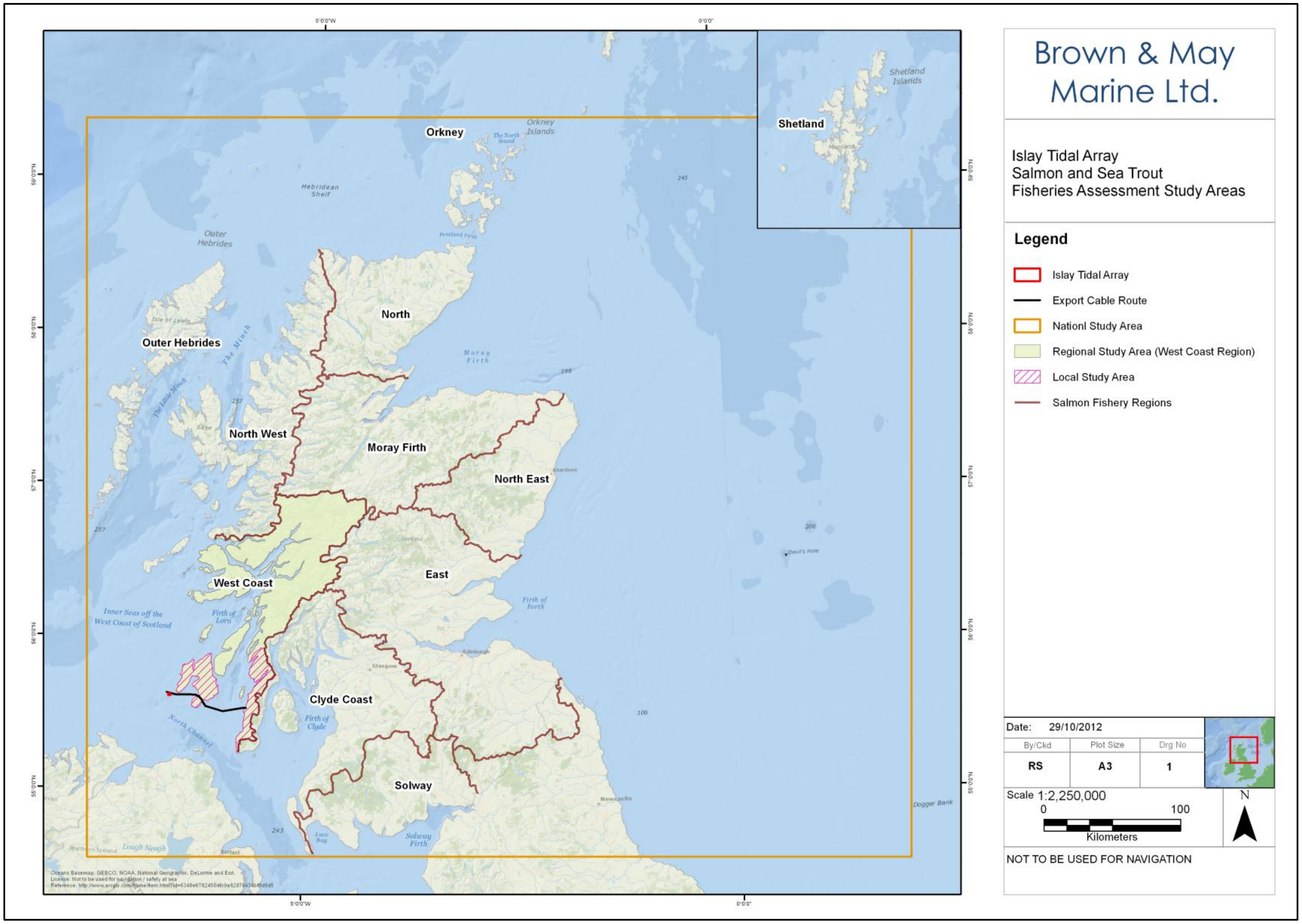


Figure 2.1 Salmon and Sea Trout Fisheries Assessment Study Areas

3.0 Methodology

There is no standard methodology for the establishment of salmon and sea trout fisheries baselines in relation to offshore renewable energy developments. A range of different data and information sources have therefore been used to inform this assessment. These are as follows:

- Marine Scotland Science (MSS);
- Association of Salmon Fishery Boards (ASFB);
- Argyll Fisheries Trust;
- Relevant District Salmon Fishery Boards (DSFBs);
- Atlantic Salmon Trust; and
- Scientific papers and other relevant publications.

3.1 Data Gaps, Limitations and Sensitivities

3.1.1 Marine Scotland Catch Statistics

MSS catch statistics divide salmon catches into "salmon" and "grilse". In this context, the term salmon refers to multi-sea-winter salmon (MSW) whilst grilse refers to one-sea-winter salmon (1SW).

The catch data used for the purposes of this assessment are as reported. Where there are no records of reported catches, it has been assumed that no fish have been caught. It is recognised that there may be a degree of error within the catch dataset due to misclassification of fish between the grilse and salmon categories or sea trout identified as salmon (or vice versa). In addition, further errors as a result of misreporting of catches may also exist. The data used are as provided by Marine Scotland Science.

It should be noted that the analysis of fisheries statistics given below is not intended as an assessment of the abundance or state of the stocks, but rather as an indication of the underlying population trends and relative importance of the fisheries of salmon and sea trout by region and fishery district in Scotland. The critical time for fisheries does not necessarily represent critical times for salmon and sea trout movement and catch data is limited in terms of presenting an accurate baseline of fish populations and fish migration outside of the time of directed fisheries. This also holds true for rod-and-line catches which do not account for the closed season and give no effort value.

The catch data used in this report are Crown copyright, used with the permission of Marine Scotland Science. Marine Scotland is not responsible for interpretation of these data by third parties.

Each fishery in Scotland is required to provide the number and total weight of salmon, grilse and sea trout caught and retained in each month of the fishing season. Rod and line fisheries are also required to provide the monthly numbers and total weight of those salmon, grilse and sea trout which were caught and released back into the river, this practice is known as "catch and release". As a result, MSS catch data for the rod and line fishery is broken down into two categories, "rod and line" and "catch and release". The total catch by the rod-and-line fishery is in effect the sum of the catches recorded in both categories. Data from both categories have been combined to give an indication of the total rod-and-line catch. Similarly, the catch by net-and-coble and fixed engines (bag and stake nets) has been combined in some instances to provide an indication of the total catch by the net fishery.

3.1.2 Salmon Fishery Regions and Districts

Each salmon fishery district applies its own voluntary or statutory conservation code, closure times, policies and regulations and has in place different management and conservation schemes (e.g. hatcheries, fish counters, water quality control and monitoring schemes).

The areas and names of some districts have changed over time. In the regional study area, for example, catch statistics are collected separately for the Creran, Awe, Nell, Add, Ormsary, Loch Head River, Stornoway (Mull), Carradale, and Ruel, districts. However, these districts along with a number of others in the neighbouring Clyde region were superseded by the Argyll Salmon Fishery District in 2005 (S.I, No. 487/2005). For the purposes of this assessment the former, smaller districts, have been used as they provide better spatial resolution of catch data.

In addition, different districts include varying numbers of rivers and tributaries within their jurisdictions and data provided by MSS is for the district as whole, rather than for individual rivers. In the format in which data is currently provided it is not possible to breakdown data provided for each district by individual river. In the context of the assessment of salmon and sea trout fisheries in the local study area this means that the Laggan district may include data from two rivers on Islay: the River Laggan and River Sorn. The Ormsary district covers five Rivers: Ormsary Water, Abhainn Learg an Uinsinn, Barr Water, Breackerie Water and Machrihanish water. The Machrihanish is currently unmanaged so is unlikely to contribute to reported fisheries statistics for the district (Kettle - White, 2005).

The boundaries of the salmon fishery regions and districts could not be provided by MSS as GIS data layers, as a result of third party copyright ownership of these data. The district and region boundaries shown in the charts provided in this report were produced by geo-referencing a raster image. These should therefore be taken as approximate and for illustrative purposes only.

3.1.3 Data Gaps

The distribution patterns, behaviour and migration routes of salmon and sea trout in the marine environment, particularly in waters off the west coast of Scotland are not fully understood. As a result, accurate estimates of the numbers, time period and origin of the salmon and sea trout potentially migrating through or otherwise using the development site or its vicinity cannot be quantitatively assessed.

4.0 Salmon and Sea Trout Ecology

4.1 Introduction

Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*) are anadromous migratory species of the family Salmonidae. Anadromous species spend a significant proportion of their life history in marine habitats and migrate to freshwater to spawn. Salmon and sea trout fisheries exploit the migratory behaviour of both species by intercepting fish in both rivers and coastal waters.

Atlantic salmon are widely distributed within the Northeast Atlantic, occupying diverse biological and physical environments from Northern Portugal to Finland (Klemetsen *et al*, 2003). The UK component constitutes a significant proportion of the stock in EU waters. Salmon are found in over 300 UK Rivers, where the size of the runs often exceeds 1000 individuals per annum (JNCC, 2010).

Sea trout are anadromous brown trout and the migratory and non- migratory forms are recognised as a single species. The mechanisms controlling anadromy in brown trout are not fully understood but involve both genetic and environmental components (Malcolm *et al*, 2010). The geographical range of brown trout is widespread; from Corsica, Sardinia and Sicily in the south to Iceland, Scandinavia and Russia in the north (Klemetsen *et al*, 2003).

The anadromous form is frequently found in brown trout populations with free access to the marine environment (Klemetsen *et al*, 2003). Accordingly, sea trout are found in suitable rivers throughout the geographical range of the species. Atlantic salmon and sea trout share many ecological similarities and frequently co-exist in UK Rivers. The life cycles of both species are broadly similar with the exception of differences in the temporal scale of marine feeding migration.

4.2 Life cycle and ecology overview

Spawning occurs in the upper reaches of rivers during late autumn and winter when females cut nests (known as a 'redds') in gravelly substrates in which the eggs are deposited (NASCO, 2012). Larvae ('alevin') hatch the following spring, feeding on an attached yolk sac before progressing to invertebrate prey at which point they are known as 'fry'. At the end of their first summer of feeding juveniles are known as 'parr' (Potter & Dare, 2003).

After spending one to five years in freshwater salmon and sea trout parr undergo 'smolting'; a process of physiological and morphological changes which prepare for ocean entry (McCormick *et al*., 1998). Through late March to June smolts migrate down river and enter the ocean where they are known as 'post smolts', until the middle of their first winter at sea.

Salmon grow rapidly in the marine environment and return to their natal rivers as adults after spending between one to five years at sea. Marine diet typically comprises a high proportion of fish such as sandeels (Ammodytidae) and cluepids including herring (*Clupea harengus*) and sprat (*Sprattus Sprattus*) pelagic crustaceans such as krill are generally of secondary importance (Fraser, 1987; Reddin, 1985; Hyslop & Webb, 1992; Jacobsen & Hansen, 2001). Time spent feeding at sea varies within and among salmon populations and different cohorts may return at different times of the year, spawning in different areas of the natal river (Klemetsen *et al*, 2003; Potter & Dare, 2003). Adults which spend only a year at sea prior to spawning are known as one-sea-winter salmon (1SW) or 'grilse' in Scotland. Those feeding at sea for multiple years are known as 'multi- sea- winter' salmon (MSW) or simply 'salmon' in Scotland.

The majority of grilse tend to enter the river from early summer- autumn. Numbers of MSW fish will also begin upstream migration at this time, although smaller numbers of this stock component may begin to ascend the river as early as the autumn of the year before spawning. These larger, earlier running individuals are particularly prized by anglers who refer to them as 'spring' run fish.

Sea age structure of populations differs between Scottish coasts; in the smaller rivers on the west coast runs tend to be dominated by grilse, whilst higher numbers of MSW are found in populations from rivers on the north and east coasts (Malcolm *et al*, 2010). In addition, significant changes have been observed in the timings of salmon runs in rivers in Scotland and elsewhere in the UK in recent years.

This is manifest as a shift from spring-summer to summer-autumn runs (Gough *et al*, 1992; Milner *et al*, 2000; Aprahamian *et al*, 2008). In most rivers the change in run timing has also been associated with a decrease in the proportion of MSW fish in the annual run (Aprahamian *et al*, 2008; Environment Agency & Cefas, 2011). In Scottish (and other UK rivers) these observations have led to a number of conversation measures aimed at protecting the MSW stock component, including blanket catch and release policies, and delays to the start of both recreational and commercial fishing seasons.

Following spawning Atlantic salmon adults are known as 'kelts', a small proportion (around 5%) of which regain sufficient condition to repeat feeding and reproductive migrations; the remainder perish following spawning (Thorstad *et al*, 2008).

Sea trout marine migration is generally shorter than that of Atlantic salmon, characterised by movements on smaller spatial scales occurring closer to natal rivers. A smaller proportion of individuals may undertake long distance offshore migration during marine feeding (Kallilo- Nyberg *et al*, 2001). In comparison to salmon, diet may be more varied with the occurrence of benthic invertebrates in addition to fish (Fahy, 1987).

Numbers of immature smolts return to freshwater to overwinter after a short spell of feeding at sea and are known regionally known as 'whitling', 'finncok' or 'herling' (Malcolm *et al*, 2010). A further component of the stock referred to as 'maidens' do not return to freshwater to spawn until at least a year after migration (Gargan *et al*, 2004).

Sea trout migrate back to the sea in the spring, both as spawned kelts and immature fish that have overwintered without spawning. In contrast to salmon, post spawning survival rates are high in sea trout and repeat, annual spawning is common (Gargan *et al*, 2004).

5.0 Salmon and Sea Trout Fisheries

5.1 Salmon Fishing Rights, Administration and Regulations

5.1.1 Fishing Rights

The right to fish for salmon in Scotland, whether in inland waters or at sea, is a heritable right. The taking of salmon without the right or written permission to do so is prohibited under the Salmon and Freshwater Fisheries (Protection) (Scotland) Act 1951.

The rights originally belonged to the Crown, however the Crown has made grants of salmon fishing to others and ownership is now widely distributed among private individuals, companies, local authorities and others. The rights can be bought, sold or leased independently of land except in Orkney and the Shetlands (Williamson, 1991).

The Crown still owns areas along the coast and in rivers. Since the late 1980s, however, the Crown Estate has supported a policy of conservation. There are therefore, no longer any coastal netting stations let by the Crown and none are actively fished (The Crown Estate, 2010); the existing working netting stations were therefore granted or sold the heritable title by the Crown Estate before the late 1980s (Crawley, 2010). Salmon fishing rights in coastal waters originally extended up to the 12 nm exclusive territorial limit. Restrictions introduced to regulate fishing activities have however resulted in salmon fishing in Scotland being limited to a short distance from the shore.

5.1.2 Fisheries Administration

Salmon fisheries in Scotland, both inland and at sea, are managed by their owner or leaseholder under a framework of regulations laid down by central government.

For the purposes of salmon fishery management, Scotland is divided into 54 statutory Salmon Fishery Districts, each with a catchment area including a river or group of rivers (ASFB, 2010). Today, almost every district has formed a District Salmon Fisheries Board (DSFB) made up of the owners or leaseholders of the fishing rights. These boards manage the rivers and coastal netting zones, being able to appoint bailiffs with the power to enforce regulations and restrictions, as well as establishing other practices for improving and maintaining fish stocks, and monitoring and controlling river conditions. Each salmon fishery in each district has a value, which is calculated by the district assessor. Individual boards are self-financing and generally raise money by taxing rights' owners within their district. This often works on a sliding scale, according to the number of fish caught. In 1999 the government made a revision to the constitution of the boards to allow for wider representation, by bodies such as the Scottish Environment Protection Agency, Scottish Natural Heritage or others such as local angling clubs and associations (ASFB, 2010).

Boards hold powers relating to the introduction of new regulations on the fishery, the purchase of property to acquire rod or net fisheries, the imposition of fishery assessments on the fishery proprietors, etc. (SPICe, 2000). Whilst the Boards themselves have no ability to make legal restrictions on fishing, applications are made to Scottish Ministers by the Boards for changes and new regulations to be introduced.

Salmon fishery districts, as formalised by the Salmon Fisheries (Scotland) Acts 1862-1868, are shown in Figure 5.1. As explained in 3.1.2, some districts have been joined together and superseded by larger districts, resulting in the current 54 districts.

In addition to the Boards, Marine Scotland (within the Scottish Executive Environment Directorate) oversees the fishery as a whole, promoting legislation and making regulations under the various Salmon and Fisheries Acts passed by the devolved government. The Inspector of Salmon and Freshwater Fisheries monitors the effects of legislation and the operation of the fisheries. Marine Scotland Compliance (formerly the Scottish Fisheries Protection Agency) enforces regulations at sea and helps the District Boards with local, coastal enforcement (Williamson, 1991); Marine Scotland Science's Freshwater Fisheries Laboratory provides scientific advice on salmon and their fisheries.

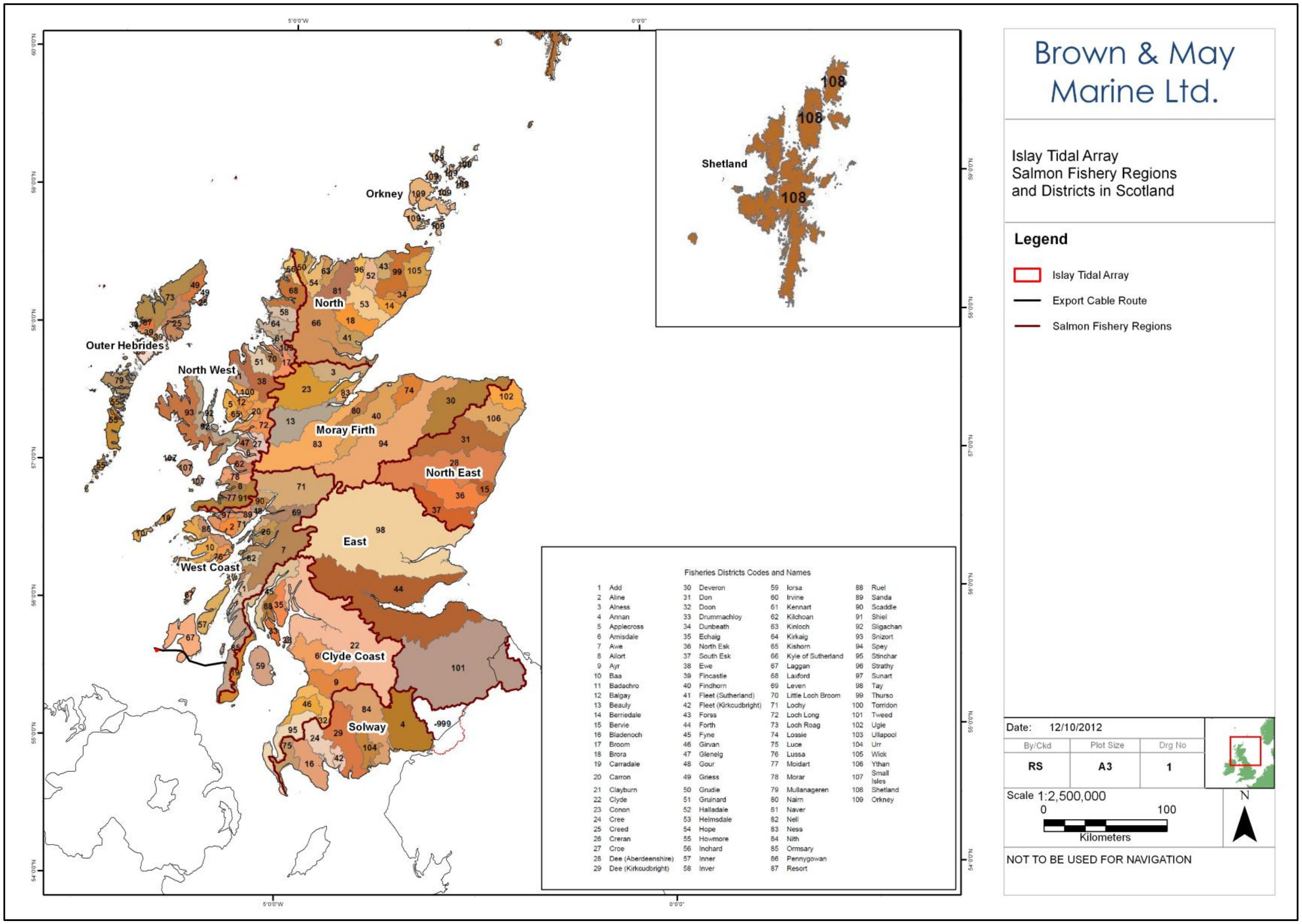


Figure 5.1 Salmon Fishery Regions and Districts in Scotland

5.2 Fisheries Regulations

5.2.1 General

The annual close time for fishing salmon in Scotland (except in the Tweed district) is a continuous period of not less than 168 days. The closure applies to all methods of fishing, except to the extent that provision is made for periods during the annual close time during which it is permitted to fish for and take salmon by rod-and-line (Crawley, 2010). Actual dates may vary but are mostly from late August to mid-February, depending upon individual District Board policy. Rod-and-line may continue for a few weeks either side of this. Weekly close times are also nationally enforced, being 24 hours (Sunday) in the case of angling and 60 hours for all other methods.

It should be noted that these close periods maybe extended in some cases through voluntary agreement, or decreased after request to Marine Scotland by DSFBs (Crawley, 2010).

It is prohibited to take juvenile salmon (not including trout). There is a minimum mesh size of 90mm for nets, to enable smolts to escape. In addition, since the introduction of the Conservation of Salmon (Prohibition of Sale) (Scotland) in 2002, it is prohibited to sell, offer or expose for sale any salmon that has been taken by rod-and-line.

There is no direct limitation on fishing effort within open fishing periods, although there are restrictions in place which act as indirect controls:

- Restrictions imposed on the various fishing methods;
- The exclusive right of the salmon fishermen through ownership or tenancy to decide fishing effort in their fishery; and
- Regulations established and enforced by individual District Boards.

Salmon fisheries are saleable and netsmen or companies may acquire fishing rights over relatively large areas. Other interested parties may also purchase rights. For example, the Atlantic Salmon Conservation Trust has historically bought coastal sites to close them down as a conservation measure in order to halt coastal netting activities. Similarly, rod-and-line interests may buy up river netting rights to close them down, often through the District Boards.

5.2.2 Inland Waters

The only lawful fishing methods in inland waters are rod-and-line and net-and-coble. Fixed nets/engines are prohibited

5.2.3 At Sea

It is prohibited to catch fish by enmeshment. Trolling and long-lining is also illegal. Effectively the only lawful methods which can be used to capture salmon and sea trout are net-and-coble, fixed engines and rod-and-line.

5.3 Fishing Methods

The principal methods for catching salmon in Scotland are as follows:

- Fixed Engine (Bag and Stake Nets)
- Net and Coble; and
- Rod and Line

5.3.1 Fixed Engines (Bag and Stake Nets)

Bag and stake nets are the most common types of gear used to catch salmon in Scottish coastal waters and are commonly referred to as fixed engines. Salmon fishing using this method is not permitted in rivers above the limits of the estuary.

Bag nets are set to fish just below the surface in rocky coasts where they will not ebb dry at low tide. Nets may be set singly or in a line extending seawards from the shore. The entire net or line of nets is not permitted to extend more than 1,300m from the mean low water mark, excluding mooring warps or anchors. The nets must not be operated between 6pm Friday until 6am Monday. Catches are generally removed from the nets at slack tide (Galbraith and Rice, 2004; SI 1992/1974).

No part of the nets may be set with the purpose of catching fish by entanglement. The minimum mesh net size is 90mm. Nets are designed to target fish swimming close to the surface while following the coastline. The gear is made up of two principal elements, the trap and the leader. The trap is approximately 13.5m wide and 4.5m deep at the mouth, tapering to about 3m in width and 2.5m in depth at the head. The leader may not exceed 300m in length. The configuration of a typical bag net is shown in Figure 5.2.

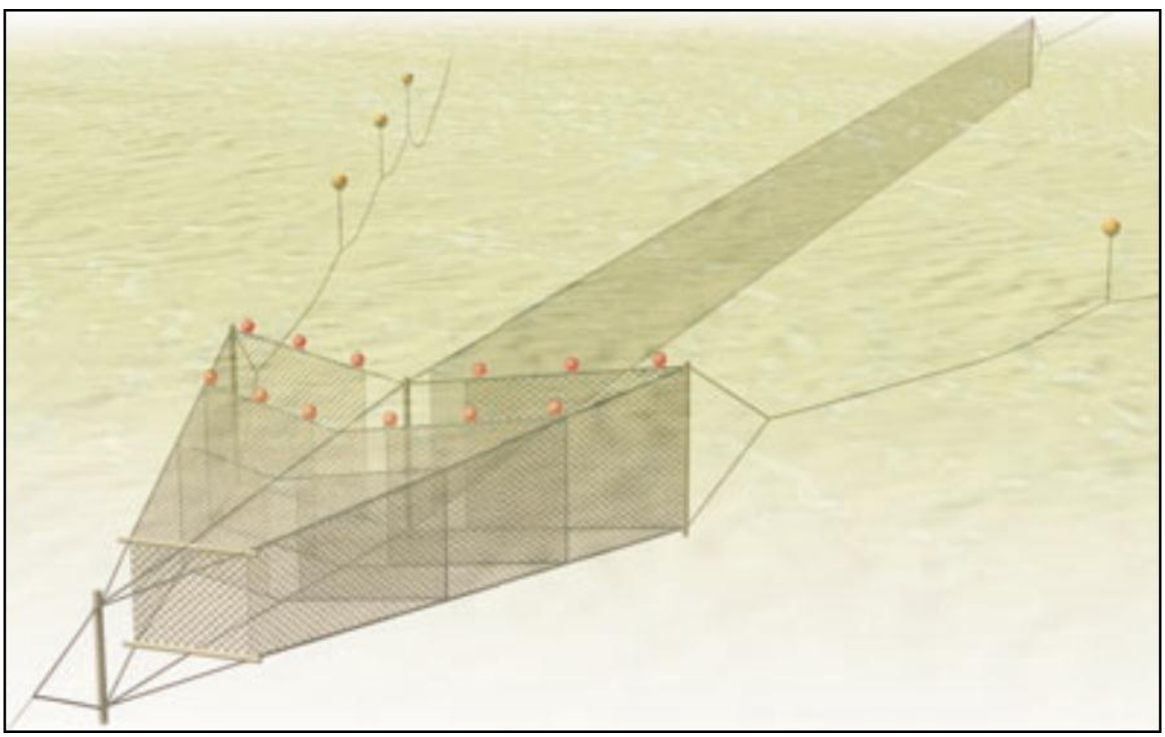


Figure 5.2 Bag Net showing the Trap, the Leader and Moorings

Stake nets are similar in design and operation to the bag nets except that they are set on sandy beaches, supported on stakes driven into the sand, where the receding tide exposes the nets. The maximum allowed leader length and total gear length are similar to those specified for bag nets.

5.3.2 Net and Coble

Traditionally nets are operated from cobles, small flat bottomed, open boats, with a shore party assisting in operations. A member of the shore party holds the upstream hauling rope and while the net is paid out from the stern of the vessel, as shown in Figure 5.3. The net must not be stationary or allowed to drift at any time and must be constantly 'swept', surrounding the fish and drawing them towards the shore. No other objects or obstructions may be used to aid fishing and adjacent netting operations must be at least 50m apart (Galbraith and Rice, 2004).

Net-and-cobles are generally operated in estuaries and the lower reaches of rivers, although small numbers are also used in coastal waters (Potter and Ó Maoiléidigh, 2006).

Figure 5.3 Net and Coble Fishing

5.3.3 Rod and Line

At present, recreational rod-and-line fishing is the most common method of fishing for salmon. The Salmon and Freshwater Fisheries (Consolidation) (Protection) (Scotland) Act 2003 defines rod and line as: "a single rod and line (used otherwise than as a set line or by way of pointing, or by striking or dragging for fish) with such bait or lure as is not prohibited". DSFBs can apply to Scottish Ministers for regulations specifying baits and lures that may not be used for rod-and-line fishing in their district to be made whilst in some cases voluntary restrictions are set by the boards. Usually the restrictions prohibit the use of shrimps, prawns or worms as bait and the use of lures bearing multiple sets of hooks (SPICe, 2000). The use of fish roe, fire or light as bait or lure is also prohibited (Salmon and Freshwater Fisheries (Consolidation) (Protection) (Scotland) 2003).

Salmon and sea trout are generally not caught by rod-and-line at sea, but along river beats. Catch and release is actively encouraged and promoted by the majority of DSFBs, and mandatory in some fisheries. As described previously, the sport makes a significant contribution to both local and regional economies.

5.4 Fisheries Data

The information given in this section is principally based on reported catches of salmon, grilse and sea trout recorded from 1952 to 2011 by region and by salmon fishery district within the regional study area from 2002 to 2011. The data were provided by Marine Scotland Science and are subject to the sensitivities and limitations outlined in section 3.1.1.

As stated previously, it should be noted that the analysis of fisheries statistics given below is not intended as an assessment of the abundance or state of the stocks, but as an indication of the underlying population trends and relative importance of the fisheries of salmon and sea trout by region and fishery district in Scotland. The critical time for fisheries does not necessarily reflect those of salmon and sea trout movements and catch data is limited in terms of presenting an accurate baseline of fish populations and fish migration outside of the time of fisheries. This also holds true for rod-and-line catches which do not account for the closed season and give no effort value.

5.5 National

5.5.1 Historical Data

An indication of the current trends in salmon, grilse and sea trout catches in Scotland with respect to those recorded historically (1952-2011) is provided below. For the purpose of clarity, data from the rod and line (including catch and release) and net (net and coble and fixed engines) fisheries are presented separately.

Figure 5.4 shows the total declared catch for salmon, grilse and sea trout from the rod and line fishery from 1952-2011. Catches of (MSW) salmon have remained relatively stable throughout the period for which data is presented. Numbers of grilse taken in the rod and line fishery have increased, particularly in the latter half of the time series. This may be partially related to an observed shift in the sea age structure of some populations from MSW to grilse dominance over the same time period (see Aprahamian *et al*, 2008). Catches of sea trout show a general pattern of decline, with current numbers taken by rod and line approximately half that recorded during the 1950s.

As stated previously, fisheries statistics derived from the rod and line fishery do not account for fluctuations in effort. Therefore, increases in the popularity of rod and line fishing and improvements in the catch reporting system may both have contributed to apparent similarities between historic and present day catch levels.

Figure 5.5, shows the total declared catch of salmon, grilse and sea trout originating from the net fisheries (all methods combined). The decline in numbers of fish resulting from these fisheries is principally a result of recent decreases in fishing effort as a result of netting stations buyouts and closures, changes in salmon and sea trout abundance and competition from the aquaculture industry which has lowered the price of wild salmon (MSS, 2008).

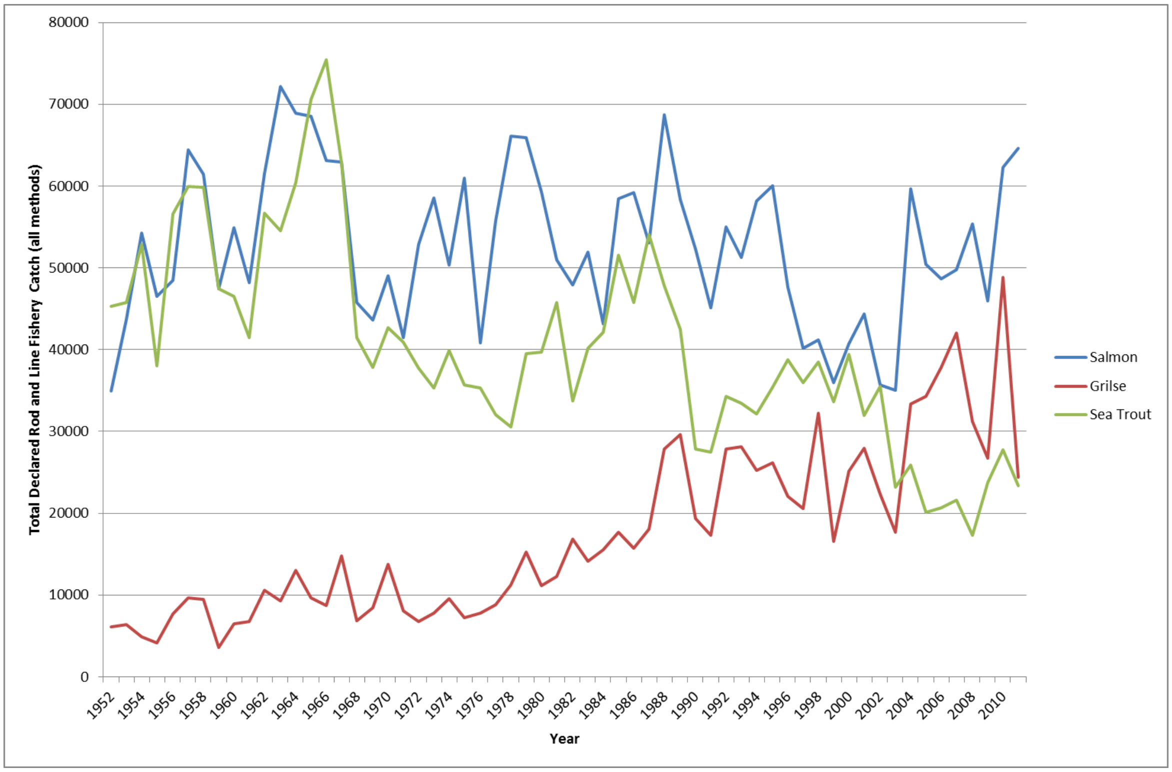


Figure 5.4 Total Declared Catch (1952-2011) in the Rod and Line Fishery (including Catch and Release)

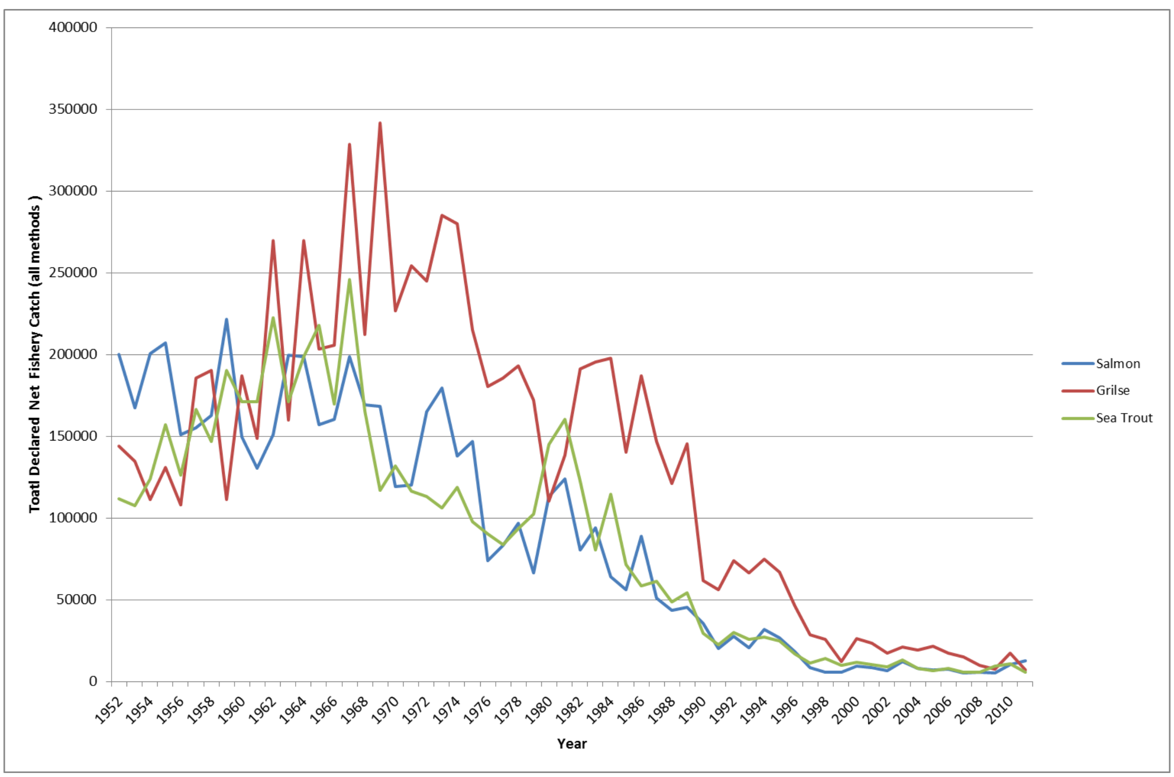


Figure 5.5 Total Declared Catch (1952-2011) in the Net Fisheries (Fixed Engines and Net and Coble)

5.5.2 Current Trends

The relative importance of the salmon and sea trout fisheries by region based on the annual reported catch for all methods (average 2002-2011) is shown in Figure 5.6.

Reported catches are highest from fisheries located in eastern and northern region and follow the order East > North East > Moray Firth > North. Catches from regions in the Outer Hebrides and regions on the west coast are comparatively lower. The highest reported catch is recorded in the Solway region, followed by the Clyde, North West, Outer Hebrides and West Coast. Shetland records much lower total average catches than these regions and both salmon (including grilse) and sea trout are absent in records from Orkney.

Salmon and grilse form the majority of the total catch in most regions, with the exception of the Outer Hebrides and Shetland. Catches of salmon and grilse are low in records from the Shetlands, where the catch is comprised almost entirely by sea trout. There are apparent differences in terms of sea age composition of salmon by region. For example, in eastern regions such as the East, North East and Moray Firth, MSW (e.g. salmon) fish form the greater proportion of combined salmon and grilse catch. The reverse is true for fisheries located on the west coast, where grilse contribute a higher proportion to total salmon catch in the Outer Hebrides, North West and West Coast. Fisheries located in the Clyde and Solway regions represent an exception, where catches of salmon are proportionally higher.

The proportion of the total catch (salmon and sea trout combined) taken by each method for each region (average 2002-2011) is shown in Figure 5.7.

In most regions rod and line (including catch and release) accounts for the greater proportion of total recorded catch. This pattern is particularly marked in west coast regions, where the method accounts for over 85% of catches in the Outer Hebrides, North West, West Coast and Clyde regions. In all regions, excepting the Clyde, over 50% of captured fish from rod and line fisheries are returned to rivers (e.g. catch and release).

The fixed engine fishery is of increased importance in the Solway region (31% of total declared catch) although on average, higher numbers of fish result from the rod and line fisheries. Net fisheries are of greater importance in northern and eastern regions. In the North East fixed engine and net and coble components represent a combined total of 46% (32% and 14%, respectively). Approximately one third of the total catch is taken by nets in the North region (31%), with the greater proportion from the fixed engine fishery (28%). In the East region the overall contribution of net fisheries is lower and net and coble accounts for comparatively higher numbers of fish than fixed engines (15% and 3%, respectively).

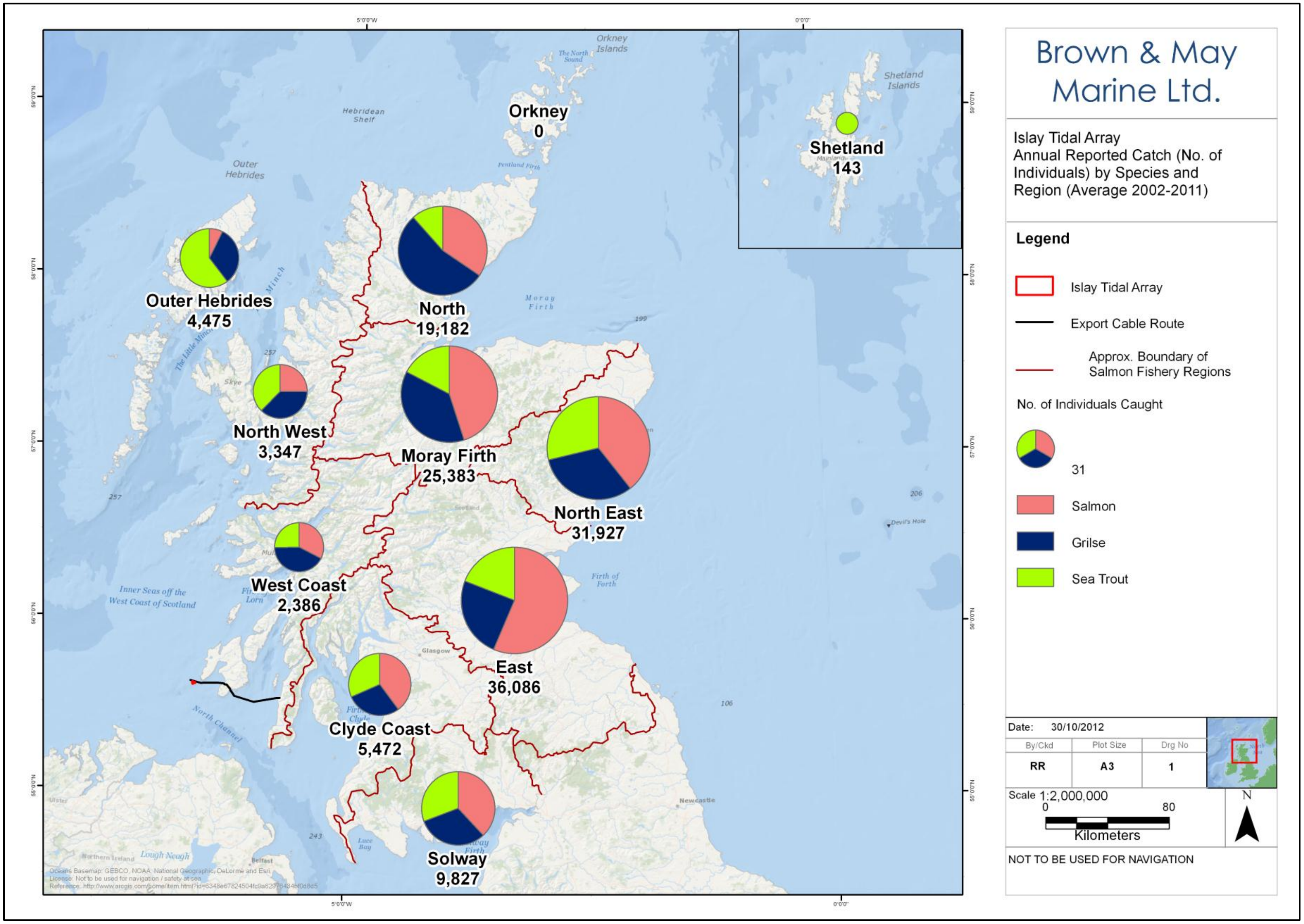


Figure 5.6 Annual Reported Catch (No. of Individuals) by Species and Region (average 2002-2011)

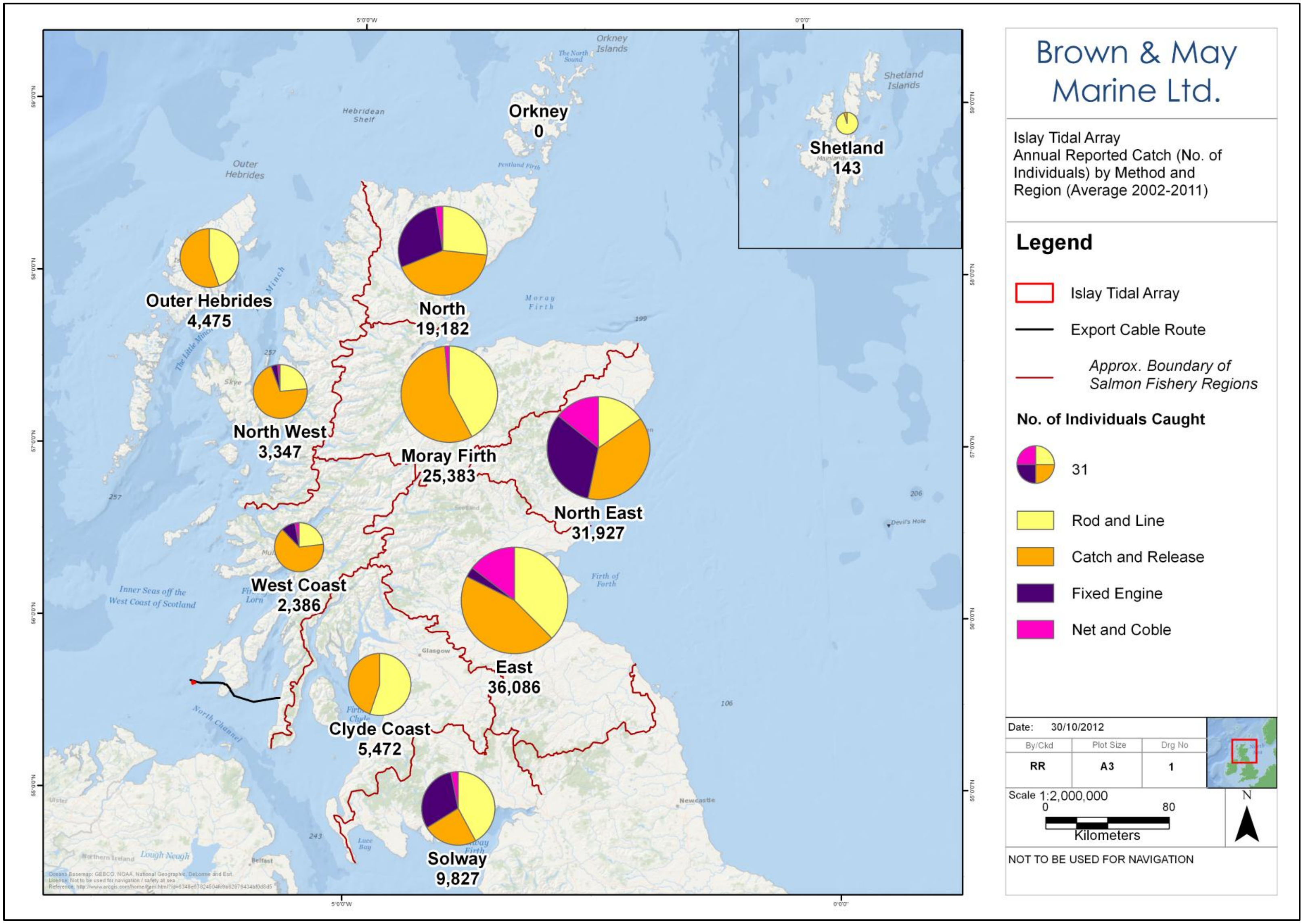


Figure 5.7 Annual Reported Catch (No. of Individuals) by Method and Region (average 2002 to 2011)

5.5.3 Regional Overview

The following section provides an overview of the salmon and sea trout fisheries for each district within the regional study area, including the local study area.

Annual reported catch (average 2002-2011) for salmon, grilse and sea trout by district is shown in Figure 5.8. On average the greatest total catch is recorded in the Lochy district (913), followed by those recorded in the Awe (526) and Laggan (305) districts. Total combined catch of salmon, grilse and sea trout are considerably lower from other districts. For example, in the Ormsary district (in which the export cable landfall is located) an average of only 58 fish is reported annually.

In addition to differences in total numbers caught, the proportion of the reported catch formed by salmon, grilse and sea trout also varies by district. In the Lochy the highest reported catches are of grilse (557; 61%), with salmon and sea trout recording lesser proportions of the total (246; 27% and 115; 13%, respectively). In the Awe district catches of both salmon and grilse are in excess of 200 per year and are approximately equal (255; 49% and 246; 47%, respectively). In comparison, reported numbers of sea trout are markedly lower (24; 5%). In the Laggan district (local study area, tidal site) salmon (128; 42%) represent a significantly greater proportion of the total average catch than grilse (44; 14%) with sea trout captures (134; 44%) contributing a similar quantity to the total catch as salmon. With the exception of lower overall numbers the distribution of salmon, grilse and sea trout catches in the Ormsary (local study area, export cable) is similar to that reported in the Laggan District: reported captures of salmon and sea trout are similar in number and percentage (22; 38% and 25; 43%, respectively), with those recorded for grilse somewhat lower (11; 19%).

The proportion of total catch (salmon, grilse and sea trout combined) by each method (average 2002-2011) is shown in Figure 5.9. Overall, rod and line (both methods combined) represents the dominant method of capture. The majority of fish captured by rod and line are returned to the water (e.g. catch and release) in the Lochy (672; 73%), Awe (429; 82%) and Aline (64; 88%) districts. The proportion of retained fish in the rod and line fishery is greater in other districts including those located in the vicinity of the tidal farm and associated export cable route. For example, approximately equal numbers of fish captured in the Laggan rod and line fisheries are retained and released (158; 52% and 148; 48%, respectively). In the Ormsary district, the proportion of the total rod and line catch that is retained is greater than that released (18; 31% and 34; 60%, respectively).

Within the regional study area, the Lochy, Nell and Stunart regions are the only districts in which fixed engine and net and coble fisheries account for significant proportions of respective total catches of salmon, grilse and sea trout. Fixed engines account for an annual average of 196 fish in the Lochy district, representing 21% of the total catch by method. Although overall numbers are lower in the Nell district catches from the net and coble fishery account for 75% (57 fish) of the total catch. In the Stunart district captures by fixed engine represent over half of the total catch (22; 52%). With reference to the local study area, only the Ormsary has historically recorded any captures by net and coble and fixed engine; in both cases these were very low and represent only a small proportion of the total catch by method (2; 3% and 3; 5%, respectively). No captures by either net and coble or fixed engine are recorded in the Laggan district.

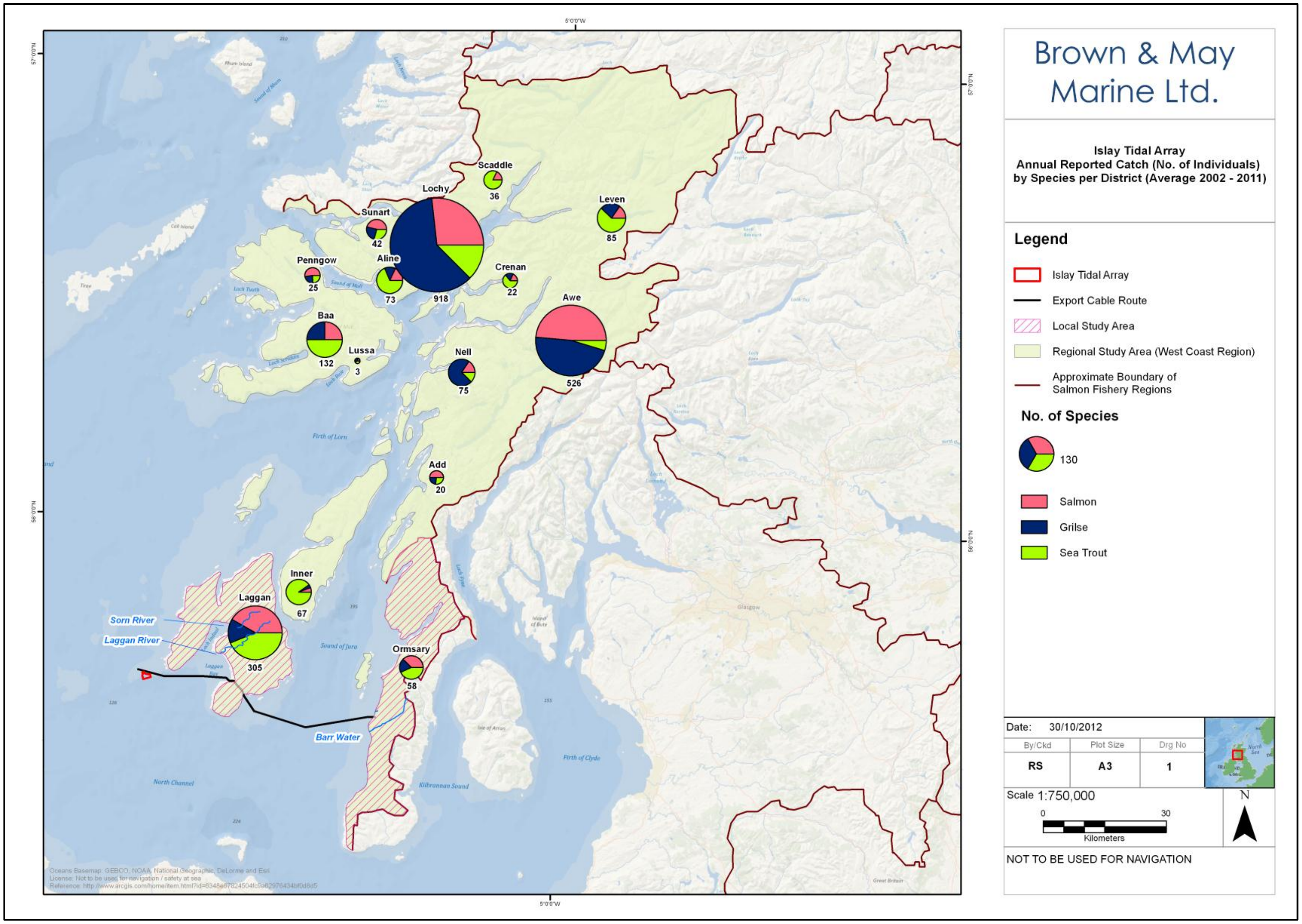


Figure 5.8 Annual Reported Salmon, Grilse and Sea Trout Catch (Average no. individuals, 2002-2011) by District in the Regional and Local Study Areas

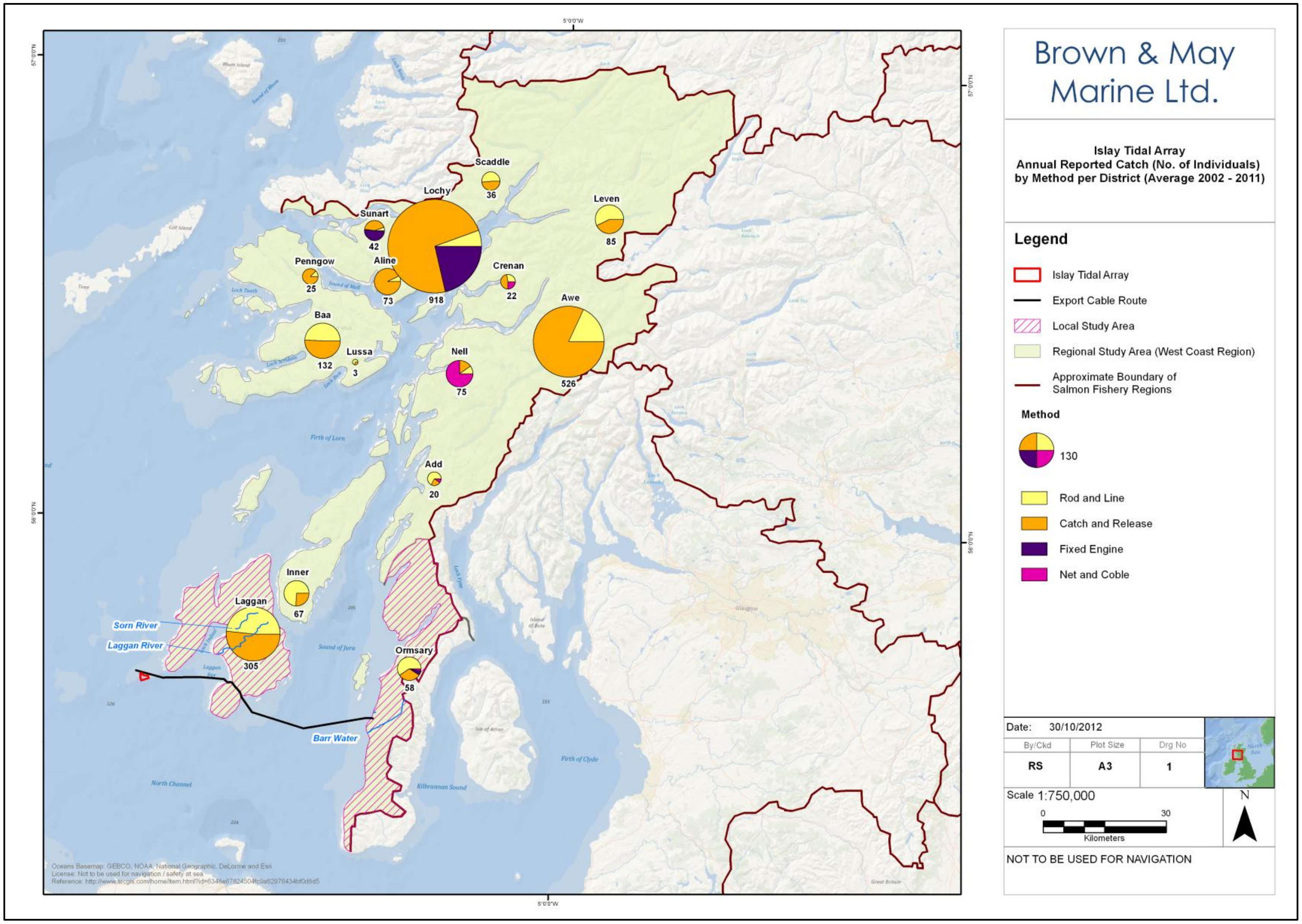


Figure 5.9 Annual Reported Catch (Average no. individuals, 2002-2011) by Method and District in the Regional and Local Study Areas

5.5.4 Net Fisheries by Region

The annual declared catch from the net fishery (net and coble and fixed engines) by salmon fishery region is provided in Figure 5.10. The catch in the regional study area (West Coast Region) has been further broken down by individual district. The location of active net fisheries in 2010 (MSS, 2012) are also provided. It should be considered that average values provided for 2001-2011 will likely overestimate the current levels of exploitation due to the inclusion of statistics from netting stations which are no longer active.

As shown previously, the numbers of salmon, grilse and sea trout reported from east coast net fisheries are considerably higher than those recorded from the west (excepting the Solway Region). The regions reporting the greatest overall numbers net caught salmon, grilse and sea trout are the North East (14, 928) East (6,360) and North (5,969). Although total numbers of netting stations are similar on the east and west coasts (25 and 23, respectively), it should be considered that on the west coast 18 (78%) of these stations are located in the Solway Region. There are therefore only 7 active netting distributed among the remaining 4 regions located on the west coast.

On the west coast (excluding the Solway), the highest numbers of net caught salmon, grilse and sea trout are reported from the regional study area (West Coast Region) in which three active netting stations are located (two fixed engine and one net and coble). Of the reported total net catch for the region, 67% (196 fish) originates from the fixed engine fishery in the Lochy District. The only net and coble fishery currently active in the regional study area is located in the Nell district from which catches represent 19% (57 fish) of the regional total. Catches from the Stunart district contribute an average of 11% of to the total recorded net catch for the region. The Crenan net and coble fishery was not active in 2010 and past captures contribute an average of only 2% (5 fish) to the current West Coast total net catch. Similar to the Crenan, the Ormsary (export cable landfall) net and coble and fixed engine fisheries were not active in 2010 and have historically recorded low average annual returns (2% of the West Coast total net catch). The most recent netting activity in the Ormsary region was recorded in 2007. There has been no licensed netting activity in the Laggan district for the ten year period from which data has been analysed.

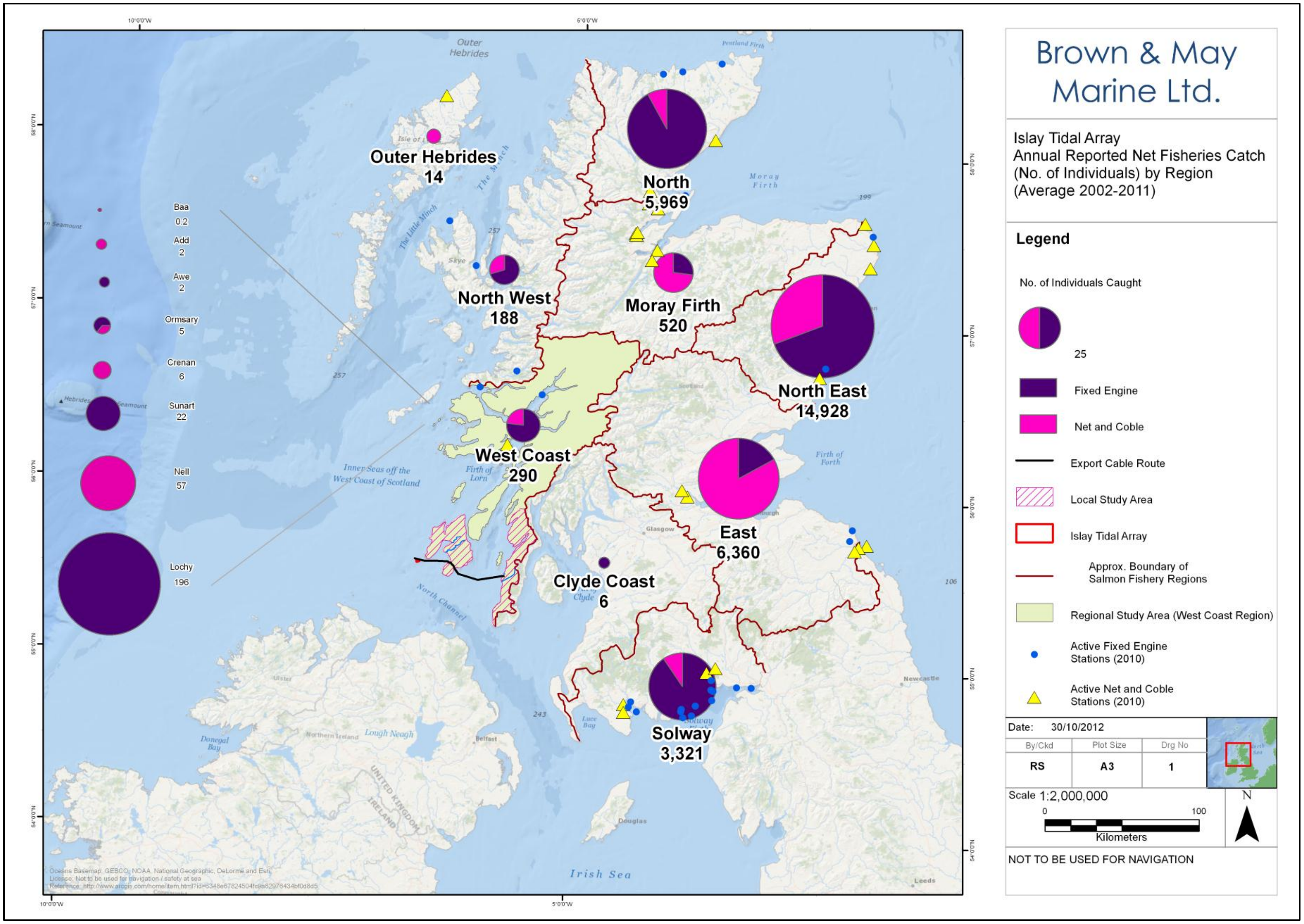


Figure 5.10 Annual (average 2002 to 2011) Net Fisheries Catch by Region and Distribution Fisheries in Scotland (2009)

5.5.5 Local Study Area (Laggan and Ormsary Districts)

As described previously the local study area has been defined by those districts which are situated within the immediate vicinity of the Tidal Farm (Laggan District) and associated export cable (Ormsary District). The following section provides an overview of the principal fishing methods, seasonality and annual variation in those districts which form the local study area.

5.5.6 The Laggan District

The Laggan and Sorn District Salmon Fisheries Board

The Laggan and Sorn District Salmon Fisheries Board are responsible for the management of migratory fish species in the River Laggan and River Sorn on Islay. In the past this has included work such has habitat and electrofishing surveys. In 2001, the Board supported the Argyll Fisheries Trust (AFT) with electrofishing surveys aimed at determining the stocks of juvenile and salmon and trout in both catchments. The results of the survey indicated that there were good numbers of adult salmon spawning during the winter of 2001/2001 and that survival from egg to fry had been high. Numbers of salmon parr were however lower than would be expected based on the number of fry present. A survey conducted in the Sorn yielded similar results, which indicated that good numbers of spawning adult salmon based on relatively high numbers of fry populating areas of suitable habitat.

Principal Fishing Methods in the Laggan District

Salmon and sea trout fishing in the Laggan district is based purely on the rod and line fishery. As shown in Figure 5.11, the proportion of fish retained and released within the fishery are approximately equal. In terms of rod and line fishing the Laggan is considered the more productive of the two Islay rivers with the most popular beat controlled by the Laggan Estate which has an annual average of 146 salmon. The Dunlossit, Islay, and Foreland estates and Port Ellen Angling Club also hold salmon fishing rights on the Laggan (FishPal, 2012). The salmon season on Islay runs from the 25th February to 31st October.

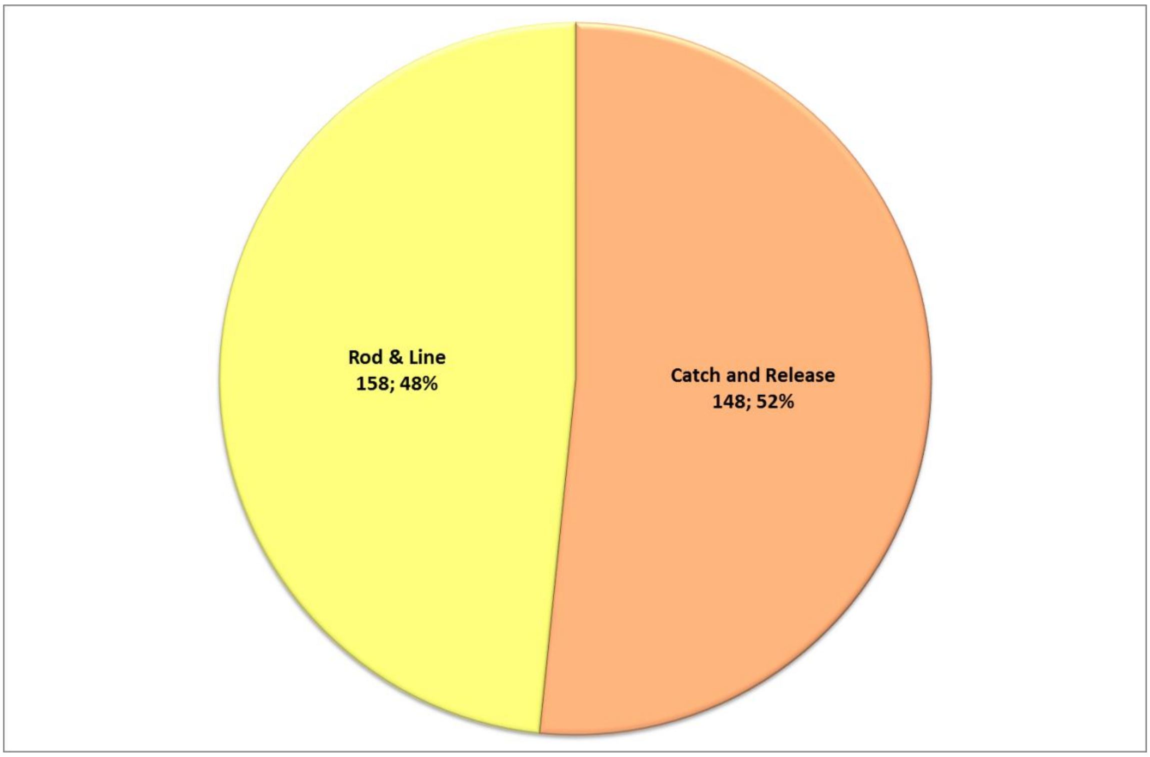


Figure 5.11 Distribution of the Catch by Method in the Laggan District

Figure 5.12 shows the seasonal distribution of the salmon and sea trout rod and line fishery in the Laggan District. Throughout the period for which data has been analysed, catches of salmon, grilse and sea trout are low in the earlier part of the season then increase markedly in the summer months. The highest numbers of grilse are, on average, recorded in July (16 fish) and then fall steadily until the end of the season in October (4 fish). Catches of salmon increase markedly from June (1 fish) to July (26 fish) with the highest numbers from the fishery recorded during August (44 fish) and September (45 fish). The seasonal distribution of sea trout captures is broadly similar to that of salmon, although the peak in reported numbers occurs slightly earlier during August (52 fish).

The annual variation in reported numbers of salmon, grilse and sea trout in the Laggan rod and fishery is shown in Figure 5.13. Recorded numbers of grilse have only exceeded 100 fish in 2003 (101 fish) and decreased yearly until 2009 (9 fish); subsequent increases were then recorded in 2010 (18 fish) and 2011 (49 fish). Catches of salmon and sea trout share a broadly similar pattern, with peak catches for both recorded in 2005 (228 and 107 fish, respectively). The lowest numbers of salmon and sea trout were recorded in 2009 (74 fish) and 2010 (63 fish), respectively; in 2011 reported catch for both was the highest since 2005 (172 and 163 fish, respectively).

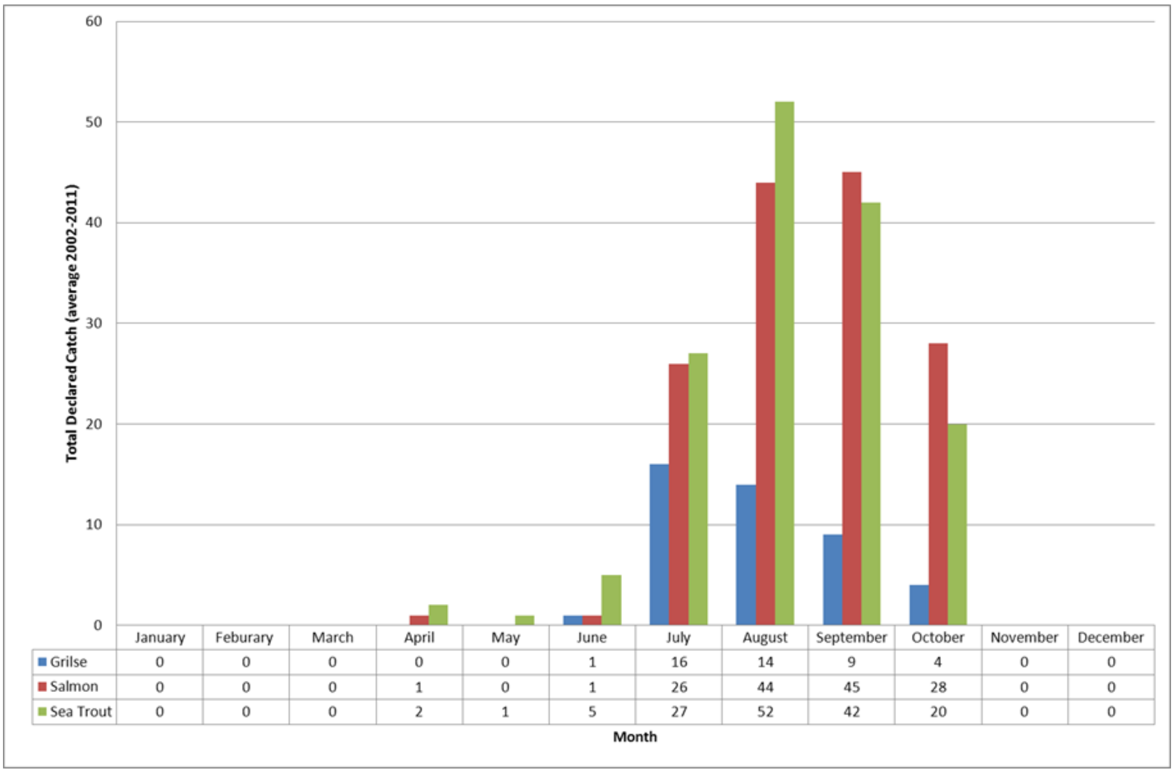
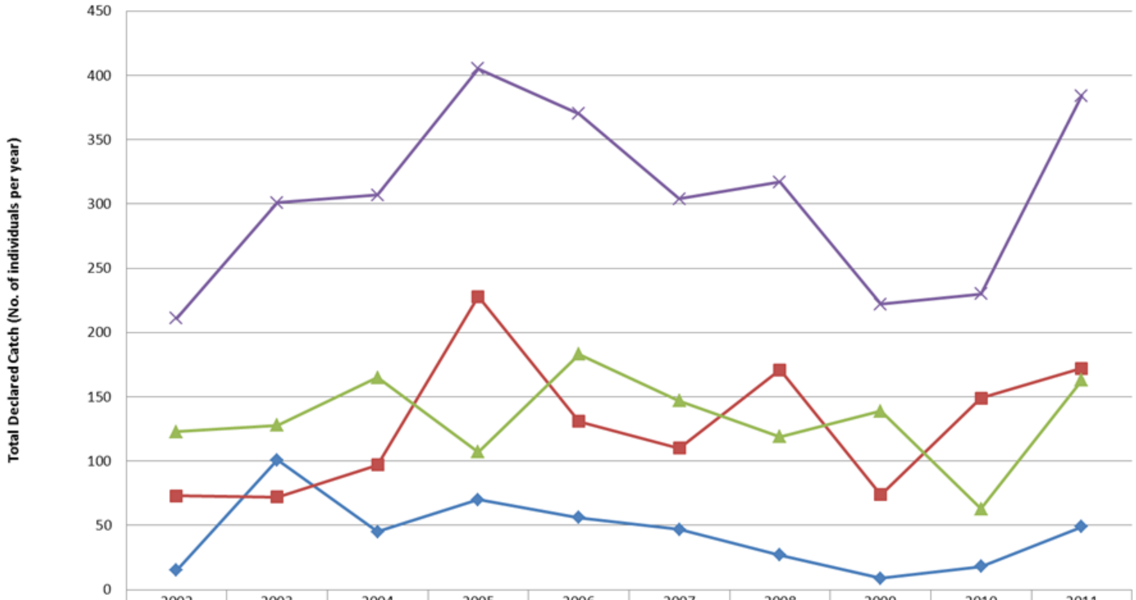


Figure 5.12 Seasonal Distribution of Catch in the Laggan Rod and Line Fishery



Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Grilse	15	101	45	70	56	47	27	9	18	49
Salmon	73	72	97	228	131	110	171	74	149	172
Sea Trout	123	128	165	107	183	147	119	139	63	163
Total Catch	211	301	307	405	370	304	317	222	230	384

Year

Figure 5.13 Annual Variation of Catch in the Laggan Rod and Line Fishery

5.5.7 Ormsary District

Argyll District Fisheries Board

The Argyll District Salmon Fishery Board (ADSFB) is the statutory body currently responsible for the management of salmon and sea trout stocks in the five rivers located within the Ormsary district. The ADSFB is responsible for all rivers in Argyll with the exception of those located on the Islands of Mull, Islay and Jura and the Eachaig catchment. The ADSFB works closely with fisheries biologists from the Argyll Fisheries Trust and a number of River Improvement Associations in order to facilitate management at the local scale (ADSFB, 2012).

Principal Fishing Methods in the Ormsary District

The principal method of salmon and sea trout fishing in the Ormsary is rod and line, with net and coble and fixed engines contributing low numbers to the total catch. In the rod and line fishery more fish are retained than released. The salmon rod and line season runs from the 21st of February to the 11th of October.

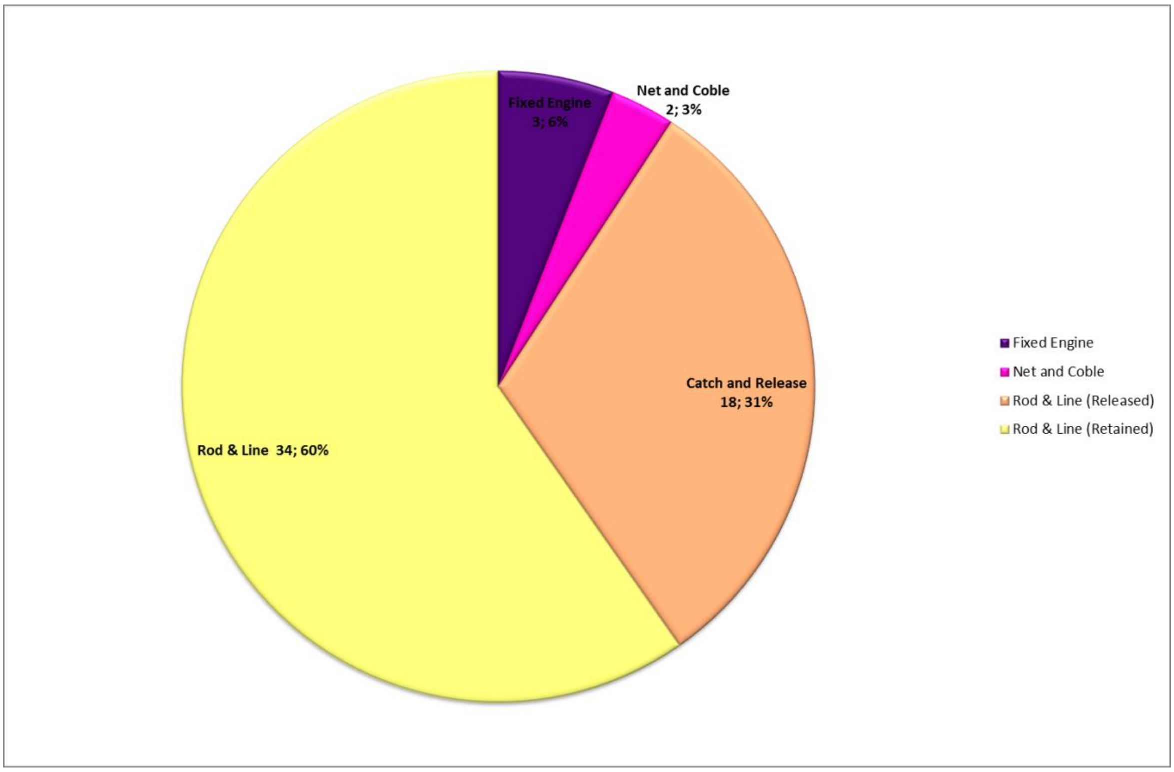


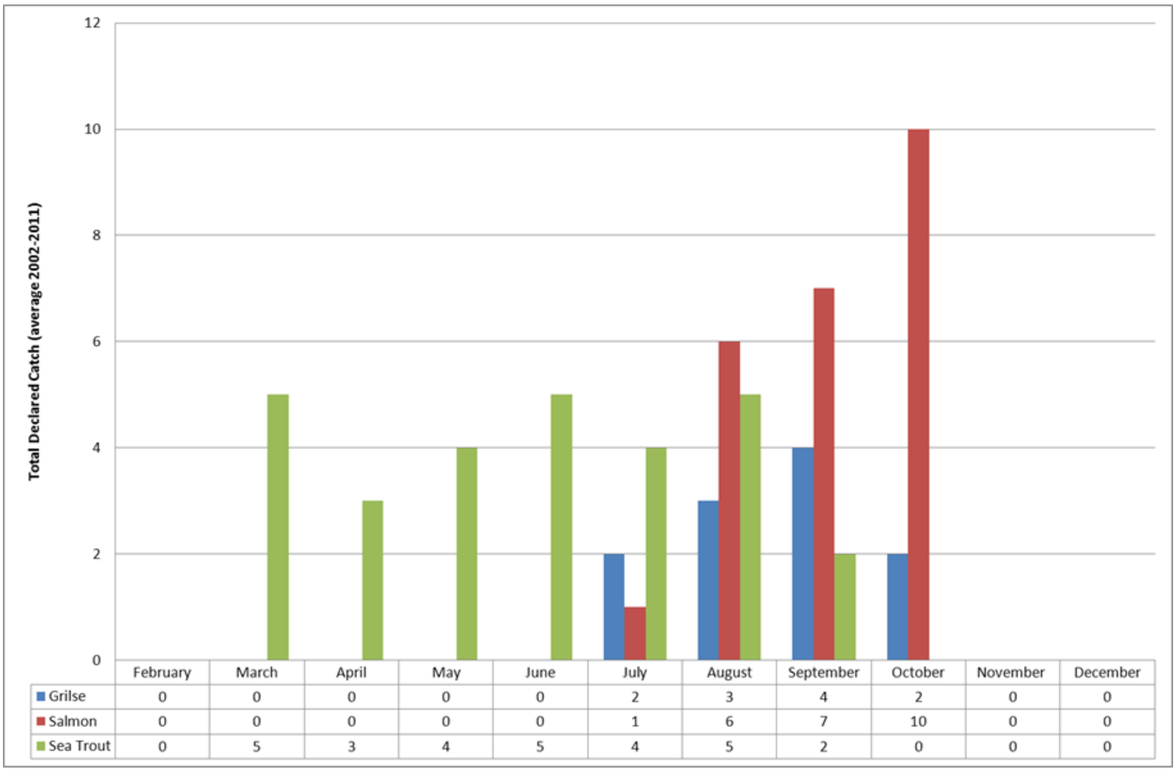
Figure 5.14 Distribution of the Catch by Method in the Ormsary District

Seasonality and Annual Variation of the Fishery

With respect to the net and coble and fixed engine fisheries no salmon, grilse or sea trout have been recorded from either fishery since 2007. In addition, due to the low average numbers (frequently < 1 individual per year) of salmon, grilse and sea trout resulting from the Ormsary net fishery, the data presented here is for the rod and line fishery only.

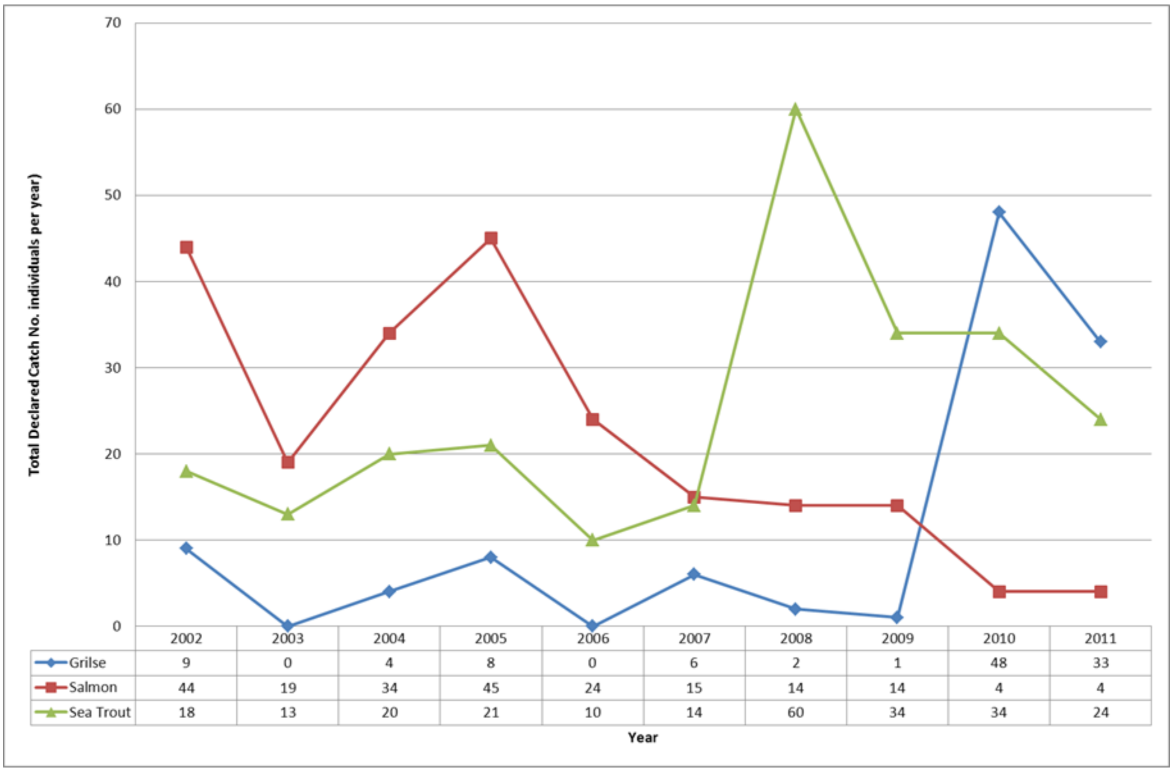
As shown previously and in Figure 5.15, overall numbers of salmon, grilse and sea trout from the Ormsary rod and line fishery are low. Catches of sea trout are comparatively more consistent and occurring in all months from March (5 fish) to September (2 fish). Reported captures of salmon increase from July (1 fish) onwards, reaching a maximum of 10 fish in October. Grilse follow a similar pattern to salmon, although on average the maximum reported catch occurs earlier, during September (4 fish).

Annual variation in the salmon, grilse and sea trout in the Ormsary district rod and line and fishery is shown in Figure 5.16. Rod and line caught grilse have only been reported in the latter five years of the data set and increased markedly from 2009 (1 fish) to 2010 (48 fish), declining again in 2011 (33 fish). The peak of reported salmon catch in the rod and line fishery occurred in 2002 (42 fish), declining in 2003 (12 fish) then increasing and remaining similar in 2004 (34 fish) and 2005 (36 fish). Post 2005 salmon catch showed a general pattern of decline with only 4 fish reported in both 2010 and 2011.



	February	March	April	May	June	July	August	September	October	November	December
Grilse	0	0	0	0	0	2	3	4	2	0	0
Salmon	0	0	0	0	0	1	6	7	10	0	0
Sea Trout	0	5	3	4	5	4	5	2	0	0	0

Figure 5.15 Seasonal Distribution of Catch in the Ormsary Rod and Line Fishery



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Grilse	9	0	4	8	0	6	2	1	48	33
Salmon	44	19	34	45	24	15	14	14	4	4
Sea Trout	18	13	20	21	10	14	60	34	34	24

Figure 5.16 Annual Variation of Catch in the Ormsary Rod and Line Fishery

6.0 The Future of Salmon and Sea Trout Fisheries

Throughout Scotland DSFBs, and organisations such as the Rivers and Fisheries Trusts of Scotland (RAFTS) work closely with other conservation bodies and foundations, implementing programmes to maintain, protect and improve salmon and sea trout stocks and the habitats on which they depend. For example, a number of DSFB's operate riparian habitat enhancement schemes and catch and release policies are increasingly encouraged, monitored, and in some instances made mandatory by the introduction of Salmon Conservation Regulations. The ASFB, reports that in 2011, the catch and release rate for salmon was 73%, increasing to 91% for early 'spring' run salmon (ASFB, 2012).

A priority for the majority of Boards is the maintenance and development of rod-and-line fishing. It is expected that this trend will continue in the future, in line with the joint aims of the ASFB and other organisations. Parallel to the maintenance and development of the rod-and-line fisheries, a decrease in coastal netting activity has been the trend in the last decade. This is likely to continue to be the case, with river and conservation interests buying up coastal stations, as well as increasing statutory and voluntary restrictions and policies being implemented, all of which are considered effective stock management measures.

Scotland, together with England, Norway and Northern Ireland has come under increasing international pressure to establish a policy for managing Multi Stock Fisheries (MSFs), such as coastal netting. This is of particular sensitivity in Scotland, where fishing is prosecuted under heritable property rights, rather than as an activity licensed by Government, as in most salmon producing countries (Crawley, 2010). International advice is that there should be a presumption against operating MSF unless they can be shown not to contravene basic conservation policies (ASFB, AST and S&TA, 2009).

Salmon and sea trout stocks in Scotland are currently subject to a number of threats in both freshwater and marine phases. In freshwater, habitat degradation through intensified agricultural practices, water abstraction, and obstruction to migration all have the potential to impact upon both juvenile and adult survival. In the marine environment, factors such as changes in prey abundance, exploitation in multi-stock fisheries, disease and threats to the genetic integrity of wild stocks from farmed salmon may all impact upon salmon and sea trout stocks returning to Scottish waters. Whilst conservation measures to protect these species have increased considerably in recent years, it remains difficult to assess the degree to which these will improve current stocks and whether stocks will fluctuate naturally during the life time of the West Islay Tidal Farm.

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WESTISLAY TIDAL

ENERGY PARK

volume 4 // appendix 13.1 //
archaeology - baseline report

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West Islay Tidal Energy Park

Maritime Cultural Heritage Baseline Technical Report

May 2013

HEADLAND ARCHAEOLOGY Ltd

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Executive Summary

This document presents the results of a maritime cultural heritage baseline technical report, incorporating an archaeological desk-based assessment and an archaeological assessment of geophysical data for the West Islay Tidal Project. The assessment was undertaken by Headland Archaeology (UK) Ltd. on behalf of DP Marine Energy Ltd. The purpose of the report is to identify any sites and features of cultural heritage significance within and in proximity to the proposed tidal energy park and export cable route that may be affected by the proposal, and to outline the archaeological potential of the marine environment. Recommendations for mitigation will be made in the impact assessment.

The assessment has examined an Immediate Study Area, a Wider Study Area and a Setting Study Area. The Immediate Study Area used for this report corresponds to the proposed tidal park and western cable route, with a 500m buffer to identify sites in close proximity that could be affected by pre- installation or/ and installation activities. A Wider Study Area extending 5 Km from the Immediate Study Area has also been examined to inform the archaeological potential of the area. The Setting Study Area has considered all scheduled monuments and listed buildings within 15 km of the tidal farm within the zone of theoretical visibility as defined in the Landscape and Visual chapter.

The assessment has established that there are no proposed Historic Marine Protected Areas, Designated Wrecks or other cultural heritage assets with legal designations within the West Islay tidal park or western cable route study areas. One recorded wreck has been identified within the western cable route immediate study area. Six wrecks and two obstructions have been identified from the UKHO records within the wider study area, with a further 31 historic losses without accurate coordinate information listed in the National Monument Record of Scotland dataset.

The assessment of marine geophysical survey data identified one target of high archaeological potential definitively identified as a wreck, four targets considered to be of medium archaeological potential and of possible archaeological interest, and 20 targets of low archaeological potential identified as likely natural features within the West Islay Tidal Energy Project immediate study area. It is noted that the geophysical survey did not cover the nearshore area and no data was available for assessment inshore from the charted 20m contour.

It is considered that there is low to moderate potential for the discovery of unexpected cultural heritage remains within the Immediate Study Area. The volume of maritime traffic historically within the North Channel and the Clyde approach is noted, and the unpredictable weather and sea state conditions in this area of the North Channel is reflected in the large number of documented maritime losses recorded in the National Monument Record of Scotland, many of which with unknown exact locations. Further, this area is noted for wartime activity due to the number of aircraft operating in the vicinity as well as shipping losses in this area of the North Channel. However, the majority of the proposed tidal energy park area and western cable route has been informed by a geophysical survey and the seabed conditions within the tidal farm site and across the western cable route site is well understood. To the central and southern areas of the tidal park where the turbines are proposed and the bedrock is often exposed, there is considered to be low archaeological potential. In the north-western area of the site where significant depths of finer gravelly sands that could conceal sites or deposits of archaeological interest are recorded there is considered to be moderate archaeological

potential. Similarly, inshore along the export cable route on the approach to and within the intertidal area not covered by the geophysical survey, there is considered to be moderate potential.

The assessment of key onshore receptors has identified five Scheduled Monuments, one Category A listed building and one Conservation Area within the Zone of Theoretical Visibility (ZTV). These have been examined in detail for potential impacts on their setting.

Glossary of Terms

AD	Anno Domini
Anomaly	Possible manmade target identified in the geophysical survey data.
Assets	Parts of the historic environment that has local and national significance such as listed buildings and war memorials.
Bathymetry	Measurements of the depth of the seabed from a datum.
BGS	British Geological Survey.
BC	Before Christ.
BP	Before Present.
COWRIE	Collaborative Offshore Wind Research into the Environment.
CPT	Core Penetration Tests.
Dead Wreck	Not detected by repeated surveys, therefore considered not to exist.
Designated Wreck	A protection put on historic wrecks so they are not put at risk from unauthorised access, undisciplined activities or investigation, the Protection of Wrecks Act 1973.
DPME	DP Marine Energy
EIA	Environmental Impact Assessment.
Fauna	Animals both invertebrates and vertebrates.
Flint	Form of quartz mineral (chert) used to made tools in prehistoric societies.
Geophysical Survey	Non-intrusive investigative survey methods, such as use of sonar measurement and ranging, magnetometers and sub-bottom profiling for features upon and below the seabed.
Geotechnical Survey	Intrusive survey methods that penetrate the seabed, recovering samples for analysis, e.g. for determining sediment type and the material properties.
GIS	Geographical Information System.
Grab Samples	A sample taken from the seafloor.
GPS	Global Positioning System.
HA	Headland Archaeology.
Holocene	Period of geological time spanning from 10,000 years BP.

ICOMOS	International Council on Monuments and Sites.
ISA	Immediate Study Area.
JNAPC	Joint Nautical Archaeology Policy Committee.
LAT	Lowest astronomical tide – typical vertical chart datum.
Lithic	Stone tools that may be associated with prehistoric cultures.
Lift Wreck	A salvaged wreck.
Live Wreck	Wreck considered to exist.
MBES	Multibeam echosounder: sonar system used to record bathymetric range, using a wide swath to sweep the seabed beneath the survey vessel.
Mesolithic	Archaeological period of time of past cultures approximately 10,000 – 6,000 BP.
Macrofossils	Fossils that can be identified by eye e.g. shell fragments.
Microfossils	Small fossils that can only be viewed under a microscope, e.g. pollen.
MOD	Ministry of Defence.
Neolithic	Archaeological period of time of past cultures approximately 6,000-4,500 BP.
NMRS	National Monument Records of Scotland.
Palaeochannel	Submerged former course of a river from the Palaeolithic era typically filled with sediment.
Palaeoenvironmental	Relating to the past environmental conditions of the Palaeolithic era.
Palaeolithic	Prehistoric era distinguished by the development of stone tools, 10,000-780,000 years BP.
Peat	An organic material formed by decayed vegetation matter that can preserve important environmental and archaeological evidence.
Pleistocene	Period of geological time prior to the Holocene, spanning 10,000 - 2.6 million years BP.
Quaternary	Of or belonging to the geologic time, system of rocks, or sedimentary deposits from the end of the Tertiary Period through to the present. Includes the Pleistocene and Holocene.
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland.

Receptor	Any environmental or other defined feature that is sensitive to or has the potential to be affected by an impact.
ROW	Receiver of Wreck, wreck administration department within the UK Maritime Coastguard Agency.
SBP	Sub-bottom Profiler: low frequency echosounder that records the seabed and underlying sediments through acoustic reflection.
Scheduled Monument	Nationally important archaeological sites which have legal protection assigned to them.
SeaZone	SeaZone Solutions Ltd.
SEPA	Scottish Environment Protection Agency.
Silt	A geological deposit that can contain evidence of past sea levels and landscapes.
SNH	Scottish Natural Heritage.
SSS	Sidescan sonar: sonar survey system that records the acoustic reflectivity of the seabed and features upon it.
TCE	The Crown Estate.
TEC	Tidal Energy Convertor
UKHO	United Kingdom Hydrographic Office.
UNESCO	United Nations Educational, Scientific and Cultural Organisation.
WSA	Wider Study Area.

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by DP Marine Energy Ltd to prepare a maritime cultural heritage report for the proposed West Islay Tidal Energy Project in the North Channel off the west coast of Scotland. The purpose of the report is to identify any sites and features of cultural heritage significance within and in proximity to the proposed tidal energy farm that may be affected by the proposal. The report comprises the results of an archaeological baseline study including an archaeological assessment of marine geophysical data; outlines the archaeological potential of the marine environment and includes information on sites and areas of archaeological significance identified within and in proximity to the proposed development.

2 PROJECT BACKGROUND

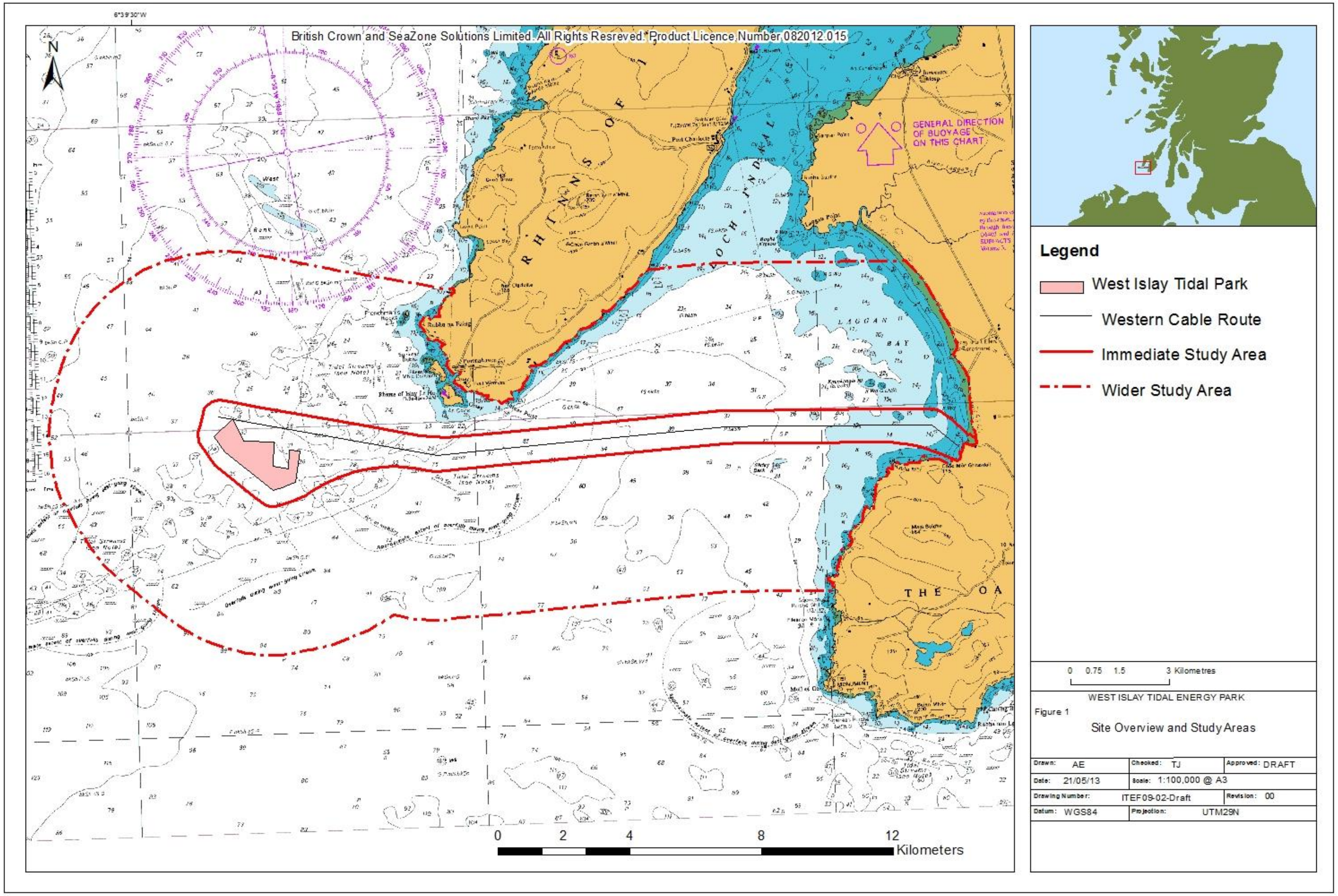
The West Islay Tidal Energy project comprises up to 30MW of tidal energy converters (TEC) and ancillary equipment, together forming the tidal farm, and the project grid connection comprising both offshore export cabling, and onshore grid connection works. The tidal farm is approximately 4.5km from Orsay off the island of Islay in Argyll and Bute occupying an area of circa 2.28km^2. The proposed western cable route, runs from the north of the tidal energy site for approximately 21km east to landfall at Kintra (131657E 648097N, British National Grid; 671942E 6170742N, UTM29N) on the island of Islay (Figure 1).

3 AIMS AND OBJECTIVES

The aims of this cultural heritage assessment are to review the known and potential archaeological receptors within the study area that could be subject to impacts and where significant, to propose mitigation. The specific objectives of the archaeological assessment were:

- To set out the statutory, planning and policy context relating to the historic environment within the study area;
- To provide an overview of the historic environment in the West Islay Tidal Energy Park study area, based on existing archaeological records and secondary sources;
- To highlight known maritime sites that may be impacted by the proposed development, with particular reference to:

    - *Shipwrecks, crashed aircraft and wreck material;*
    - *Geophysical anomalies of anthropogenic origin;*
    - *Submerged prehistoric sites and derived artefacts; and*
    - *Areas of archaeological potential.*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WEST ISLAY TIDAL ENERGY PARK
Figure 1
Site Overview and Study Areas
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Scale: 1:100,000 @ A3
Drawing Number: ITEF09-02-Draft
Revision: 00
Datum: WGS84
Projection: UTM29N

4 LEGISLATIVE FRAMEWORK AND GUIDANCE

This assessment takes account of the following national and international legislative procedures and guidelines:

- Marine (Scotland) Act 2010;
- Protection of Wrecks Act 1973;
- The Protection of Military Remains Act 1986;
- Ancient Monuments and Archaeological Areas Act 1979;
- Merchant Shipping Act 1995;
- Valetta Convention;
- The International Council on Monuments and Sites *(*ICOMOS);
- United Nations Education Scientific and Cultural Organisation (UNESCO) Convention on the Protection of the Underwater Cultural Heritage (2001);
- Historic Scotland's *Marine Heritage Strategy 2012-15*;
- PAN2/2011 Planning and Archaeology, 2011;
- Proposed Argyll and Bute Local Development Plan 2013;
- *Argyll and Bute Local Plan 2009.*

Full details of these legislative and guidance procedures is given in Appendix 1.

The Desk-top baseline study and assessment has been compiled in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. These include:

- *Institute for Archaeologists (IfA) guidelines: Standard & Guidance for Archaeological Desk Based Assessment* (2008);
- *Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development* (2008);
- *COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector* (2007);
- *COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy* (2008);
- *COWRIE Guidance for Offshore Geotechnical Investigations and Historic Environment Analysis: guidance for the renewable energy sector* (2011);
- *Offshore Renewables Protocol for Archaeological Discoveries* (The Crown Estate, 2010);
- *Round 3 Offshore Renewables Projects Model Clauses for Archaeological Written Schemes of Investigation* (The Crown Estate, 2010); and
- *Towards a Strategy for Scotland's Marine Historic Environment* (Historic Scotland 2009).

5 OFFSHORE STUDY AREA

The following study areas have been used for this baseline report:

- Immediate Study Area (ISA, Figure 1) - consisting of the tidal farm area and export cable route with a 500m buffer zone;
- Wider Study Area (WSA, Figure 1) - extending 5km from the application area boundary.
- Setting Study Area (SSA) - extending 15km from the proposed tidal energy farm site based on the Zone of Theoretical Visibility (see Chapter 15 LVIA, Figure 15.1).

A gazetteer of all known or identified maritime cultural heritage sites and potential maritime cultural heritage sites included in this report are depicted on Figure 2 and presented in Appendices 2-4, which detail each maritime cultural heritage asset with a unique Headland Archaeology (HA) number. Onshore cultural heritage assets considered for potential setting impacts are labelled according to their scheduled monument (SM) or listed building (HB) number and are illustrated on Figure 4.

6 METHODOLOGY

The following section sets out the methodology followed for the report, including the sources used for collation of data.

6.1 Desk Based Survey

The desk-based assessment is a documentary and cartographic search utilising a number of sources in order to locate all known cultural heritage assets within the defined study areas outlined above Sources used for this assessment include:

- Databases of designated cultural heritage assets maintained by Historic Scotland including designated wrecks;
- Maritime records held by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS);
- West of Scotland Archaeology Service (WoSAS) HER Records;
- UK Hydrographic Office Wrecks and Obstructions Database (SeaZone);
- National Library (for historic charts and maps only);
- Ministry of Defence (military remains only);
- Receiver of Wreck (ROW);
- Relevant SEA reports and Coastal Survey Assessment reports; and
- Other readily available published sources and grey literature e.g. marine geophysical and geotechnical survey reports.

6.2 Site Visit and Walkover

A walkover survey, intertidal survey, and site visits to onshore cultural heritage assets identified that may be subject to impacts on their setting was undertaken between the 1st October and the 4th of October 2012. Five Scheduled Monuments, one category A listed building and one Conservation Area within the Zone of Theoretical Visibility (ZTV) were examined (Appendix 5). The baseline condition of each accessible monument was recorded, as were key views from each location accompanied by 360˚ photographs.

6.3 Assessment of Marine Geophysical Survey Data

An archaeological review, analysis and assessment of marine geophysical survey data acquired by ESG Ltd. (February 2013) on behalf of DP Marine Energy Ltd has been undertaken (Appendix 6). The specific objectives of this marine geophysical survey assessment were:

- to confirm the presence of previously identified marine sites and to comment on their apparent character;
- to identify, locate and characterise hitherto unrecorded marine sites;
- to review available data in respect of seabed and sub-seabed deposits likely to be of archaeological interest; and
- to present mitigation measures in association with the results of the desk-based study and impact assessment.

Geophysical survey data collected using sidescan sonar and sub bottom profiler was archaeologically reviewed in its 'raw' digital state with appropriate software. Geophysical anomalies were detected, 'tagged' and sample images of each were acquired. The targets were then cross referenced with recorded sites identified in the desk based survey as well as anomalies identified by ESG and assessed as to their archaeological potential. The initial potential of identified targets was gauged using a ranking system (see Table 1 below) as a means of prioritising potential assets in order to inform subsequent interpretation. It must be stressed that the ranking system is only seen as a guide and is not used as a substitute for professional judgment. The position and dimensions of identified targets along with any additional anomalies were recorded into a gazetteer (Appendix 4) and mapped in ArcMap10 GIS (Figure 3). Information on the equipment used, survey parameters and processing software is detailed in Appendix 6.

Table 1: Criteria for Identifying Archaeological Potential of Targets

Potential	Character of anomaly
HIGH	A target that is identified as a known archaeological asset or in the vicinity of such; or a target that is clearly recognisable as a well preserved feature or maritime loss such as a vessel or aircraft (or parts of) and any associated debris.
MEDIUM	A target with data that exhibits characteristics likely to represent the remains of a feature or maritime loss such as a vessel or aircraft including any associated debris; or fragments of the same, but with no supporting verification data.
LOW	An isolated or fragmentary target that is recognised to be of some interest but is likely to be a modern or natural feature.

7 BASELINE ENVIRONMENT

The following section outlines the nature of the existing cultural heritage baseline following all relevant policy and guidance, International and European charters and conventions, UK and Scottish legislation, Scottish national planning policy and all relevant regional and local planning guidance.

7.1 Bathymetry, Geology, Geomorphology & Sedimentology

7.1.1 Bathymetry

The geophysical survey undertaken by ESG in February 2013 established the bathymetry of the seabed within the tidal farm area to be deeper towards the west, with charted depths ranging between 26.8m upon rock outcrops at the east to 49.0m at the sandy western edge (ESG, 2013).

The Holocene sediments across the tidal farm are described as sandy gravel, set amongst large areas of outcropping bedrock dominating the eastern areas of the site. No significant sand formations were observed, and only small isolated boulders provide any features of note across the area.

The Western cable route leads from the rocky outcrops of the turbine site to finer gravelly sands, before outcropping glacial till is encountered at the eastern landfall. Depths for the cable route are greatest to the south of Rinns Point, approximately half way between the turbine site and landfall. This is an area of strong tidal streams at the confluence of the North Channel and Loch Indaal meeting the Atlantic Ocean, and has a maximum recorded depth of 100m below chart datum (*ibid*).

7.1.2 Geology, Geomorphology & Sedimentology

The solid geology of the south west of Islay is characterised by considerable relief, made up of basins and rockheads, with some of the rockheads descending to below 300m LAT. In the offshore area to the south west of Islay there are two main structures below the seabed - the Islay-Donegal Platform to the south west, and the Loch Inchdaal Basin to the south, the latter comprising Mesozoic (Permo-Triassic and Jurassic) sediments. The Islay-Donegal platform is composed principally of Dalradian metasediments of the Southern Highland Group with some tectonised Lewisian gneiss inshore of the Rinns of Islay that regularly outcrop in north western parts of Scotland. Other intrusions are thought to have been shaped in the Tertiary period, between 65 million to 2.6 million years BP, however, their main relief is resultant from the numerous glacial episodes that have occurred since (Sutherland, 1984).

The inner continental shelf beneath the proposed West Islay Tidal Energy Park is made up of a complex mix of Precambrian through to modern Holocene sediments. The bedrock formations vary from old Precambrian crystalline basement to Mesozoic sedimentary rocks in this area of the Scottish Western Isles. Results from the geophysical surveys and research into the study area shows that there is only a thin covering of Quaternary sediments present across the area and generally of less than 50m thickness.

No geotechnical surveys were carried out alongside the geophysical survey by ESG in February 2013, although the areas of rock outcropping are clearly distinguishable from the surrounding sediments in the bathymetric data. It is thought from the surveys that a glacial boulder till underlies the upper sediments to the north west of the exposed bedrock (ESG, 2013), based on the continuous lack of acoustic penetration achieved in the SBP survey across the turbine site.

Table 2: Archaeological and Geological Chronology

Approximate Timespan	British Stages	Archaeological Period
100AD - Present Day	Holocene	Roman; Early Medieval/Medieval; Post-Medieval to Modern
2,500 BP - 100AD		Iron Age
4,500 - 2,500 BP		Bronze Age
6,000 - 4,500 BP		Neolithic
10,000 - 6,000 BP		Mesolithic
11,000 - 10,000 BP	Younger Dryas (Loch Lomond Stadial)	Palaeolithic
13,000 - 11,000 BP	Windermere Interstadial	
22,000 - 13,000 BP	Dimlington Stadial	
70,000 - 22,000 BP	Early/Middle Devensian	
130,000 - 70,000 BP	Ipswichian	
374,000 - 130,000 BP	Wolstonian	
424,000 - 374,000 BP	Hoxnian	
478,000 - 424,000 BP	Anglian	
866,000BP - 478,000 BP	Cromerian Complex	

7.2 Relative Sea Level Change (RSL) and the Potential for Submerged Prehistoric Archaeology and Palaeolandscapes

Paleoenvironmental remains offer the potential to reconstruct former terrestrial landscapes and identify any evidence of human occupation within that landscape. It can also provide information regarding how the area affected by rising RSL and what impact would this have had on any human populations that may have been present. Fluctuating sea-levels throughout the Quaternary era has enabled the potential burial of submerged areas of formerly terrestrial landscapes and associated archaeological remains. Throughout the Quaternary period up to the Devensian glacial maximum (approximately 100,000BP to 10,000 BP) there have been at least six glacial episodes that have resulted in major sea level changes as a consequence of melting ice and glacio- isostatic rebound. Although the sea-level model for Islay is poorly understood with relatively little research, it has been suggested that sea levels could at one point have been c. 120m below the present day level, and may have been c. 20m below the present level 10,000- 5,000 years BP (Wickham-Jones forthcoming). Therefore it is possible that some of the offshore area we are examining to the south west of Islay would have been in the past exposed as dry land, offering us the chance to examine palaeoenvironmental evidence contained in submerged prehistoric landscapes as well as material culture.

Between periods of glaciation exposed landmasses would have provided favourable conditions for humans to exploit coastal and marine resources (Coles, 1998) coinciding with the initial occupation of Britain around 70,000BP and throughout the Lower, Middle and Early Upper Palaeolithic (800,000 BP – 18,000 BP). Sites from this period are rare and limited to tool finds and cave sites. The earliest known settlement from this period in northern Europe has been identified at Happisburgh in East Anglia, where an assemblage of 78 flint artefacts dated to c. 700,000BP were discovered in fluvial gravels and laminated estuarine sands (Parfitt et al., 2010). An array of flint tools and associated faunal remains believed to have been deposited during the Devensian Ice Age (c.100,000BP) were uncovered when an amateur archaeologist identified them in a gravel load that had been taken to the Netherlands during offshore dredging works 13km off the Great Yarmouth coast in Norfolk (Wessex, 2009). Having been removed from context nothing could be learned from the deposits they came from, they do however demonstrate the potential for significant numbers of noteworthy Palaeolithic artefacts to survive and be discovered in offshore submerged contexts. Elsewhere in Britain Palaeolithic cave sites on the Welsh coast are well documented (Lynch et al., 2000), a cluster of which occur at Colwyn Bay including Pontnewyyd Cave where the skeletal remains of at least three individuals were identified. A late Palaeolithic site from coastal England is known at Blackpool (Manley, 1989). To date, no evidence for human occupation during the Lower, Middle or Early Upper Palaeolithic has been identified in Scotland, from a terrestrial or maritime context. Evidence for such may have been eroded away by successive ice sheets or indeed may survive under glacial material, or in caves, rock shelters or palaeochannels, potentially allowing palaeoecological studies and artefact retrieval.

Species of mammal have been recovered from the Scottish North Sea including reindeer, bison, woolly mammoth and woolly rhino (Flemming, 2004), however there is no evidence for the occupation of Scotland during the Late Upper Palaeolithic (18,000 BP – 11,000 BP). A single worked flint recovered from a vibrocore taken in a water depth of 143m near Viking Bank 150km north-east Shetland represents the only artefact from this period in the Scottish North Sea and the earliest accepted date for human occupation follows the Devensian glacial maximum at the beginning of the Mesolithic period (10,000BP). Changes in relative sea level prior to the beginning of the Mesolithic period would again appear to have been complex due to isostatic readjustment of the land surface combined with global sea level rises resulting in flooding and emergence of both seafloor and landmass (Wickham-Jones, forthcoming). Recent investigation and modelling of ice cover suggests that extensive land areas were exposed along the entire coast of the Western Isles around 10,000 years ago (*ibid*.). A few Mesolithic sites occur on Islay at coastal locations (see Section 7.3.2), although with sea levels rising during this period these sites would have occurred further inland than it would appear today. Coastal locations could have been extremely attractive to Mesolithic hunter-gatherer societies, having a large range of resources readily available for exploitation and there is great likelihood of finds relating to the Mesolithic (10,000BP – 6,000BP) and Neolithic (6,000BP – 4,500BP) periods on the shallower parts of the Scottish Shelf (down to c.-45m) in areas where the conditions for site preservation can be met (*ibid*.).

Submerged forests and peats are known throughout the western and northern Isles such as at Clachan Harbour, Raasay (Dawson, 2009), Borve, Benbecula (Ritchie, 1985) and Isle of Coll (Dawson et al., 2001). Recent strategic environmental assessment of the area has suggested that submerged landscapes and associated deposits with palaeoenvironmental potential may occur on a local basis around Islay, in particular where there are low beach and off-shore gradients, topographic shelter and a context of cohesive deposits, such as peat, in which archaeological remains are embedded (Wickham-Jones and Dawson, 2006). In particular, areas falling within the depth range of 4.5 to 10m below sea level may contain submerged archaeological remains of Mesolithic (c. 10,000BP – 4,000BP) or early Neolithic (6,000BP-4,500BP) date. Ulva cave, off the Isle of Mull provides an example of this type in Scottish waters. The cave has a record of human use extending back more than 8000 years, including a shell midden that represents 2–3,000 years of sporadic use of the cave during the Mesolithic and Neolithic (Bonsall, 1996).

The West Islay Tidal Energy Park lies about 6km south west from the coast of Islay and at least some of the surrounding seabed may well have been exposed as dry land a number of times during repeated glacial periods, particularly towards the cable landfall site. The bathymetry has been established across the development area ranging from the intertidal zone down to 100m LAT, with depths of 20m or less potentially exposed in times of human habitation. According to the ESG survey report, the sub bottom profiler data indicates that post-glacial sediments are generally present at the site up to 10m along the western cable route, becoming deeper towards the centre, with sandy gravels, boulders and occasional outcropping of bedrock throughout. The majority of the south western section of the turbine site is outcropping bedrock. The dynamic, high energy, mobile environment in this area of the North Channel would be highly erosive of any relatively soft material, such as peat or submerged topsoil. On this basis the survival of in situ submerged archaeological remains is highly unlikely. However, durable redeposited material, such as lithics, may survive.

7.3 The Potential for Unrecorded Maritime Cultural Heritage Assets

7.3.1 Palaeolithic 800,000-10,000BP

The possible reasons for the dearth of evidence for a Scottish Palaeolithic have been discussed in Section 6.2. With regard to maritime travel during the Palaeolithic, it is possible that simple forms of craft have been used in earliest prehistory, however, no examples of Palaeolithic vessels have ever been discovered. The potential for the presence of maritime archaeological material predating the last (Devensian) glacial maximum is considered to be low.

7.3.2 Mesolithic 10,000-6,000BP

Mesolithic sites can be difficult to locate and identify but are well known from coastal locations and most commonly comprise shell middens, flint scatters and ephemeral settlement sites (Saville, 2004). The earliest known remains of human settlement in Scotland to date have been uncovered at Cramond near Edinburgh where stone tools, debotage and hazelnut shells from what was believed to be a Mesolithic hunting camp overlooking the Forth Estuary have been radiocarbon dated to about 8500 BC (Telford, 2002). Studies investigating the human occupation of Scotland provide evidence that the west coast was populated during the Mesolithic from at least 7500 BC (Hardy & Wickham-Jones, 2004). One of the earliest recorded settlements located in the Western Isles of Scotland was found at Bolsay Farm on Islay where evidence of a structure (possibly a wooden hut) was identified in association with some pits and a stone tool assemblage. Thermoluminescence and radiocarbon dates were found for burnt flint and charcoal ranging from 7.93 ±0.59 thousand years BP to 7.25 ±0.14 thousand years BP respectively (Mithen, 1990). Possible house remains dating to the 7th millennium BC have also been identified at Newton (Wickham-Jones & Dawson, 2006) and and Glean Mor (Mithen et al, 1996). It has been noted that building remains of this period on Islay such as those found at Killellan (Burgess, 1976) and Newton (McCullagh, 1989) indicate that the structures of this period were rough shelters, most likely temporary or seasonal, dug into the sand.

As stated earlier, coastal locations could have been extremely attractive to hunter-gatherer societies in terms of readily-available resources. It has been suggested that as well as the resources of the coastal zone, the relative ease of waterborne transport is likely to have been a factor in the early settlement of the west coast (*ibid*.). Although no Mesolithic vessels have been discovered in the study area, maritime travel is known from the Mediterranean and Aegean. The evidence also suggests that Ireland, which would have been visible from Western Scotland and Islay on a clear day, was already an island by the time it became inhabited c. 7000BC (Breen & Forsythe, 2004). This means the first inhabitants would have had to cross a stretch of open water, a voyage that could have been achieved in a matter of hours in a small rowed or paddled craft with favourable conditions (*ibid*.). The dearth of evidence from the Mesolithic period in the marine zone in the North Channel has been noted, but the isolated discovery of a flint scraper recovered from a borehole core sample on the Viking Bank in the northern North Sea again demonstrates that prehistoric artefacts can survive within submerged landscape contexts and marine environments and illustrates archaeological potential from this period, albeit low.

7.3.3 Neolithic 6,000-4,500BP

Neolithic sites are widely known from coastal locations in Scotland including a large number of examples from the western coastline (Jones, 1996). From the Early Neolithic period there is an evident change in the types of sites with more permanent structures such as standing stones, megalithic tombs and stone circles surviving (Wickham-Jones & Dawson, 2006).

Evidence for maritime travel in the Neolithic is demonstrated through a number of examples of sea-faring vessels recovered from coastal locations throughout the British Isles and Ireland. This includes an example from the east of Ireland where a logboat was recovered under two metres of sand during offshore trenching at a landfall site at Gormanstown, County Meath (Brady, 2002). It was suggested that this example was modified with outriggers to accommodate long distance sea travel (*ibid*.). Trade of goods, common ritual ideas and possible migrations are the other main indications of maritime contact during the Neolithic period. The similarities between ritual monuments such as passage and court tombs at coastal locations in Scotland and Ireland suggest cultural contacts across the Irish Sea (Waddell, 1991). Trade was an important aspect of Neolithic settlements and the use of logboats during this period is highly likely. Crops and domesticated animals are likely to have been brought from Europe by a type of craft, and the major tidal streams of western Britain are known to have formed the main communication routes with continental Europe in prehistory (Wessex, 2006). Particularly of significance to the West Islay Tidal Energy Park, a Neolithic flint axehead was recovered from the seabed during scallop dredging in outer Loch Indaal, about midway between the Mull of Oa and Portnahaven. This axehead now held in the National Museum of Scotland is unpolished, of Irish type, and clearly made of Irish flint. The axe must be seen as indicative of seaborne communication between Scotland and Ireland in the Neolithic (Saville, 2006).

7.3.4 Bronze Age 4,500-2,500BP

Contacts across the North Channel during the Bronze Age are evidenced by the distribution of trade items. The Irish Bowl Tradition (2,300- 1,800BC) present in the archaeological record of northern and eastern Ireland, and south west Scotland includes findspots on Islay (Waddell, 1991). It has been noted that these bowls are concentrated along important trade routes, one of them being the western sea route up the southwest coast of Scotland (*ibid*.). Logboats continued to be utilised in the Bronze Age with the earliest known example in Scotland recovered at Locharbriggs in Drumfriesshire dated to 1,800 BC. More than 150 logboats have been recovered across Scotland (Mowat, 1996) and a number of examples are known from Bronze Age contexts. One example is from the intertidal zone of the Tay estuary near Newburgh, that has been radiocarbon-dated to 1,130-970BC (Strachan, 2004).

Advances in boat building technology during the Bronze Age demonstrates the ability for long distance maritime travel and is best witnessed by the Dover Logboat discovered in September 1992 between Dover and Folkestone. The boat is c. 3,500 years old and was damaged but may have originally measured 18 metres long and 2.4 metres wide, making it capable of crossing the channel and carrying a substantial cargo. The boat was made up of at least six oak timbers strewn together with yew wood, with all the joints reinforced with a thin lath of oak, covering moss pushed into the joint. The two central planks are joined by the use of wedges pushed through a central rail and a series of cleats (Clark, 2002).

No Bronze Age vessels have been discovered to date in Western Scotland, but with the archaeological record displaying common concepts and ideologies resulting from the growth of commerce, and advances in boat building technologies offering the opportunity for long distance travel, there is potential for the discovery of craft and cargo from this period within the study area.

7.3.5 Iron Age & Roman 2,500BP-410AD

This archaeological record indicates that Islay would have had a significant population in the 1st millennium BC. The evidence is best seen in the territorial structures such as brochs and dúnta (forts), examples of which are seen on Islay at Dún Bhoraraic, Rinns Point, An Dún, Dún Athad, Cnoc Eabriic, Dún Bheolain, Beinn A'Chaisteal, Beinn Sholaraidh and Port Ellen. The siting of these structures on promontories overlooking the coastal approaches suggests that as well as being residences they also had a defensive purpose as look out posts to protect against unwelcome seafarers. The archaeological evidence for maritime travel is evident in the common culture and traditions across much of Europe and the British Isles. We know that Wales, Scotland, the Isle of Man and Ireland adopted a Celtic culture at this time and this could not have occurred without maritime travel. The type of craft used for transportation at this time is known to have evolved to that known as the Romano-Celtic type, similar to one discovered in the Severn Estuary (Lawler & Nayling, 1993). However, it is likely that skin covered vessels and dugout canoes of the Bronze Age continued to be used. A gold ornament representing a boat discovered as part of an Iron Age hoard in Co. Derry in Northern Ireland is generally accepted to represent the type of vessel in use at that time. The detail includes a mast and yard arm, 18 miniature oars and rowers benches, a type of rudder or steering oar, a grappling hook and other tools (Rafferty, 2008). According to Rafferty it gives us a unique insight into the type of vessel used for deep sea and ocean travel but the one detail that cannot be discerned is whether the vessel was intended to represent a boat of hide or of timber (*ibid*.).

Archaeological evidence for Roman activity on Islay is sparse. A coin of Alexandria struck in the fourth year of Diocletian (AD 287-8) was found on an island in Finlaggan Loch (Macdonald, 1918) and a brooch also from the third century AD could suggest that trade links had been established. While there is no evidence that Islay was ever subject to Roman military control, there is no question that both military and merchant Roman maritime traffic would have been extensively employed during this period. A chart by Ptolemy from the 2nd century AD with a series of latitude and longitude co-ordinates was reconstructed to depict Britain and Ireland and includes details that could only have come from the observation of sailors. Although no archaeological Roman crafts have been discovered in the North Channel area, it has to be a distinct possibility that evidence of such activity may well survive within the vicinity of the study area.

7.3.6 Early Medieval and Medieval 410AD – 1550AD

The Early Medieval Period witnessed increasing contact between cultural groups throughout the British Isles, particularly between Ireland and Scotland. The evidence suggests that significant numbers crossed the North Channel to Scotland from Ireland, integrated and settled in the Western Isles and Argyll, and established a new kingdom known as Dalriada (Cunliffe, 2001). The chronicle of medieval Irish history, '*Annals of the Four Masters*', refers to an assembled fleet of Dalriada travelling to Coll and Islay in 564 AD. A paddle of this period was discovered at a crannog site in Loch Glashan 12km east of the Sound of Jura, and it is possible that further remains of this type could be found off the coast of Islay. This interaction is embodied in maritime contact, evidence for which is suggested in pictorial graffiti, such as that discovered at the early Christian site on Inchmarnock opposite the Isle of Bute (Lowe, 2008). The depiction of vessels on stones discovered at this site suggests evidence for the variation of maritime boatbuilding traditions associated for this period.

Maritime links assumed renewed importance in the early medieval period, especially in relation to the spread of Christian culture and the written record from this period makes constant reference to journeys undertaken by those involved with the church between Scotland and Ireland, Wales, Cornwall and Brittany. Well documented voyages include those of Colm Cille, who travelled with a group of monks from Northern Ireland to set up a monastery in Iona and Columbanus who travelled to Gaul (Ó Cróinín, 2005). The medieval text '*Navigatio Sancti Brendani Abbatis'* (The Voyage of St Brendan the Abbot) tells how a group of 6th century monks built a leather skinned 'curragh' type boat and set sail west over the ocean. During this period Christianity spread to Islay as is demonstrated by the number of churches and carved stone crosses, a fine example of which is the Kildalton Cross, which has Pictish, Irish, Northumbrian and Celtic influence (Fisher, 2001).

The Irish Sea and North Channel were frequently navigated by Danish and Norse Vikings, who had a major impact on the western seaboard of Britain, the Isle of Man and Ireland. This is evident in both documentary evidence and in the material culture. The *Annals of Ulster* tell us of intermittent raids being carried out by the Norse at monastic sites on the west coast of Scotland at Iona; the east coast of Ireland at Lambeg Island in 795AD; and Northern England at Lindisfarne in 793AD. The Viking longship, with a hull of clinker construction, was a major factor in the success of their raids and voyages. Not only were they were suited to rough seas but also with the ability to navigate shallow estuaries and waterways, through having a shallow draft.

There is little physical evidence for significant Viking settlement on Islay but two 10th century Viking graves were discovered at Ballinaby on the northwest coast of Islay in 1877 (Brown, 1997) . Evidence for Scandinavian influence is also apparent in the place names such as Bolsay (homestead farm), Conisby (King's estate) and Nave Island (holy island). Evidence for significant Viking settlements has been found on Orkney, the Isle of Man, at Portrush in County Antrim and on Rathlin Island off the coast of County Antrim, in close proximity to Islay. As Islay is on the sea route between Scandinavia and these settlements it is likely that encampments of at least a temporary nature were established at coastal locations on the island. These Viking trade and maritime routes were commonplace up until around the 12th Century. However, the Western Isles were not incorporated into feudal Scotland before the 13th century, with Lewis remaining in Norwegian hands until 1266 (Ritchie, 1997).

During the medieval period it was military campaigns, migration and consequent commercial expansion that accounted for much of the sea travel of the time. During this time the English, Spanish and French had significant naval forces and the west coast of Scotland saw the construction of many medieval castles. The importance of ports grew, as did significant populations, prompting an expansion in seaborne trade and commerce. Custom accounts from the 15th century provide evidence of a thriving import and export industry (Rodger, 1997).

The coastline around western Scotland, particularly between the islands, was and still is a very hazardous route. Apart from wind and waves the major hazard for vessels travelling in this area throughout the medieval period was the presence of pirates and vagrants. Trading routes with Europe boomed post- 12th Century onwards and with this the increase in ship building and evolution. The sea between the Isle of Man, Ireland and the North Channel was described in 1322 as being infested with the 'enemies' of the King who were 'intent on plundering merchant ships' (Breen & Forsythe, 2004), illustrating pirate activity.

Larger military and merchant vessels developed during this time including cogs, hulcs and keels, followed by carracks, galleons and balingers, purpose built vessels designed accommodate larger crews and carry bigger cargoes (Breen & Forsythe, 2004). Scandinavian-style highland galleys built in clinker construction were the common feature of north-coast traffic into the 16th and even 17th centuries (Rixson, 1998).

7.3.7 Post- Medieval to Modern, 1550AD-Present

The post-medieval period saw a steady increase in coastal activity where military activity and the expansion of world-wide trade meant further growth in the volume of shipping. After being broken up by the English fleet in the North Sea, the infamous Spanish Armada fleet attempted to return home via the west coast of Scotland and although the exact number is unknown, at least 35 of their ships were lost in the unfamiliar and dangerous waters off the west coast (Breen and Forsythe 2004). One of these ships, the *Castillo Negro*, is believed wrecked in the Rinns of Islay peninsula to the the north of the cable route site. There is the possibility that more of these wrecks lie undiscovered on the seabed.

From the 18th century onwards comprehensive records of ship losses became widespread and from the middle of the 19th century these records became far more comprehensive. This is reflected in the NMRS data collected that shows over 1240 wrecks in the Western Isles area alone. Many of the recorded losses occurred during major storms, including the Great Storm of 1800 and other famous storms in 1852, 1874, 1875 and 1876. So severe were losses due to storms it encouraged the adoption of steam power for cargo vessels and by the end of WWI most of the larger vessels in the area were steam powered. Fishing has also been a significant industry in the area, with the rise of numerous fishing settlements along the Scottish west coast during the 18th and 19th centuries with major increases in the population - driven mainly by the growth of the herring fishing. It is not surprising therefore, that many of the reported losses in this area are of smaller fishing vessels of various designs. It was not until the 20th century that metal hulls came into use in the herring trade and many of the earlier losses of wooden vessels are likely to be highly degraded and difficult to detect.

Islay's prominent coastal location in the North Channel has meant that it has seen numerous shipwrecks over the years, particularly on the western coast where there are strong wind and violent tides (Moir & Crawford, 2004). The Mull of Oa, extending off the southwest Islay coast, and the Mull of Kintyre to the east were two peninsulas often used as directional markers, but given their physical similarities, in poor visibility these land masses could easily be mistaken for each other causing navigational catastrophes. Abundant shipwrecks lie in Islay's western inlets that had become victims of the jagged rocks and rocky outcrops. These wrecks that litter the coastline are often dispersed and broken up and their remains as well as cargo could be carried miles offshore in the strong currents. More often than not these are trawler and steamships carrying rich cargos from and to the island.

7.3.8 Military Remains

A large number of identified shipwrecks and casualties in the seas around Scotland are the result of military activity during WWI and WWII. Initial losses during WWI were caused by the extinguishing of coastal lights which resulted in numerous wrecks concentrated along the shoreline. The North Channel is noted for submarine activity during both world wars. On February 5th, 1918, the American ship the *Tuscania* was torpedoed by a German submarine. In the North Channel en route to Britain with more than 2,000 American soldiers on board. She sank seven miles off the Mull of Oa with the loss of more than 200 lives (Whittaker, 1998). On October 6th the same year, another American troop carrier the *Otranto* collided with another ship and sank in Machir Bay on the west coast of the Islay with over 400 lives lost (*ibid*.). During World War II the *Jacksonville*, a U.S. tanker en route from New York to Loch Ewe, was torpedoed by the German submarine U-482 on August 30th 1944, resulting in the loss of 76.

There is a moderate concentration of offshore aircraft losses along the west coast of Scotland resulting from military operations. The base at Benbecula in the Hebrides has been operational since World War I and throughout the 20th century, and several other air bases are known along the west coast and the islands such as on Tiree, at Machrihanish on the western side of the Kintyre peninsula, and on Islay itself. The first airstrips on Islay were beaches and grass runways. In 1935, Glenegedale Airfield opened on the site of today's airport. Later, during World War II Churchill ordered military airbases to be constructed in the western islands of Scotland to defend against a German assault on the Scottish mainland, and to provide bases for reconnaissance planes to fly missions over the Atlantic Ocean. Glenegedale Airfield was taken over by the Royal Air Force and became known as RAF Port Ellen. One of the RAF's first moves was to build concrete runways from which Avro Anson aircraft of 48 Squadron operated, patrolling the surrounding seas primarily looking for U Boats. Later in the war the base was used by Bristol Beaufighter and Beaufort aircraft of 304 Ferry Training Unit, having at one time 1400 personnel stationed there. Nearby RAF Machrihanish began life in August 1918 as a sub-station of the airship base at Luce Bay. Closing in late 1918, it was rebuilt at the beginning of the WWII, becoming HMS Landrail during 1941. Early in 1945, it became disused but was maintained until December 1951 when it was recommissioned for training (Smith, 1983).

A number of aircraft are known to have been lost off the coast of Islay but the locations are described in the NMRS as arbitrary. Among these are a Fairey Swordfish I, which crashed into the sea 15 miles west of Islay; a Dornier Do.17*,* lost over the North Channel west of Islay on 13th May 1941; a Blackburn Botha I is said to have crashed into the sea off Saligo Bay on the west coast of Islay on 5th June 1942; and a Vickers Wellington lost between Islay and Colonsay on April 1st 1944.

8 RECORDED MARITIME CULTURAL HERITAGE

8.1 Limitations of data

One of the greatest limitations when researching known and potential offshore cultural heritage is the difficulty of locating recorded maritime losses. For many losses the location of the sinking of the vessel can be in the form of a general area description, as in 'Western Isles' or 'off Islay', which is not practically useful for the purpose of accurate assessment, except to show the potential exists to encounter cultural remains. Recorded losses are far more numerous than confirmed wrecks but are usually very poorly located, and as such are useful only to characterise the type of shipwrecks in the area and assess the potential for further discoveries. Wrecks have been located remotely through sonar survey since WWII but this too presents difficulties as many were recorded by older positioning techniques. Commercially available GPS was until relatively recently only accurate to 100m at best (Baird, 2009), whilst the superseded DECCA positioning gave locations accurate to only a kilometre. Another important point about the recorded maritime losses is that they are heavily biased towards 19th and 20th century losses when more comprehensive records of losses began to be compiled by the British Admiralty (later handled specifically by the UKHO).

The details for specific offshore cultural heritage assets are derived from two main sources, the National Monuments Record of Scotland held by the Royal Commission on Ancient and Historic Monuments of Scotland (RCAHMS) and SeaZone Hydrospatial Data (itself largely derived from UK Hydrographic Office data). These databases are both derived in turn from a variety of sources including various published lists of marine losses and marine surveys (e.g. Baird, 2009, and Larn & Larn, 1998). There is consequently a large overlap between the datasets. Wrecksite (http://wrecksite.eu), a website which contains additional open-source material often updated by divers and surveyors was also consulted.

The discussion and tables below covers all UKHO entries within the study area including 'dead' entries. This is due to the fact that while in some cases there may be vessels which have failed to show up on recent geophysical surveys, the locations may still contain remains of cultural heritage interest. In other cases, however, it is clear from the details of the entry that there is no reason to believe that there are now or ever have been archaeological remains. These entries have also been included in the text and illustrations and are discussed on a case by case basis below. Definitions of the state of wrecks and obstructions in the SeaZone database are as follows:

- Live: all wrecks and anomalies found by UKHO survey;
- Dead: not detected by repeated surveys, therefore since considered no longer to exist;
- Lift: a salvaged wreck.

The baseline environment has been sub-divided into the following categories, each of which is addressed individually below:

i. Known wrecks and obstructions from UKHO Database/ Receiver of Wreck and from the RCAHMS.
ii. Maritime sites and losses listed by the RCAHMW.
iii. Sites/ potential sites identified through the assessment of marine geophysical data.

8.2 Sites of Cultural Heritage Interest in the Immediate Study Area

8.2.1 Known Wrecks and Obstructions

The desk based assessment established that there are no Historic Marine Protected Areas, Designated Wrecks or other cultural heritage assets with legal designations within the ISA. Similarly, no known wrecks, obstructions or any other cultural heritage assets have been identified within the ISA.

8.2.2 Maritime sites and losses listed by the RCAHMS

There is one NMRS record from the RCAHMS within the Islay immediate study area (Table 3, Figure 2). The *State Of Florida* is a 19th century steamship that was lost in 1888 in Laggan Bay. The record states that the wreck (or at least its cargo) was reputedly recovered to a great extent so it was not recorded as a maritime 'loss', in the absolute sense of the phrase. The position is vague but the wreck was specifically mentioned to be in Machrie Bay, into which the proposed export cable route passes to its landfall. There is therefore the possibility of this ship's remains or debris associated with the same being encountered.

Table 3: NMRS records in the Immediate Study Area					
HA No.	Name	Description	NMRS No.	Lat./Long. (WGS84)	UTM29N

Table 3: NMRS records in the Immediate Study Area					
HA No.	Name	Description	NMRS No.	Lat./Long. (WGS84)	UTM29N
026	*State of Florida*	19^{th} c. steamer	269610	55^{o} 39.5874’ -6^{o} 16.7118’	671326 E 6171464 N

8.2.3 Sites identified from the Archaeological Assessment of Geophysical Survey data

Geophysical survey data collected by ESG using sidescan sonar, multibeam echosounding, magnetometer survey and sub-bottom profiling was archaeologically reviewed by Headland Archaeology (see Appendix 6 for full details of analysis). A number of anomalies or targets from the dataset have been identified as cultural heritage and potential cultural heritage sites. These are presented below. ESG identified a total of 61 sidescan sonar targets, all described as boulders. No magnetic anomalies were identified in the turbine site or southern cable route.

In total, 25 targets of archaeological potential were identified by Headland Archaeology in the supplied datasets, in accordance with the methodology described in section 6.3:

- One target of high archaeological potential (HA001);
- Four targets of medium archaeological potential (HA002, HA003, HA004, HA005); and,
- 20 targets of low archaeological potential (HA006 to HA025 inclusive).

The targets can be broadly summarised into the following categories:

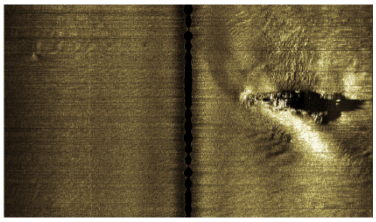
- Wrecks (HA001 – one site);
- Debris/ possible debris/ features (HA002 – HA007 inclusive – 6 sites);
- Linear debris/ features (HA008 – one site); and,
- Object/ possible natural features (HA009 -HA025 inclusive – 17 sites).

Appendix 4 presents a list of all geophysical targets identified by Headland Archaeology during the assessment, and Appendix 6 describes the geophysical analysis in full. The locations of all geophysical targets considered to be of high and medium archaeological potential are depicted on Figure 2 below.

8.2.3.1 Targets of High Archaeological Potential

Headland Archaeology identified one target as being of high archaeological potential, HA001. The wreck is currently uncharted and was not identified by ESG in their survey. The wreck appears to be approximately 80m long by 29m wide and with a height of at least 6m proud from the seabed. It lies in a north/south orientation to the north of the cable route as it passes Rinns of Islay. At its closest, the wreck is approximately 250m from the cable route centreline. The wreck appears fully in the sidescan imagery but only the extreme southern tip is covered by the multibeam data, which was available only in processed 1m resolution. There is a strong magnetic anomaly associated with the wreck, and so is likely to date from the mid/late 19^{th} c. onward in order to have a substantial metal hull structure for a ship of this size. As the wreck appears roughly coherent in its form i.e. not too dispersed, a metal hull is likely, as opposed to a timber one simply with metallic elements within it (e.g. anchors). The measurements stated refer to the general size of the wreck based on sidescan results only, which do not offer accurate geometry.

Table 4: Anomalies with High Archaeological Potential in the Immediate Study Area

HA	Description	Dimensions L x B x H (m)	Position UTM29N (m)	Position WGS84 (Long/Lat)	Image
001	Uncharted wreck	80 x 29 x 6	657052E 6170857N	55°39.4859' -6°30.2127'	

8.2.3.2 Targets of Medium Archaeological Potential

Headland Archaeology identified four targets as being of medium archaeological potential. These all occur in the cable route corridor and appear to be the more significant examples of potential debris. None of these targets refer to any of the listed targets by ESG in their survey. Refer to Appendix 6 for detailed analysis of these features.

Table 5: Anomalies with Medium Archaeological Potential in the Immediate Study Area

HA	Description	Dimensions L x B x H (m)	Position UTM29N (m)	Position WGS84 (Long/Lat)
002	Debris/ possible debris/ feature	13.0 x 10.1 x 6.9	661132E 6171119N	55°39.5467' -6°26.3165'
003	Debris/ possible debris/ feature	3.1 x 1.7 x n/a	656992E 6170639N	55°39.3697' -6°30.2774'
004	Debris/ possible debris/ feature	4.2 x 5.0 x n/a	659770E 6171050N	55°39.5387' -6°27.6162'
005	Debris/ possible debris/ feature	2.2 x 1.0 x 1.0	657477E 6170753N	55°39.4236' -6°29.8114'

8.2.3.3 Anomalies with Low Archaeological Potential

In total, 20 targets that are considered to be of low archaeological potential have been identified within the immediate study area. They have some characteristics of natural features e.g. shape or locality, but have some unusual aspect to their form that stands them out from their surroundings. Appendix 4 lists these sites in full along with descriptions of each of them. These are not considered further in this assessment.

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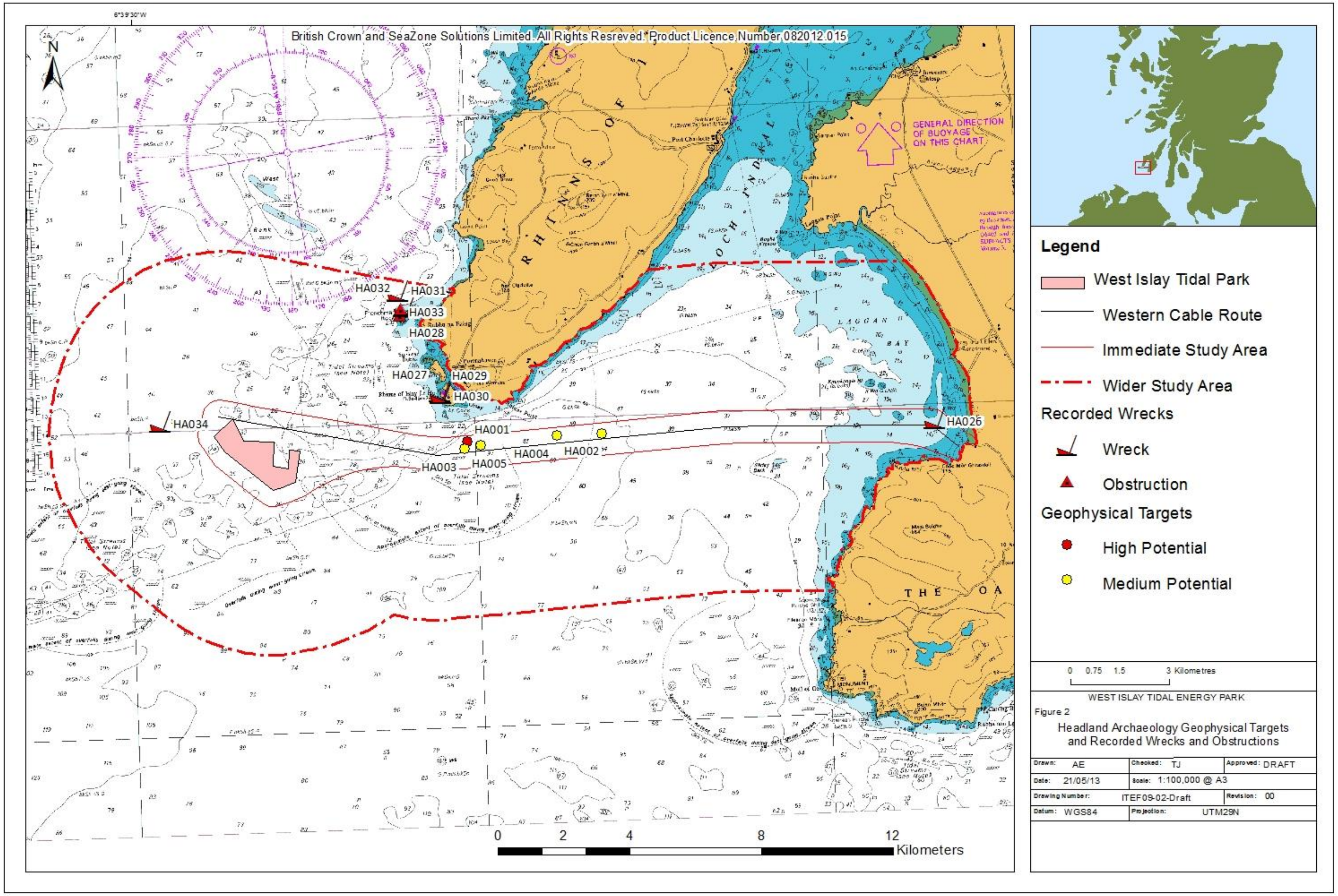


8.2.3.4 Features derived from sub-bottom profile data

The sub-bottom data were recorded on all lines run within the survey site at 100m spacing. From an archaeological point of view, it is important to note that palaeo-topographical features represent both zones of potential human habitation and areas of potential for the survival of evidence of such. The edges of palaeochannels are likely to accumulate fluvial gravels that early humans would regularly exploit and where the remains of tool making activities may reside. More generally, SBP data can sometimes discern buried features within sediments, which is of obvious potential value to archaeological assessment.

The data supplied by ESG did not provide any level of detail on the sub-bottom stratigraphy or features within the survey site, and no raw data images illustrating the rockhead or strata have been provided. ESG describe in their report a layer of glacial till of unknown thickness passing beneath a central band of sandy gravel along the western cable route, with overlaying sediments upon the till varying from 0-10m for much of the route, increasing to 30m in the central deep (100m) section. ESG have recorded the levels of the rockhead at the sandy western side of the turbine site as varying up to over 20m, with the rockhead exposed for much of the south-eastern area of the site/ west end of the western cable route. These findings could not be verified by Headland Archaeology from the data supplied. In the opinion of Headland Archaeology, the upper sediments are either acoustically impenetrable or the SBP data provided to Headland was not the same data as that processed by ESG. No features of any kind, including bedrock levels could be identified in the dataset. Refer to Appendix 6 for further details on the SBP data assessment.

8.2.3.5 Features derived from bathymetric data

The multibeam data has enabled the cross referencing of targets identified in the sidescan sonar and magnetometer datasets to some corroborative degree. It has highlighted clear geological characteristics such as areas of boulder fields, rocky outcropping and ridges, as well as the changing depths across the site. Data was provided as 1m resolution gridded points, so no details of the various small scale targets were able to be gleaned from the bathymetric data alone. However, the majority of the targets identified in the sidescan have some manifestation in the bathymetric data, albeit often as a single data point placed above the seabed, or as an evident scour pit (with the small feature within it missing). Refer to Appendix 6 for further details on MBES data assessment.

8.2.3.6 Magnetometer Data

Magnetometer data was provided by ESG for use of cross-referencing at the sites of observed targets, and for prompting further inspection where anomalies in the magnetic field were recorded. The data was of good quality but the site itself was very noisy for background field readings. Most of the large anomalies noted are from geological features coming into close contact to the sensor, thus obscuring any potentially useful data nearby. With the exception of wreck HA001, none of the targets from the geophysical assessment tallied in with any particular measured magnetic anomaly. Refer to Appendix 6 for further details on magnetometer data assessment.

8.3 Cultural Heritage assets within the Wider Study Area

A wider study area extending 5km from the application area boundary was also examined in order to identify and inform the archaeological potential of the area. The results are presented below.

8.3.1 Known Wrecks and Obstructions

The desk based assessment established that there are no Designated Wrecks or other cultural heritage assets with legal designations within the wider study area. There are six wrecks and two obstructions from the SeaZone data within the Islay Wider Study Area (Figure 2, Table 6). These sites are losses from the 18th, 19th and 20th centuries, one is classed as a dead wreck (UKHO no. 3800) with the remainder classed as live wrecks or obstructions.

Table 6: UKHO records in the Wider Study Area

HA	UKHO	NMRS	Type	Status	Description	Lat/ Long	UTM29N
027	3695	102613	Wreck	Live	*Exmouth*- A sailing ship bound for Canada, wrecked on the southern Rinns of Islay in 1857. Ship was dashed to pieces on the rocks, 3 survived out of 254 aboard. Wreck condition unknown, rough position logged only.	55° 40.3002’ -6° 30.9228’	656254E 6172329N
028	3696	102961	Obst.	Live	*SS Blythville*- Steam cargo ship wrecked on the Rinns of Islay in 1908. Wreckage last observed in 1983 when ship’s bell was recovered. Heavily dispersed debris in rocky gullies only – classed as obstruction only.	55° 41.5998’ -6° 32.0064’	655033E 6174698N
029	3697	116865	Wreck	Live	*Thomas/Tomath*- Brig wrecked on the southern Rinns of Islay en route to Canada in 1870. Had at least two locomotives as deck cargo when lost, at least one is present in this location (observed in 1977).	55° 40.3230’ -6° 30.9642’	656209E 6172378N
030	3799	116865	Wreck	Live	*Thomas/ Tomath (possibly)*- Further wreckage associated with 3697, remains of locomotive engines, observed in 1996.	55° 40.3002’ -6° 30.9228’	656254E 6172329N
031	3800	116252	Wreck	Dead	*Ida Adams*- Steam-powered fishing trawler, ran aground off the Rinns of Islay in 1930 with no loss of life. Amended to ‘dead’ in 2013 as not detected in UKHO survey.	55° 41.9580’ -6° 32.0562’	654954E 6175439N

Table 6: UKHO records in the Wider Study Area							
HA	**UKHO**	**NMRS**	**Type**	**Status**	**Description**	**Lat/ Long**	**UTM29N**
032	3698	102615	Wreck	Live	Remains of a small 18th c. frigate or brig with numerous 9 pounder cannons. Intermingled with at least one other wreck of indeterminate age; protection order was revoked in 1984 after no more wreckage of value deemed remaining.	55° 41.7456′ -6 ° 31.8894′	655145E 6174981N
033	65739	102615	Obst.	Live	Further remains (cannons) believed to relate to 3698. Last recorded in 1975.	55° 41.6958′ -6 ° 31.9896′	655044E 6174885N
034	3797	No record	Wreck	Live	*SS Norman*- Steel steamship which foundered 5 miles west of Orsay lighthouse (Rinns of Islay) in a storm in 1900. Was carrying salt from the US at time of loss.	55° 40.0000′ -6 ° 39.0552′	647751E 6171476N

The *SS Norman* is described as lost at an offshore location some distance away from any known terrestrial features. The noted position itself appears to one rounded to the nearest minute – a suggested accuracy of 1,900m in real terms. The wreck does bear similarities in its dimensions to the geophysical target HA001, but the position of this target does not relate to the account of ship's position of loss (1,500 m south of Orsay lighthouse as opposed to 5 miles west of it in the records). However, the *SS Norman* is still the closest wreck of appropriate scale to HA001. Figure 3 shows the original ship's plans, from the Falkirk Community Trust Archives, which may prove useful to consult should the observed wreck be inspected any further as part of the ongoing works.

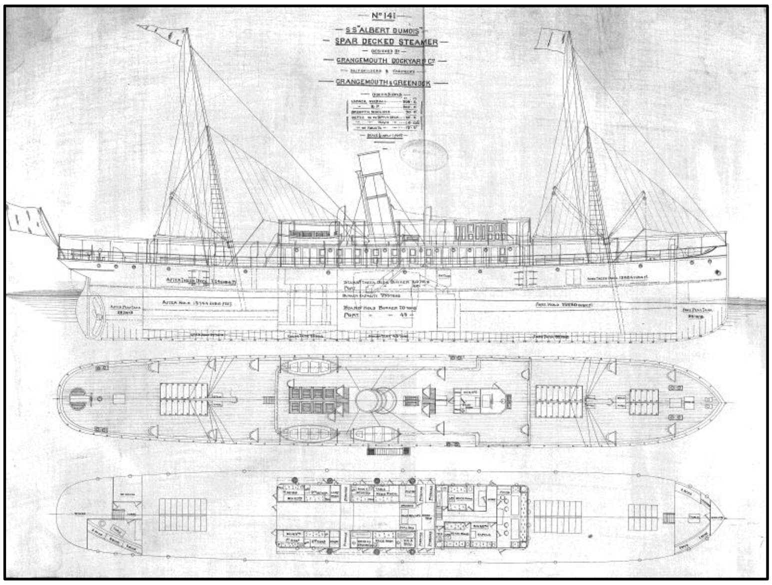


Figure 3. Construction drawings for the *SS Norman* (built as the *SS Albert Dumois*) at Grangemouth, 1891 (courtesy of Falkirk community Trust Archives).

8.3.2 Maritime sites and losses listed by the RCAHMS

In addition to the UKHO SeaZone data, 31 sites are recorded in the NMRS data as being located in the wider study area (in addition to those in the Inner Study Area). These consist of one 16th century wreck; one 18th century wreck; 14 losses from the 19th century; eight losses from the 20th century including two from World War 2; three aircraft from Worl War 2; one aircraft from the 1970's. One record listed in Table 7 is an offshore findspot, referring to the Neolithic axehead found just south of the proposed cable route; while the remaining three sites are unknown losses. The coordinates associated with these sites are arbitrary and tentative, often derived from historical accounts and approximations with the principle purpose of highlighting these records being to demonstrate the variety and distribution of wrecks recorded as lost within the wider study area, therefore informing the archaeological potential. For all of the UKHO SeaZone data described in section 8.3.1, corresponding records exist in the NMRS archive (not repeated in Table 7 below).

Table 7: NMRS records in the Wider Study Area

NMRS No.	Type	Name	Description
119164	Steam trawler	*Anida*	Steam trawler wrecked on the rocks at Orsay Island (Rinns of Islay) in 1924. Reported loss only.
125146	Ketch	*Eliza Charlotte*	Timber vessel carrying coal, ran aground off Orsay Island (Rinns of Islay). Reported intact during dives in the 1990s.
125147	Brig	*Robert*	Unknown details, loss reported on Rinns of Islay in the 19th century. Mentioned in diving literature. Likely to be a repeated record of NMRS 262351.
220711	Steamship	*Narwhal*	19th c. cargo ship carrying ballast only, stranded on 'Ruer Vore', thought to be Rubha More at south extremity of Laggan Bay. Reported loss only.
220659	Barque	*Ella*	Stranded at Glen Astle in 1893, cargo of coal. Reported loss only.
262351	Brigantine	*Robert*	Stranded at Portnahaven, in 1872, carrying ballast only. Reported as total wreck at the time. Likely to be a repeated record of NMRS 125147.
271844	Brig	*Friendship*	Ran aground at Kintra in 1824. Intact upon the rocks at time of reporting and likely to have been salvaged (no specified cargo).
282246	Craft	*John and Eliza*	Small timber boat, sank intact in 1848 off Orsay Island after losing rudder. Reported loss only.
286239	Schooner	*Panuco*	Foundered off Rinns of Islay with a cargo of slates. Reported loss only.
297971	Craft	*St Columba*	Wreckage washed ashore (with vessel's name on some of it), found in 1868 on Laggan Strand, from an unreported loss.

Table 7: NMRS records in the Wider Study Area			
NMRS No.	**Type**	**Name**	**Description**
302762	Galleon	*Castillo Negro*	Reputed Spanish Armada wreck (1588) from local folklore, said to have been lost on 'the French Rocks' on the Rinns of Islay. Possibly confused with the (more modern) cannons found in UKHO records 3698 and 65739.
302774	Warship	*Oise*	Wreck of French privateer from local folklore only, upon the subsequently called French Rocks. Possibly relates to the cannons found in UKHO records 3698 and 65739.
117099	Craft	*Sir Colin*	Recorded loss of wooden brigantine carrying ballast only, lost in 1870 in the north of Lossit Bay. Positioning is imprecise and wreckage may be encountered within the WSA.
286426	Craft	*Harpswell* (possibly)	Lifebuoy and other debris found washed ashore, 1869. May refer to a vessel from New York, no other details known. Recorded position is imprecise and further related wreckage could be encountered in the WSA.
103036	Tanker	*Jacksonville*	151m tanker carrying petrol and motor spirit, sunk by U-Boat in 1944. Wreck position was recorded in 1945 outside the WSA but subsequent surveys have not located the wreck. Unconfirmed reports from diving community place the wreck nearer inshore to Islay.
302525	Craft	Unknown	Wreckage (possibly just lost deck cargo) found washed ashore at Rockside Farm. May relate to a vessel lost within the WSA.
102618	Obstruct-ion	Unknown	Reported sinking of a vessel in November 1944. No other records known about the vessel. Subsequent naval surveys failed to locate the wreck. Approximate position given only.
116878	Ship	*Forest Chief*	Vessel stranded on west coast in 1872 – cargo of corn subsequently salvaged. Reports refer to Kilchoman Bay but related wreckage may be found in the WSA.
302489	Craft(s)	Unknown	Reports of two coasters lost off Coul Rock, West Islay, 1868. Imprecise position of loss.
302584	Barque	*Ocean*	Wreck of small iron-hulled vessel, carrying ballast only, in 1911. Reported location refers to a bay no longer known on charts, is thought to be somewhere on the west of Islay.
116864	Barque	*Ocean*	Additional wreckage/ location of loss associated with the *Ocean*, record number 302584.

Table 7: NMRS records in the Wider Study Area			
NMRS No.	**Type**	**Name**	**Description**
286243	Ship	Unknown	Wreckage associated with large sailing ship found ashore in 1862 at Kilchiaran. Recorded position is outside the WSA but possible that other wreckage may be found within it.
102962	Steamship	*Dalton*	Wreck of 95m iron steamship from 1895 carrying grain, oil and wood, stranded at a reef at Kilchiaran. Recorded position is likely to be inaccurate, and no surveys have been able to reach the (shallow) location to confirm the wreck's presence.
116877	Tug	*Flying Falcon*	Wreck through diving literature only – no details known. Recorded position is outside the WSA but likely to be inaccurate.
102616	Steamship	*Tobago*	57m Latvian cargo ship carrying fish, wrecked on the rocks in Lossit Bay in 1940. Salvaged in 1955. Recorded as just outside the WSA, though unreliably.
265452	Craft	*Lephenstrath*	Wreckage described as coming from a ship of this name found washed ashore at Tormisdale, 1875. Outside the WSA but associated wreckage may be found within.
102575	Steamship	*Agate*	Steel steamship carrying coal reportedly wrecked off Tormisdale in 1940. Diving literature places this outside the nearby WSA but the wreck has not been confirmed by surveys in that position.
115654	Steamship	*Agios Minas*	98m Liberian freighter carrying timber, wrecked on the rocks on the west of the Rinns of Islay in 1968. Believed mostly salvaged. UKHO record for this places accurate position of reported loss just outside the WSA, however associated wreckage may be encountered within it.
301326	Aircraft	Fairey Swordfish I, *W5916*	British torpedo bomber reported lost off the west of Islay, 1943. No known location of wreck.
301327	Aircraft	Dornier 17	German bomber reported shot down over the North Channel in 1941. No identity or precise location known.
301360	Aircraft	Brequet Atlantique SP-13A, *MLD253*	Dutch military aircraft lost in 1978. No known casualties or details. Thought to be lost off NW of Islay, wreck not found and no further details known.
302420	Aircraft	Blackburn Botha I, *L6276*	British bomber lost in 1942, reportedly crashed into the sea off Saligo Bay, west Islay. No wreckage found or further details known.

Table 7: NMRS records in the Wider Study Area			
NMRS No.	**Type**	**Name**	**Description**
288487	Flint Axehead	n/a	This Neolithic flint axehead was recovered from the seabed in outer Loch Indaal, during scallop dredging about midway between the Mull of Oa and Portnahaven. It is unpolished, of Irish type, and clearly made of Irish flint. The axehead is complete and in excellent condition, except for very minor modern edge damage. It has acquired a dense brown staining on the seabed, and one surface has retained varied traces of marine life'. (Saville, 2006).

The majority of these wrecks have been assigned arbitrary or tentative locations, but for those tied to an existing physical landmark, for example those described as wrecked upon the rocks of the Rinns of Islay, it can be assumed that their cited place of loss are not too inaccurately placed. Nonetheless, the remains of such losses are likely to be highly dispersed and fragmented due to the volatile marine environment here that would have contributed to their foundering.

8.4 Cultural Heritage Onshore Key Receptors

The potential for the proposed development to have operational impacts on the setting of designated on-shore cultural heritage assets has been considered. A number of designated assets lie within the preliminary zone of theoretical visibility (ZTV) of the proposed offshore tidal farm. The ZTV has been calculated on a tidal energy convertor (TEC) height of 16m above mean sea level, equivalent to 21m above Lowest Astronomical Tide (LAT) and is based on a 15km radius Study Area, the extent of which is shown on Figure 4 below. The calculations are based on the 'bare earth' model of the landform and do not allow for any effects of screening from obstacles such as buildings and vegetation. The landform data was taken from Ordnance Survey Profile 10m digital terrain model - gridded height data at 10m intervals. The visibility maps are calculated for a viewer's eye height of 2m above ground height to the top of the Tidal Energy Converters (TEC) using a calculation grid size of 20m (Chapter 15: Landscape & Visual Assessment).

8.4.1 15km Study Area

Within the 15km study area there are five Scheduled Monuments, one category A listed building (HB11944, Rinns of Islay Lighthouse) and one Conservation Area within the Zone of Theoretical Visibility (ZTV).

Table 11. Assets Assessed for Setting Impacts		
Ref No	**Name**	**Designation**
SM2334	Tobar an-t Sagairt,chapel,Tockmal	Scheduled Monument
SM2337	Kilchoman Church, Cill Chomain Cross and tombstones	Scheduled Monument
SM3814	Cultoon stone circle	Scheduled Monument
SM2367	Eathain,chapel 370m NE of Lower Killeyan	Scheduled Monument

Table 11. Assets Assessed for Setting Impacts		
Ref No	**Name**	**Designation**
SM2315	Orsay Island, Chapel	Scheduled Monument
HB11944	Rinns of Islay Lighthouse	Category A Listed Building
C488	Portnahaven / Port Wemyss	Conservation Area

SM2334 Tobar an-t Sagairt, chapel Scheduled Monument

This chapel is located on the left bank of the Kilbride River c.250 m southeast of Kilbride farmhouse. The remains of St Bride's Chapel measuring 30ft by 12ft within walls standing to a maximum height of 3ft. The entrance appears to have been in the south, and one or two heavy blocks of stone lie within the building, which is dry built. There are traces of an enclosure. A cross marked slab which formerly stood 11ft east of the ruin. It is 2ft 3ins long; the cross, in relief within a ring, is equal armed; and the affinities appear to be with 7th to 9th century Wales.

The contextual value of these assets lies in their representativeness of a medieval carved cross slab. The original church to which cross marked slab were related is no longer standing and while these stones have been clearly located here as it is a burial ground there is no clear relationship between the chapel or the cross marked slab and the wider landscape. The associative value of the cross marked slab is in its aesthetic attributes in that it is an art piece with historical, cultural and social influences related to the carvings and the evidence they provide for communication of styles from the 7- 9th centuries.

All of the devices within the proposed tidal energy park will be visible from this site at a distance of 18.4 km to the west.

SM2337 Kilchoman Church, Cill Chomain Cross and tombstones Scheduled Monument

This scheduled monument relates to the Cill Chomain Cross and the other carved stones situated in the burial ground of Kilchoman Church. The upstanding Church is not included within the scheduled area. Cill Chomain Cross is a free standing stone cross which stands in its original socket stone in the south east corner of the burial ground. This cross dates to the 14th to 15th century and its design is of the Iona School. There are approximately 20 further medieval carved grave slabs or fragments of grave slabs and carved stones within the churchyard to the south of the church also largely dating from the 14th -15th centuries.

The intrinsic value of this asset lies in the information the stone carvings may yet give to the researcher of medieval carvings. The contextual value of these assets lies in their relative rarity and their representativeness of medieval carved stones of the Inner Hebrides. The original church to which these stones were related is no longer standing and while these stones have been clearly located here as it is a burial ground there is no clear relationship between these stones and the wider landscape. The associative value of these stones is in their aesthetic attributes in that they are attractively carved pieces of art. It also lies in the historical, cultural and social influences related to this carvings and the evidence they provide for communication of styles from the Iona School during the 14th – 15th centuries.

All of the devices within the proposed tidal energy park will be visible from this site at a distance of 16.4 km to the south.

SM3814 Cultoon stone circle

Cultoon stone circle is the scheduled remains of a stone circle comprising of two standing stones and 12 prostrate stones. This stone circle was excavated in the 1970s and it appears that this stone circle was never completed but rather abandoned mid construction (MacKie 1976). This incomplete stone circle lies in an area of relatively upland rough pasture. It has been noted that looking south from this stone circle the mountain of Slieve Snaght, Donegal, Ireland is visible under good weather conditions and it is suggested that the view from these stones aligns with this mountain at the winter solstice. (McGregor K http://www.islayinfo.com/islay-cultoon-stone-circle-ballynaby-standing-stones.html).

Cultoon stone circle remains some intrinsic value as it was not fully excavated in the 1970s and therefore may still have the potential to reveal information on the ritual and architectural activities of the early prehistoric. This intrinsic value will be diminished by the level of previous excavations at this site. Cultoon stone circle has contextual value in its relationship with the surrounding landscape. That this circle was never completed somewhat reduces this value. However this asset appears to have been located for its relatively high moorland location and the views this afforded. If MacKie's theory is to believed the most significant of these views is that to the south west towards Ireland and in particular Slieve Snaght mountain. The surviving upstanding stones have limited associative value due to the aesthetic appeal of standing stones.

All of the devices will be visible from the site located 10.8 km away looking southwest.

SM2357 Cill Eathain, chapel Scheduled Monument

The ruin of the grass-covered remains of an alleged medieval chapel and burial ground situated on a level stance on the south bank of the Abhainn Ghil. They comprise a rectangular structure 6.5m north-south by 5.0m over walling spread to 1.5m and surviving to a height of 0.4m within a sub-circular enclosure 20.0m across. The enclosure wall is 2.0m wide and up to 0.7m high on all but the north quadrant where there is a scarp 1.7m high. This chapel, which was evidently dedicated to St John (Watson 1926) is situated on a natural terrace some 30m S of the Abhainn Ghil, about 500m E of that stream's outfall into Loch Indaal and 360m NE of Lower Killeyan farmhouse. The monument has little left standing on the ground and is very overgrown with a few surface stones visible on the ground surface. The views to the north, east, south and west are of low lying cultivated fields with little relief. The intrinsic value of this asset lies in its fabric and the potential information this contains on architectural and ecclesiastical practices in the medieval period.

All of the devices within the proposed tidal energy park will be visible from this site at a distance of 17.4 km to the west.

SM2315 Orsay Island, chapel Scheduled Monument

Scheduled monument Orsay Island Chapel is situated on Orsay Island off the south westerly point of Islay. The monument is within a walled enclosure which was formerly a burial ground and situated to

the west of Port an Eilein. The chapel is inaccessible to visitors apart from by boat. Partial remains of the chapel are visible from Islay mainland at the most south westerly edge of the island from Port Wemyss. The scheduled monument the Orsay Island Chapel is the remains of a medieval chapel within a walled enclosure it is located on a flat topped promontory at the north end of the small island of Orsay of the south coast of Islay.
The intrinsic value of this chapel lies in its fabric and the information it and the surrounding burial ground may contain on this medieval chapel and whether it has earlier origins as has been suggested by the presence of a 8-9th century cross slab found on the island. The contextual value of this monument is seen in its clear relationship with its island setting. That this chapel was located not on the larger island of Islay but on this neighboring small island would have been a deliberate choice to separate the chapel from the more populated and accessible island of Islay. Located at the north west corner of this island the main view from this chapel would have been northwards over the narrow Sound to Islay. Likewise the key view of this chapel would have been from Islay looking south to the island. The associative value of this monument is found in its aesthetic attributes and that it is a relatively attractive ruin.

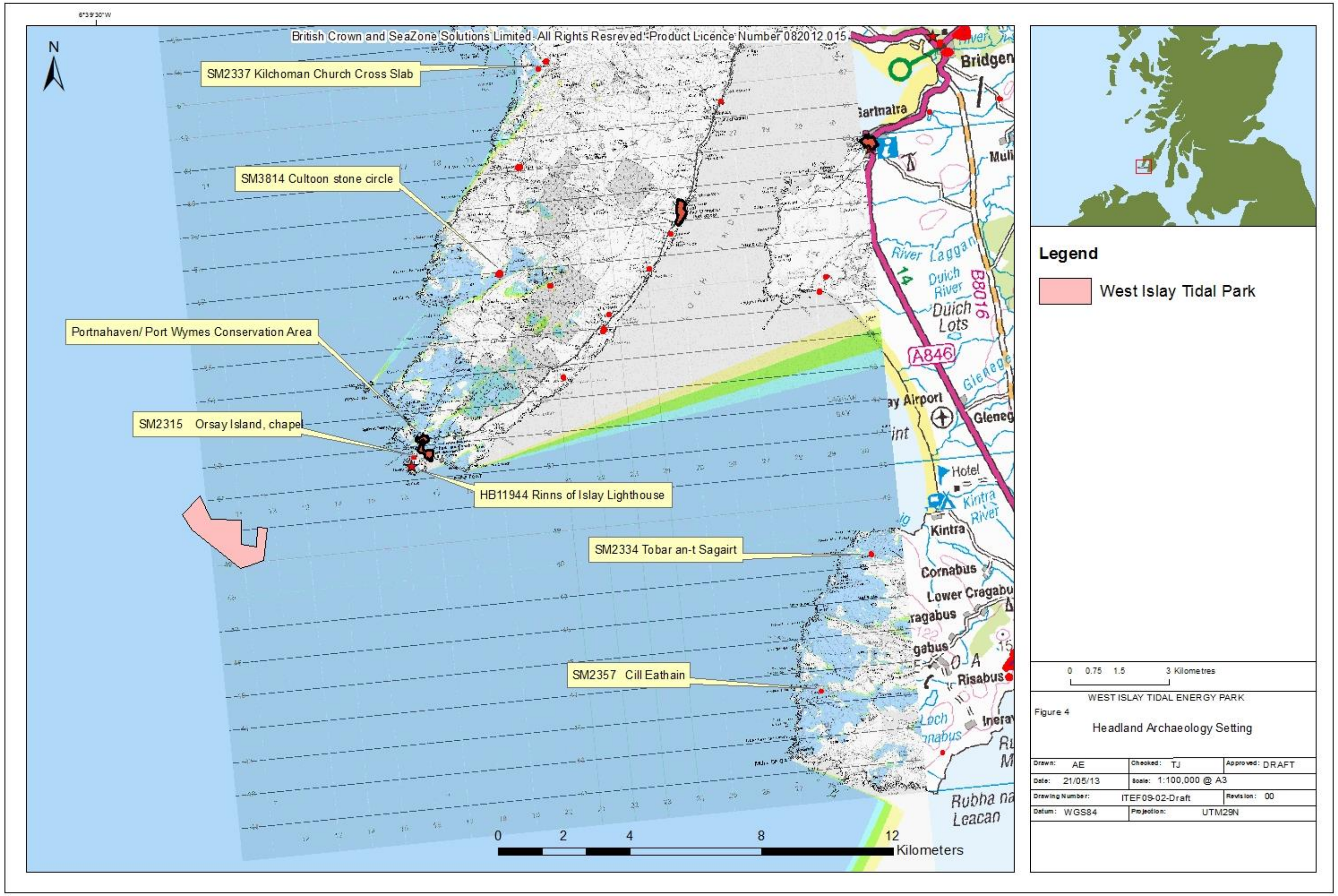
All of the devices will be visible from the chapel on Orsay Island being located 4.995 km away looking southwest.

HB11944 Rinns of Islay Lighthouse

The category A listed building the Rhinns of Islay Lighthouse is a well preserved and still operational lighthouse. It was completed in by Robert Stevenson and was a fine example of his ability to set the lights to different intervals to allow seafarers to distinguish between the different lighthouses. This lighthouse was automated in 1998.

The Rhinns of Islay Lighthouse was built on the small island of Orsay close to the south coast of Islay. From this location there are wide views over the surrounding seascape with along the coast of Islay and south to the northern coasts of Northern Ireland. This Lighthouse was built as a purely functional structure. It was designed to ensure that ships avoided the south west coast of Islay and were safely guided into Loch Indaal or Portnahaven and Port Wemyss. Its intrinsic value lies in its technological importance and is potential as a data source on the architecture of the early 19th century lighthouses. It has contextual value through its direct relationship with the Stevenson family and hence the development of Scottish Lighthouses. It has further contextual value in its clear relationship with its surroundings, this lighthouse was clearly positioned to see and be seen by seafarers. It also has aesthetic value as a prominent landmark, located on a small island particularly in the views south from Port Wemyss.

All of the devices will be visible at a distance of 4.85 km looking southwest from Rinns of Islay Lighthouse.


British Crown and SeaZone Solutions Limited. All Rights Resreved. Product Licence Number 082012.015
SM2337 Kilchoman Church Cross Slab
SM3814 Cultoon stone circle
Portnahaven/ Port Wymes Conservation Area
SM2315 Orsay Island, chapel
HB11944 Rinns of Islay Lighthouse
SM2334 Tobar an-t Sagairt
SM2357 Cill Eathain
0 2 4 8 12 Kilometers
Legend
West Islay Tidal Park
WEST ISLAY TIDAL ENERGY PARK
Figure 4
Headland Archaeology Setting
Drawn: AE
Checked: TJ
Approved: DRAFT
Date: 21/05/13
Scale: 1:100,000 @ A3
Drawing Number: ITEF09-02-Draft
Revision: 00
Datum: WGS84
Projection: UTM29N

9 CONCLUSIONS

The assessment established that there are no proposed Historic Marine Protected Areas, Designated Wrecks or other cultural heritage assets with legal designations within the study areas. The report identified one recorded wreck site from the NMRS dataset within the Immediate Study Area, although the survival of this wreck at this recorded location is somewhat doubtful, assumed salvaged or totally dispersed.

The archaeological assessment of geophysical survey data identified one unknown wreck located within the Immediate Study Area to the north of the proposed western cable route as it passes Rinns of Islay. The identity of this uncharted wreck is unknown, as is the associated sensitivity of the site to potential impacts. Based on its hull construction and condition, the vessel is likely to be a wreck dating from at least the 19th century. Four other geophysical anomalies considered to be of medium archaeological potential and of possible archaeological interest were identified in the geophysical dataset, with a further 20 targets of low archaeological potential identified as natural features and modern debris.

The geo-archaeological assessment has not established whether there is palaeo-environmental potential within the Immediate Study Area. The sub-bottom profile data supplied is inconclusive in determining the presence of palaeochannels or deposits that may be associated with former terrestrial landscapes, and no core samples have been provided for assessment. It is thought that the now-submerged landscapes of Islay with potential for human activity could only be in depths currently charted of 20m or less. Therefore the highest potential of uncovering formally terrestrial remains exists within the inshore section of the cable route and particularly within the intertidal area. .

Overall it is considered that there is moderate to low potential for the discovery of further unexpected cultural heritage remains within the ISA. There is strong evidence of vessels having sailed these particular waters since the Neolithic age as the findspot of an Irish flint Neolithic stone axe testifies. The volume of maritime traffic historically within the North Channel and the Clyde approach is noted, and the unpredictable weather and sea state conditions in this area of the North Channel is reflected in the large number of documented maritime losses recorded in the National Monument Record of Scotland, many of which with unknown exact locations Further, this area is noted for wartime activity with aircraft also operating in this area of the North Channel. However, the proposed tidal energy park and the majority of the western cable route has been informed by a geophysical survey and the seabed conditions within the tidal farm site and across the export cable route site is well understood, and there is strong confidence that all sizeable wreck debris within the geophysical survey area has so far been identified and a low likelihood of more being uncovered. To the central and southern areas of the tidal energy park where the turbines are proposed and the bedrock is often exposed, there is considered to be low archaeological potential. In the north-western area of the site where significant depths of finer gravelly sands that could conceal sites or deposits of archaeological interest are recorded there is considered to be moderate archaeological potential. Similarly, inshore along the export cable route on the approach to and within the intertidal area, there is considered to be moderate potential.

The assessment of key onshore receptors has identified five Scheduled Monuments, one category A listed building and one Conservation Area within the Zone of Theoretical Visibility (ZTV). These have been examined in detail for potential impacts on their setting.

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Designated wreck data was downloaded from Historic Scotland's website © Historic Scotland

Offshore Sites and Monuments Record information derived from NMRS data (dated 15/02/2011) © Crown Copyright RCAHMS

Wrecks and Obstructions information derived from SeaZone data © Copyright UKHO- Licence# 082012.015

APPENDIX 1 - Legislative framework and guidance.

Marine (Scotland) Act 2010

The Marine Scotland Act 2010 contains a new power which allows Scottish Ministers to designate Marine Protected Areas (MPAs). This provides greater flexibility for Ministers to use area-based measures to conserve marine biodiversity as well as nationally important historic assets such as historic shipwrecks. The new power broadens the scope of what types of historic asset can be protected if they are of national importance and allows Scottish Ministers to target protection and management according to the preservation objectives of each Historic MPA.

Protection of Wrecks Act (PWA) 1973

The Protection of Wrecks Act 1973 enables the Secretary of State to protect wreck sites from unauthorized interference if they are of historic, archaeological or artistic importance. Under the Act it is an offence to carry out certain activities in a defined area surrounding the site, unless a license for those activities has been obtained from the Government. Section One of the PWA is administered by Historic Scotland (HS) in Scottish territorial waters. This Act also provides protection for wrecks that are designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck (ROW). It is possible that a dangerous wreck designated under this section might also be of archaeological or historic interest.

The Protection of Military Remains Act 1986

Under the Protection of Military Remains Act 1986 the Ministry of Defence has powers to protect vessels that were in military service when they were wrecked. The MOD can designate named vessels as Protected Places even if the position of the wreck is not known. In addition, the MOD can designate Controlled Sites around wrecks whose position is known. In the case of Protected Places, the vessel must have been lost after the 4th August 1914, whereas in the case of a wreck protected as Controlled Sites, no more than 200 years must have elapsed since loss (MOD 2001).It is an offence to tamper with, damage, move or remove sensitive remains. However, diving, salvage and excavation are all prohibited on Controlled Sites, although licences for restricted activities can be sought from the MOD. Additionally, it is an offence to carry out unauthorized excavations for the purpose of discovering whether any place in UK waters contains remains of a vessel which has crashed, sunk or been stranded while in military service. It is worth noting that under the Protection of Military Remains Act 1986, all aircraft that have crashed in military service automatically constitute a Protected Place.

Ancient Monuments and Archaeological Areas Act (AMAAA)1979

The main legislation concerning archaeological remains in the UK is the Ancient Monuments and Archaeological Areas Act (AMAAA) 1979. This Act primarily deals with land sites but there is provision to designate sites of vessels in territorial waters as Scheduled Monuments. Monuments are defined by the AMAAA 1979 as including buildings, structures, works, caves, excavations, vehicles, vessels, aircraft or other movable structures. Monuments can only be scheduled if they are of national importance. Section 53extends the AMAAA 1979 to monuments situated in, on or under the seabed within UK territorial waters. Once a monument has been scheduled, visiting or diving on the site is not necessarily restricted. It is, however, an offence to demolish, destroy, alter or repair the monument without prior authorisation, in the form of Scheduled Monument Consent.

Merchant Shipping Act (MSA) 1995

The Merchant Shipping Act 1995 (MSA 1995) is used to regulate the reporting and disposal of wreck, including wreck of archaeological interest found or recovered from UK waters, or found or recovered outside UK waters but brought within those waters. Within the context of the MSA 1995, wreck refers to flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ships, aircraft and hovercraft, parts of these, their cargo and equipment. All wreck that is found or taken into possession must be notified to the Receiver of Wreck by the finder. The wreck is then delivered to the Receiver, or, more commonly, held by the finder to the order of the Receiver. The ownership and disposal of wreck is decided according to procedures contained within the MSA 1995. Provision is made for original owners to come forward to claim their property. Ownership of unclaimed wreck from within territorial waters lies with the Crown or in a person to whom rights of wreck have previously been granted by the Crown. The Receiver has a duty to ensure that finders who report their finds as required receive an appropriate salvage payment. In the case of material considered to be of historic or archaeological importance, a suitable museum is asked to buy the material at the current valuation and the finder receives the net proceeds of the sale as a salvage payment. If the right to, or the amount of salvage cannot be agreed, either between owner and finder or between competing salvors, the Receiver will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

Historic Scotland's Marine Heritage Strategy 2012-15

In April 2012, Historic Scotland published a Strategy for the protection, management and promotion of marine heritage 2012-15 setting out priorities for protecting, managing and promoting Scotland's outstanding marine heritage under the new marine legislation (Marine Scotland Act 2010), in accordance with the following strategic aims: helping to advance knowledge about marine heritage and make information widely available; improving stewardship of key marine heritage sites; and developing wider understanding and enjoyment of marine heritage.

Code of Practice for Seabed Development produced by The Joint Nautical Archaeology Policy Committee (2008)

Produced by The Joint Nautical Archaeology Policy Committee, this document sets out a best practice model for seabed development in the UK, both within and beyond the remit of the formal Environmental Impact Assessment process.

The Valletta Convention

Ratified by the UK in 2000 and brought into force in 2001, bounds Scotland to implement protective measures for archaeological heritage within the jurisdiction, including sea areas. Insofar as the state exerts jurisdiction over the Continental Shelf, then it would appear that the provisions of the Valletta Convention apply to those jurisdictions.

The International Council on Monuments and Sites *(ICOMOS)*

The International Council on Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage 1996 (the Sofia Charter) includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all'. The UK is a member of ICOMOS.

*United Nations Education Scientific and Cultural Organisation (UNESCO) Convention on the Protection of the Underwater Cultural Heritage (2001)*The UNESCO Convention 2001 is a comprehensive attempt to codify the law internationally in respect of the underwater archaeological heritage. Although the UK abstained in the vote on the final draft of the Convention, it has stated that it supports most of the articles, particularly the provisions in the Annex governing the conduct of archaeological investigations.

United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS 1982 was ratified the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. Article 303 also provides for coastal states to exert a degree of control over the archaeological heritage to 24 nautical miles, though no measures have been introduced to implement this right.

Scottish Planning Policy (SPP)

The Scottish Government's planning policy in relation to Cultural Heritage is set out in paragraphs 110-114 of Scottish Planning Policy (SPP) (February 2010), which is supported by the Scottish Historic Environment Policy (SHEP) (December 2011). Further guidance is given in the form of the Managing Change in the Historic Environment series (2010) from Historic Scotland and PAN2/2011 Planning and Archaeology (July 2011). The underlying aim of these policies and guidance documents is to manage development in such a way that the special character and values of the historic environment are preserved. The SPP provides guidance for the protection of the historic environment within the context of the planning system. It requires planning authorities to take into account the planning policy and guidance regarding the historic environment when determining planning applications and developers to do likewise formulating development proposals. The SPP states that, in most cases, the historic environment can accommodate change that is sensitively managed without the loss of its special character, but in some instances this may not be possible. Where this is the case, planning decisions should be based on a clear understanding of the importance of the heritage asset.

Listed Buildings and Conservation Areas (Scotland) Act 1997

Listed Buildings are defined as buildings of special architectural or historic interest in the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 (as amended). The Act states that "the planning authority, in determining any application for planning permission for development that affects a listed building or its setting, is required to have special regard to the desirability of preserving the building, or its setting, or any features of special architectural or historic interest which it possesses." (Section 59(1))

Argyll and Bute Local Plan

Within the Argyll and Bute Local Plan (adopted 6th August 2009) there are a number of policies within Chapter 3 'Environment' which are relevant to this development. These include Policy LP ENV 13a (Development Impact on Listed Buildings), Policy LP ENV 16 (Development Impact on Scheduled Ancient Monuments) and Policy LP ENV 17 (Development Impact on Sites of Archaeological Importance).

Policy LP ENV 13a Listed Buildings states:

"Development affecting a listed building or its setting shall preserve the building or its setting, and any features of special architectural or historic interest that it possesses."

Policy LP ENV 16 Scheduled Ancient Monuments states:

"Where development would affect adversely a heritage asset or its setting the developer will be expected to satisfactorily demonstrate that the impact of the development upon that asset has been assessed and that measures will be taken to preserve and enhance the special interest of the asset."

Policy LP ENV 17 Sites of Archaeological Importance states:

"There is a presumption in favour of retaining, protecting, preserving and enhancing the existing archaeological heritage and any future discoveries found in Argyll and Bute."

APPENDIX 2 - Gazetteer of all UKHO SeaZone records within the offshore study areas.

HA	UKHO No.	Type	Status	Study Area	Name	Description	Lat/ Long	UTM29N
027	3695	Wreck	Live	*Wider (<5km)*	*Exmouth*	A sailing ship bound for Canada, wrecked on the southern Rinns of Islay in 1857. Ship was dashed to pieces on the rocks, 3 survived out of 254 aboard. Wreck condition unknown, rough position logged only.	55° 40.3002’ -6 ° 30.9228’	656254E 6172329N
028	3696	Obstruction	Live	*Wider (<5km)*	*SS Blythville*	Steam cargo ship wrecked on the Rinns of Islay in 1908. Wreckage last observed in 1983 when ship’s bell was recovered. Heavily dispersed debris in rocky gullies only – classed as obstruction only.	55° 41.5998’ -6 ° 32.0064’	655033E 6174698N
029	3697	Wreck	Live	*Wider (<5km)*	*Thomas/ Tomath*	Brig wrecked on the southern Rinns of Islay en route to Canada in 1870. Had at least two locomotives as deck cargo when lost, at least one is present in this location (observed in 1977).	55° 40.3230’ -6 ° 30.9642’	656209E 6172378N
030	3799	Wreck	Live	*Wider (<5km)*	*Thomas/Tomath (possibly)*	Further wreckage associated with 3697, remains of locomotive engines, observed in 1996.	55° 40.3002’ -6 ° 30.9228’	656254E 6172329N
031	3800	Wreck	Dead	*Wider (<5km)*	*Ida Adams*	Steam-powered fishing trawler, ran aground off the Rinns of Islay in 1930 with no loss of life. Amended to ‘dead’ in 2013 as not detected in UKHO survey.	55° 41.9580’ -6 ° 32.0562’	654954E 6175439N
032	3698	Wreck	Live	Wider *(<5km)*	Unknown	Remains of a small 18^{th} c. frigate or brig with numerous 9 pounder cannons. Intermingled with at least one other wreck of indeterminate age; protection order was revoked in 1984 after no more wreckage of value deemed remaining.	55° 41.7456’ -6 ° 31.8894’	655145E 6174981N
033	65739	Obstruction	Live	Wider *(<5km)*	Unknown	Further remains (cannons) believed to relate to 3698. Last recorded in 1975.	55° 41.6958’ -6 ° 31.9896’	655044E 6174885N
034	3797	Wreck	Live	Wider *(<5km)*	*SS Norman*	Steel steamship which foundered 5 miles west of Orsay lighthouse (Rinns of Islay) in a storm in 1900. Was carrying salt from the US at time of loss.	55° 40.0000’ -6 ° 39.0552’	647751E 6171476N

APPENDIX 3 - Gazetteer of all National Monument Records of Scotland within the offshore study areas.

NMRS No.	Study Area	Type	Name	Description	Lat/Long	UTM29N
269610 (HA026)	*Inner (<500m)*	Steamship	*State of Florida*	19th c. steamer lost in Machrie Bay in 1888. Wreck and cargo reputedly recovered to a large extent. Position uncertain but possibly in cable route 500m corridor (as recorded position is).	55° 39.5874’ -6° 16.7118’	671326E 6171464N
119164	Wider (<5km)	Steam trawler	*Anida*	Steam trawler wrecked on the rocks at Orsay Island (Rinns of Islay) in 1924. Reported loss only.	55° 44.1’ -6 ° 30.8’	656328E 6173584N
125146	Wider (<5km)	Ketch	*Eliza Charlotte*	Timber vessel carrying coal, ran aground off Orsay Island (Rinns of Islay). Reported intact during dives in the 1990s.	55° 40.2’ -6 ° 30.4’	656768E 6172222N
125147	Wider (<5km)	Brig	*Robert*	Unknown details, loss reported on Rinns of Islay in the 19th century. Mentioned in diving literature. Likely to be a repeated record of NMRS 262351.	55° 40.4’ -6 ° 30.7’	656429E 6172590N
220711	Wider (<5km)	Steamship	*Narwhal*	19th c. cargo ship carrying ballast only, stranded on ‘Ruer Vore’, thought to be Rubha More at south extremity of Laggan Bay. Reported loss only.	55° 39.1’ -6 ° 18.0’	669796E 6170528
220659	Wider (<5km)	Barque	*Ella*	Stranded at Glen Astle in 1893, cargo of coal. Reported loss only.	55° 37.7’ -6 ° 19.3’	668547E 6167991N
262351	Wider (<5km)	Brigantine	*Robert*	Stranded at Portnahaven, in 1872, carrying ballast only. Reported as total wreck at the time. Likely to be a repeated record of NMRS 125147.	55° 41’ -6 ° 31’	655981E 6173047N
271844	Wider (<5km)	Brig	*Friendship*	Ran aground at Kintra in 1824. Intact upon the rocks at time of reporting and likely to have been salvaged (no specified cargo).	55° 39’ -6 ° 17’	671298E 6170580N
282246	Wider (<5km)	Craft	*John and Eliza*	Small timber boat, sank intact in 1848 off Orsay Island after losing rudder. Reported loss only.	55° 40.4’ -6 ° 30.7’	656429E 6172590N
286239	Wider (<5km)	Schooner	*Panuco*	Foundered off Rinns of Islay with a cargo of slates. Reported loss only.	55° 40’ -6 ° 31’	656082E 6172052N
297971	Wider (<5km)	Craft	*St Columba*	Wreckage washed ashore (with vessel’s name on some of it), found in 1868 on Laggan Strand, from an unreported loss.	55° 41’ -6 ° 17’	670895E 6174557N
302762	Wider (<5km)	Galleon	*Castillo Negro*	Reputed Spanish Armada wreck (1588) from local folklore, said to have been lost on ‘the French Rocks’ on the Rinns of Islay. Possibly confused with the	55° 42’ -6 ° 32’	654934E 6175452N

NMRS No.	Study Area	Type	Name	Description	Lat/Long	UTM29N
				(more modern) cannons found in UKHO records 3698 and 65739.		
302774	Wider (<5km)	Warship	*Oise*	Wreck of French privateer from local folklore only, upon the subsequently called French Rocks. Possibly relates to the cannons found in UKHO records 3698 and 65739.	55° 41.7' -6° 31.9'	655094E 6174865N
117099	Wider (<5km)	Craft	*Sir Colin*	Recorded loss of wooden brigantine carrying ballast only, lost in 1870 in the north of Lossit Bay. Positioning is imprecise and wreckage may be encountered within the WSA.	55° 42.8' -6° 30.0'	657053E 6177007N
286426	Wider (<5km)	Craft	*Harpswell* (possibly)	Lifebuoy and other debris found washed ashore, 1869. May refer to a vessel from New York, no other details known. Recorded position is imprecise and further related wreckage could be encountered in the WSA.	55° 45' -6° 29'	657952E 6181124N
103036	Wider (<5km)	Tanker	*Jacksonville*	151m tanker carrying petrol and motor spirit, sunk by U-Boat in 1944. Wreck position was recorded in 1945 outside the WSA but subsequent surveys have not located the wreck. Unconfirmed reports from diving community place the wreck nearer inshore to Islay.	55° 44.295' -6° 48.054'	638066E 6179138N
302525	Wider (<5km)	Craft	Unknown	Wreckage (possibly just lost deck cargo) found washed ashore at Rockside Farm. May relate to a vessel lost within the WSA.	55° 47' -6° 28'	658862E 6184871N
102618	Wider (<5km)	Obstruct-ion	Unknown	Reported sinking of a vessel in November 1944. No other records known about the vessel. Subsequent naval surveys failed to locate the wreck. Approximate position given only.	55° 45.9948' -6° 44.0544'	642147E 6182425N
116878	Wider (<5km)	Ship	*Forest Chief*	Vessel stranded on west coast in 1872 – cargo of corn subsequently salvaged. Reports refer to Kilchoman Bay but related wreckage may be found in the WSA.	55° 47' -6° 28'	658862E 6184871N
302489	Wider (<5km)	Craft(s)	Unknown	Reports of two coasters lost off Coul Rock, West Islay, 1868. Imprecise position of loss.	55° 47' -6° 30'	656772E 6184795N
302584	Wider (<5km)	Barque	*Ocean*	Wreck of small iron-hulled vessel, carrying ballast only, in 1911. Reported location refers to a bay no longer known on charts, is thought to be somewhere on the west of Islay.	55° 45.1' -6° 28.2'	658782E 6181340N
116864	Wider (<5km)	Barque	*Ocean*	Additional wreckage/ location of loss associated with the *Ocean*, record number 302584.	55° 45.3' -6° 28.3'	658677E 6181336N

NMRS No.	Study Area	Type	Name	Description	Lat/Long	UTM29N
286243	Wider (<5km)	Ship	Unknown	Wreckage associated with large sailing ship found ashore in 1862 at Kilchiaran. Recorded position is outside the WSA but possible that other wreckage may be found within it.	55° 45' -6° 29'	657952E 6181124N
102962	Wider (<5km)	Steamship	*Dalton*	Wreck of 95m iron steamship from 1895 carrying grain, oil and wood, stranded at a reef at Kilchiaran. Recorded position is likely to be inaccurate, and no surveys have been able to reach the (shallow) location to confirm the wreck's presence.	55° 44.3952' -6° 29.2566'	657724E 6179993N
116877	Wider (<5km)	Tug	*Flying Falcon*	Wreck through diving literature only – no details known. Recorded position is outside the WSA but likely to be inaccurate.	55° 46' -6° 30'	656839E 6182940N
102616	Wider (<5km)	Steamship	*Tobago*	57m Latvian cargo ship carrying fish, wrecked on the rocks in Lossit Bay in 1940. Salvaged in 1955. Recorded as just outside the WSA, though unreliably.	55° 42.3624' -6° 30.0564'	657024E 6176193N
265452	Wider (<5km)	Craft	*Lephenstrath*	Wreckage described as coming from a ship of this name found washed ashore at Tormisdale, 1875. Outside the WSA but associated wreckage may be found within.	55° 44.4' -6° 29.4'	657574E 6179996N
102575	Wider (<5km)	Steamship	*Agate*	Steel steamship carrying coal reportedly wrecked off Tormisdale in 1940. Diving literature places this outside the nearby WSA but the wreck has not been confirmed by surveys in that position.	55° 43.6788' -6° 30.2232'	656761E 6178628N
115654	Wider (<5km)	Steamship	*Agios Minas*	98m Liberian freighter carrying timber, wrecked on the rocks on the west of the Rinns of Islay in 1968. Believed mostly salvaged. UKHO record for this places accurate position of reported loss just outside the WSA, however associated wreckage may be encountered within it.	55° 42.0954' -6° 30.6564'	656413E 6175676N
301326	Wider (<5km)	Aircraft	Fairey Swordfish I, *W5916*	British torpedo bomber reported lost off the west of Islay, 1943. No known location of wreck.	55° 50' -7°	625263E 6189340N
301327	Wider (<5km)	Aircraft	Dornier 17	German bomber reported shot down over the North Channel in 1941. No identity or precise location known.	55° 50' -7°	625263E 6189340N
301360	Wider (<5km)	Aircraft	Brequet Atlantique SP-13A, *MLD253*	Dutch military aircraft lost in 1978. No known casualties or details. Thought to be lost off NW of Islay, wreck not found and no further details known.	55° 50' -6° 30'	656572E 6190357N

NMRS No.	Study Area	Type	Name	Description	Lat/Long	UTM29N
302420	Wider (<5km)	Aircraft	Blackburn Botha I, *L6276*	British bomber lost in 1942, reportedly crashed into the sea off Saligo Bay, west Islay. No wreckage found or further details known.	None given.	None given.
288487	Wider (<5km)	Flint Axehead	n/a	'This Neolithic flint axehead was recovered from the seabed in outer Loch Indaal, during scallop dredging about midway between the Mull of Oa and Portnahaven. It is unpolished, of Irish type, and clearly made of Irish flint. The axehead is complete and in excellent condition, except for very minor modern edge damage. It has acquired a dense brown staining on the seabed, and one surface has retained varied traces of marine life'. (Saville, 2006).	55° 38.0' -6 ° 25.0'	662450E 6168680N

APPENDIX 4 - Geophysical targets identified by Headland Archaeology

HA	Description	Dimensions L x B x H (m)	Arch. Potential	ESG sidescan survey file	ESG target	Description	Position UTM29N (m)	Position WGS84 (Long/Lat)
001	Uncharted wreck	80.0 x 29.0 x 6.1	High	76_202	No	Partially buried uncharted wreck, possibly timber decking visible. Some superstructure remaining, with masts (total height tbc).	657052E 6170857N	-6°30.2127' 55°39.4859'
002	Debris/ possible debris/ feature	13.0 x 10.1 x 6.9	Medium	76_202	No	Oblong object with rounded ends, with tall profile. Isolated from other similar features, Possibly a mooring with a rising rope to the surface.	661132E 6171119N	-6°26.3165' 55°39.5467'
003	Debris/ possible debris/ feature	3.1 x 1.7 x n/a	Medium	77_200	No	Small bright anomaly with scour. Close to wreck HA001, approx. 190m away.	656992E 6170639N	-6°30.2774' 55°39.3697'
004	Debris/ possible debris/ feature	5.0 x 4.2 x n/a	Medium	76_202	No	Rounded object, possibly with hollow centre.	659770E 6171050N	-6°27.6162' 55°39.5387'
005	Debris/ possible debris/ feature	2.2 x 1.0 x 1.0	Medium	76_202	No	Small bright feature, likely to be metallic.	657477E 6170753N	-6°29.8114' 55°39.4236'
006	Debris/ possible debris/ feature	18.8 x 9.5 x 1.1	Low	49_111	No	Cluster of small elements, possibly debris or boulders.	651709E 6169060N	-6°35.3629' 55°38.6200'
007	Debris/ possible debris/ feature	13.2 x 20.2 x n/a	Low	75_212	No	Small cluster of bright contacts in plain sandy region, possibly debris or boulders.	661155E 6170684N	-6°26.3099' 55°39.3120'
008	Linear debris/ feature	17.5 x 1.0 x 0.7	Low	43_118	Yes	Series of small objects in line upon sandy bed - possibly boulders.	649193E 6171415N	-6°37.6826' 55°39.9364'
009	Object/ possible natural feature	12.3 x 6.5 x 1.7	Low	42_121	No	Isolated feature with stepped profile - possibly boulder.	650479E 6170684N	-6°36.4811' 55°39.5178'
010	Object/ possible natural feature	3.3 x 2.8 x 2.7	Low	48_115	Yes	Tall feature, possibly manmade due to dimensions compared to boulders nearby.	651138E 6169784N	-6°35.8829' 55°39.0207'
011	Object/ possible natural feature	3.5 x 1.5 x 1.4	Low	39_116	No	Small, relatively isolated pointed feature with strong reflectance, possibly boulder.	649424E 6171164N	-6°37.4707' 55°39.7959'
012	Object/ possible natural feature	4.3 x 1.6 x 1.0	Low	56_132	Yes	Small bright feature with two raised elements at either end. Possibly pair of boulders, distorted.	650722E 6171259N	-6°36.2306' 55°39.8230'
013	Object/ possible natural feature	4.5 x 1.6 x 0.8	Low	39_116	Yes	Pair of high-reflectant contacts, possibly boulders. Largest measured.	649579E 6171067N	-6°37.3261' 55°39.7408'

HA	Description	Dimensions L x B x H (m)	Arch. Potential	ESG sidescan survey file	ESG target	Description	Position UTM29N (m)	Position WGS84 (Long/Lat)
014	Object/ possible natural feature	57.2 x 51.4 x n/a	Low	76_202	No	Large smooth-sided ridge feature atypical of surrounding sediment.	661786E 6171101N	-6°25.6941' 55°39.5239'
015	Object/ possible natural feature	4.3 x 4.1 x n/a	Low	78_211	No	Small bright anomaly with scour.	656203E 6170207N	-6°31.0438' 55°39.1523'
016	Object/ possible natural feature	70.0 x 23.0 x 2.0	Low	79_201	No	Mound of unusual location and direction relative to surrounding geology.	651656E 6171128N	-6°35.3449' 55°39.7349'
017	Object/ possible natural feature	10.0 x 7.0 x 2.0	Low	73_201	No	Small mound, with scour.	668224E 6171428N	-6°19.5491' 55°39.5686'
018	Object/ possible natural feature	6.0 x 5.0 x 1.0	Low	76_202	No	Small mound.	663972E 6171317N	-6°23.6038' 55°39.5962'
019	Object/ possible natural feature	30.0 x 8.0 x 1.0	Low	74_211	No	Deep cut in seabed.	663822E 6171169N	-6°23.7520' 55°39.5195'
020	Object/ possible natural feature	32.0 x 28.0 x 1.5	Low	75_212	No	Small series of mounds, small possibility of debris.	655436E 6170460N	-6°31.7658' 55°39.3033'
021	Object/ possible natural feature	.5 x .5 x 1.4	Low	78_211	No	Very small feature (1 sounding in MBES data).	652201E 6171046N	-6°34.8283' 55°39.6805'
022	Object/ possible natural feature	8.0 x 8.0 x 1.4	Low	57_134	Yes	Small feature in scour hole. Similar hole nearby (43 m away).	650768E 6171366N	-6°36.1833' 55°39.8798'
023	Object/ possible natural feature	36.0 x 18.0 x 2.0	Low	51_122	No	Ridged feature. Near to rock outcrop and could be itself rock, but has weak backscatter.	650128E 6170979N	-6°36.8059' 55°39.6832'
024	Object/ possible natural feature	4.0 x 4.0 x 2.1	Low	77_200	Yes	Small feature in scour hole.	648920E 6171767N	-6°37.9313' 55°40.1300'
025	Object/ possible natural feature	8.0 x 7.0 x 2.0	Low	49_111	No	Possibly rectangular feature, isolated in sandy area.	649498E 6170842N	-6°37.4107' 55°39.6211'

APPENDIX 5 - Key onshore receptors

SM	Name	Description	Easting	Northing
2315	Orsay Island Chapel	This medieval chapel stands within a walled enclosure upon a flat-topped promontory at the N end of the island, overlooking the narrow sound that divides Orsay from the Islay mainland. The chapel is now incorporated within an oblong gable-ended building measuring about 13.1m in length from E to W by 3.8m transversely within walls some 0.8m in thickness	116402.9	651677.9
2334	Tobar an-t Sagairt,chapel, Tockmal	The monument comprises the turf-covered footings of an early medieval chapel and its associated burial ground, situated 270m SSE of Craigens, Islay. The monument was first scheduled in 1963, but an inadequate area was included to protect all of the archaeological remains: the present rescheduling rectifies this.	129937.3	647354.3
SM2337	Kilchoman Church, Cill Chomain Cross and tombstones	This scheduled monument relates to the Cill Chomain Cross and the other carved stones situated in the burial ground of Kilchoman Church. The upstanding Church is not included within the scheduled area. Cill Chomain Cross is a free standing stone cross which stands in its original socket stone in the south east corner of the burial ground. This cross dates to the 14th to 15th century and its design is of the Iona School. There are approximately 20 further medieval carved grave slabs or fragments of grave slabs and carved stones within the churchyard to the south of the church also largely dating from the 14th -15th centuries.	121600.4	663224.6
SM3814	Cultoon stone circle	Cultoon stone circle is the scheduled remains of a stone circle comprising of two standing stones and 12 prostrate stones. This stone circle was excavated in the 1970s and it appears that this stone circle was never completed but rather abandoned mid construction (MacKie 1976). This incomplete stone circle lies in an area of relatively upland rough pasture. It has been noted that looking south from this stone circle the mountain of Slieve Snaght, Donegal, Ireland is visible under good weather conditions and it is suggested that the view from these stones aligns with this mountain at the winter solstice.	119554.3	656960.8
2357	Cill Eileagain Chapel	The monument comprises the turf-covered footings of an early medieval chapel and its associated burial ground, situated 270m SSE of Craigens, Islay. The monument was first scheduled in 1963, but an inadequate area was included to protect all of the archaeological remains: the present rescheduling rectifies this.	129883.1	666937.0

11944	Rinns Of Islay Lighthouse	1825. Robert Stevenson Engineer. Rubble. Tower in 5 stages; string courses. Dioptric flashing light by Barbier and Bernard, Paris, 1896. Cast-iron turnpike stair. Round-ended vestibule at ground floor; platform roof. Flanked by 2 Keeper Houses: Georgian; 1 storey; rubble; flat lead roofs; octagonal chimneys.	116404.2	651679.4
C488	Portnahaven / Port Wemyss	Conservation Area	116728.2	651824.3

APPENDIX 6 - Archaeological geophysical survey report

Introduction

This report presents the results of an archaeological assessment of marine geophysical data acquired by ESG Ltd. on behalf of DP Energy Ireland Ltd. The data was collected in advance of the construction of an offshore tidal energy farm and associated export cable offshore of Islay.

Aims

This assessment has been undertaken in order to identify any cultural heritage assets recorded in the geophysical survey for the development area and to inform the baseline and Environmental Impact Assessment for the proposed development. This assessment is intended to be read in conjunction with the ESG survey report *L3201-13 Islay Tidal Array* (ESG, 2013).

The specific objectives are:

- to confirm the presence of previously identified marine sites and to comment on their apparent character;
- to identify, locate and characterise hitherto unrecorded marine sites;
- to review available data in respect of seabed and sub-seabed deposits likely to be of archaeological interest; and
- to present mitigation measures in concert with the results of the desk-based study and impact assessment.

ESG survey methodology & specifications

The geophysical survey was acquired between 16th – 22nd February 2013 using the survey vessel *RV Aora*. The techniques employed included side scan sonar and magnetometer surveys, sub-bottom profiling and bathymetric multibeam surveys. Data was to be gathered and processed to IHO S44 Order 1a standard, and presented to Headland Archaeology as raw and processed formats, with coherent geodetic parameters used throughout the survey (WGS84 UTM zone 29N, UTC). Calibration of positioning and bathymetric systems was to be published, along with reports of the acquisition and analysis of the survey for features.

Survey Parameters

The marine geophysical survey of the proposed tidal array and cables undertaken by ESG was initiated with a view to satisfying a number of requirements (e.g. geological, engineering etc.) of the proposed development.

The proposed phases of works comprised:

- 100% coverage of 1m bins for bathymetry conforming to IHO S44 Order 1 requirements for gridded sounding density and geometric total propagated uncertainty. Feature detection resolution for Order 1a is 2m. A 1m resolution DTM was to be produced.
- Charted bathymetry reduced to local chart datum;
- Reflective seismic profiling of the seabed and interpretation performed by sub-bottom profiling (SBP) with effective range of at least 20m below seabed;
- High-resolution (>0.5m) side scan sonar (SSS) survey and interpretation;

- High-sensitivity (>5nT) magnetometer survey.

Positioning

The primary positioning used by ESG was a CNAV 3500 with Real-time Gypsy corrections, post-processed with blended PosMV-320 inertial measurements. Data was processed with OSNet corrections but it is unclear which form of processing was applied. Heights were reduced to chart datum using a single VORF-derived ellipsoidal separation value across the entire survey. Subsurface USBL (ultra-short baseline) positioning using a Sonardyne system was generally used to calculate the layback of towed equipment.

Sidescan Sonar

ESG used a Klein 3000 sidescan sonar, operated at dual frequencies of 100/500kHz. Sidescan sonar works through sound bursts emitted from the transducers, producing echoes from the water column and seabed which are then received and relayed to the transceiver unit. The power, control and signals are multiplexed onto a standard armoured coaxial cable. These signals are processed for their time of flight and made into sonar images based on the recorded backscatter strength at the deduced slant ranges. Generally, harder (denser) objects give stronger reflective signals and softer sediments weaker return signals thus allowing speculative classifications of seabed and structures. The data was recorded in high frequency mode to enable optimal imagery of the seabed.

Multibeam Echosounder

An R2Sonic 2024 multibeam system was used by ESG for the survey. This high resolution system is capable of ranges up to 500m with 256 beams. This system uses conventional beam forming techniques to generate a narrow ping to be reflected off the seafloor. The returning signal is processed for time-of-flight at distinct angular intervals, using either amplitude or zero-phase crossing methods to determine the range of the echo at the specified directions.

Magnetometer

A Geometrics G882 magnetometer was used during the survey, towed behind the vessel. This magnetometer equipment has a typical accuracy of 0.02nT. This survey method detects variations in the total magnetic field of the underlying seafloor and sub-seabed geology on the basis of anomalies in the Earth’s magnetic field, relative to the towed sensor. Materials high in ferrous or ferric compounds will be detected by the magnetometer, and is primarily used for the indication of metallic features.

Archaeological suitability of the survey methodology and specifications

Considering the guidelines presented by *COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector* (COWRIE, 2007), the specifications of the survey were suitable for the recommended level of detail and precision required for adequate archaeological assessment of geophysical survey data. However, as demonstrated on Plate 1 below, the geophysical survey did not fill the entire 500m buffer area, and the geophysical survey did not extend far inshore beyond the 20m contour.

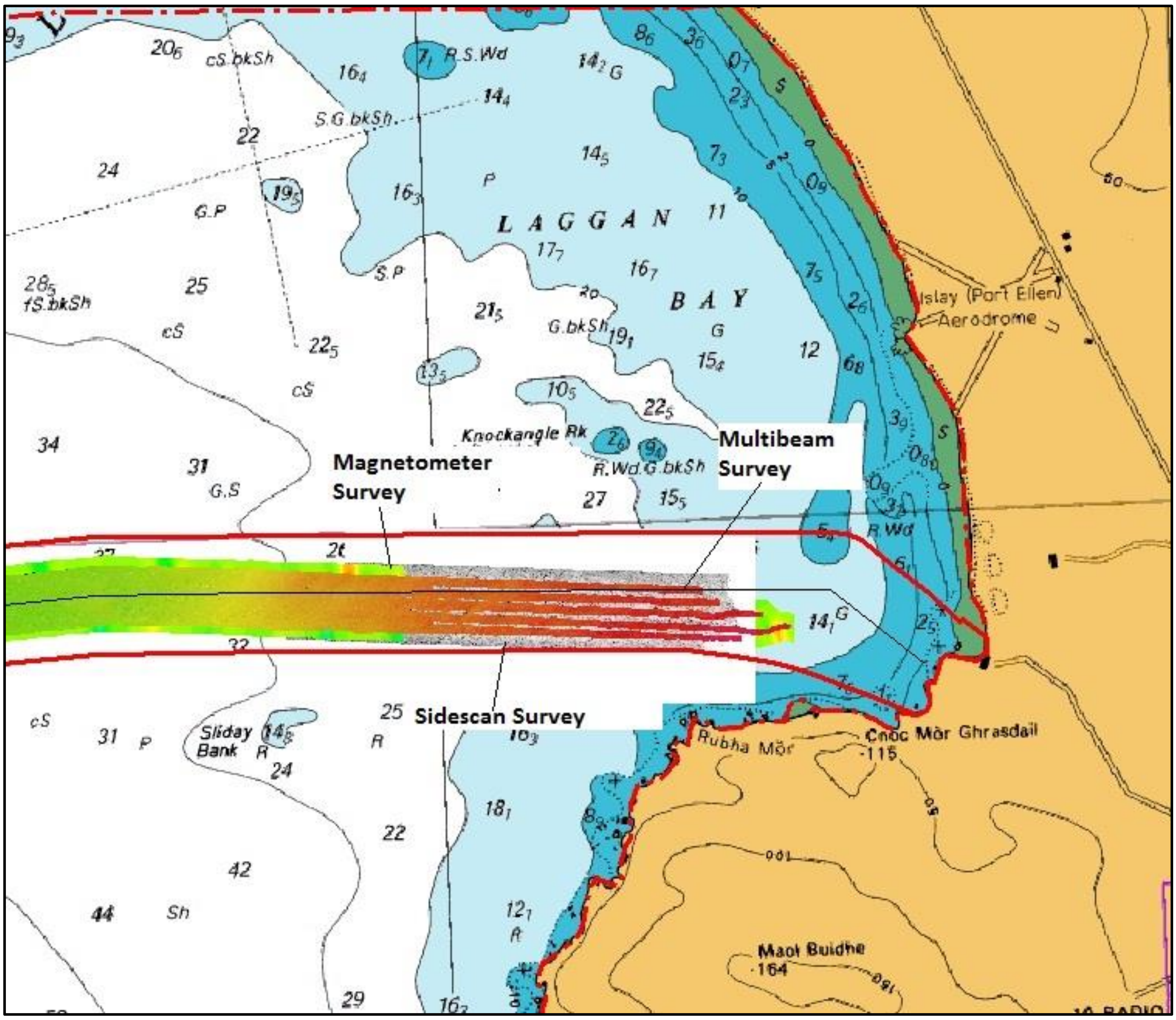


Plate 1. Limit of sidescan, magnetometer and MBES survey at the landfall at Kintra

The sidescan data is of good quality, with high resolution and tight positioning allowing small (<1m) features to be identified from the surrounding seabed. Likewise the magnetometer data appears to be good although the background geology severely limits the usefulness of the data beyond a simple crude corroboration for larger magnetic anomalies such as wrecks.

In the multibeam data, not all the 1m bins of the survey area have been filled, and some have been interpolated according to the ESG report. The specifications for the R2Sonic2024 MBES state a dedicated set range of 256 beams, available at variable swath widths, which for line spacings of 100m at a maximum depth of 100m for the site (a 90^{o} swath), allows just over 1 sounding per metre across track. According to the manual, 100m of water should allow nearly 6 pings a second, which for a typical survey speed of 6knots allows approximately 2 pings per metre along track. Motion of the vessel will of course skew the distribution of the swath's soundings but the line spacing used easily allows 100% overlap, doubling the potential density. Similarly, gaps are particularly prevalent at the shallower landfall end of the cable route, where it appears the swath was not adjusted as the depth beneath the vessel decreased. However, the multibeam data was only available to Headland Archaeology in gridded format, so the usefulness of the data was for clarification of sidescan anomalies only.

Headland Archaeology cannot confirm the findings of the surveyors for measurements of the rockhead levels across the site, or underlying sediments, as the data supplied lacked clarity. No comment can therefore be made on the potential of palaeolandscapes and associated artefacts beyond speculation based on the baseline environment study outlined in the technical report.

Archaeological review of the survey data

All survey data supplied was reviewed in its most 'raw' digital state with appropriate software. This allowed for the data to be replayed and interrogated in order to effectively asses the position, extent and nature of potential targets. All information with regard to the survey conditions was provided by ESG in order to gauge the quality of the data for the identification of potential cultural heritage assets.

The data was subject to an initial scan for any targets of potential cultural heritage interest, after which the data was assessed in detail to:

- familiarise the maritime archaeologist with the survey area;
- correlate anomalies with previously recorded sites;
- identify the absence of anomalies in the vicinity of previously recorded sites;
- identify anomalies indicative of hitherto unrecorded sites;
- check the accuracy of the position, nature and extent of known wrecks; and
- locate and assess unrecorded targets identified by ESG.

All targets were 'tagged' and then assessed as to their archaeological potential. The initial potential of identified targets was gauged using a ranking system (see table below) as a means of prioritising potential assets in order to inform upon subsequent interpretation. It must be stressed that the ranking system is only seen as a guide and is not used as a substitute for professional judgment.

Criteria for identifying archaeological potential of targets

Potential of Asset	Character of Anomaly
HIGH	A target that is identified as a known archaeological asset or in the vicinity of such; or a target that is clearly recognisable as a well preserved feature or maritime loss such as a vessel or aircraft (or parts of) and any associated debris.
MEDIUM	A target that exhibits characteristics likely to represent the remains of a feature or maritime loss such as a vessel or aircraft or fragments of the same, including any associated debris.
LOW	An isolated or fragmentary target that is recognised to be of some interest but is likely to be a modern or natural feature.

The position and dimensions of identified targets along with any additional anomalies were recorded into a gazetteer (Appendix 4) and sample images of these targets were acquired. The data was cross-referenced with the desk based assessment and the anomalies identified by ESG. The position of these identified sites and geophysical targets have been mapped in GIS (see Figure 4 in the Technical Report), all positions are given in UTM29N.

Results

ESG Targets

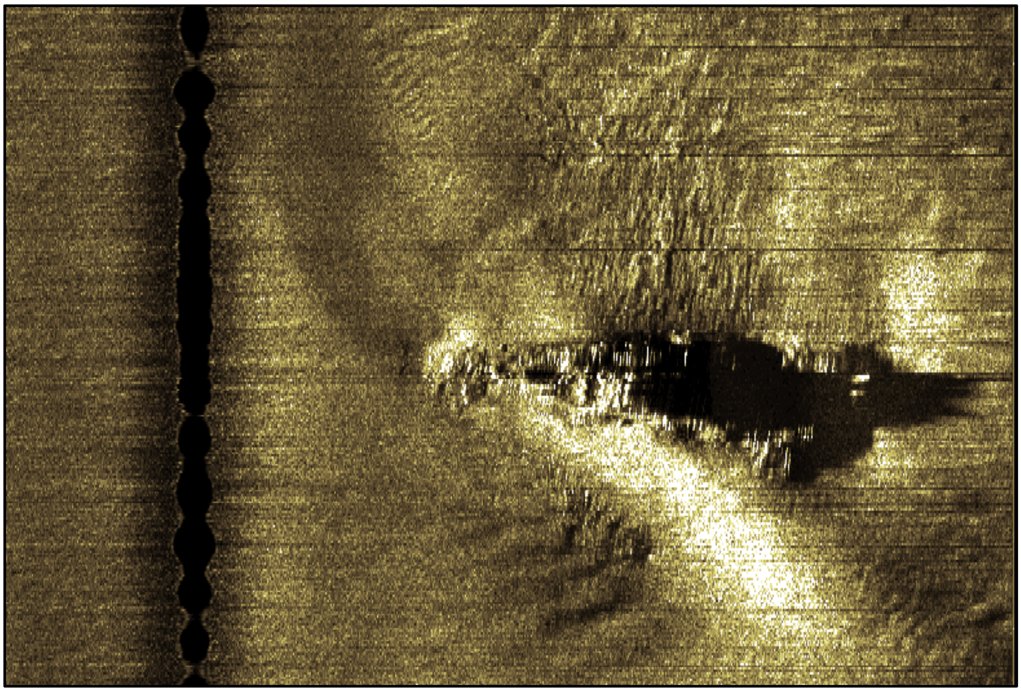
ESG highlighted 61 target features, all described as boulders. 6 of these were also tagged by Headland Archaeology, all as low potential targets. Refer to the Appendix 4 for further details. No magnetic anomalies on the main turbine site or cable route had been identified by ESG in their report.

Headland Archaeology Targets within the Development Area

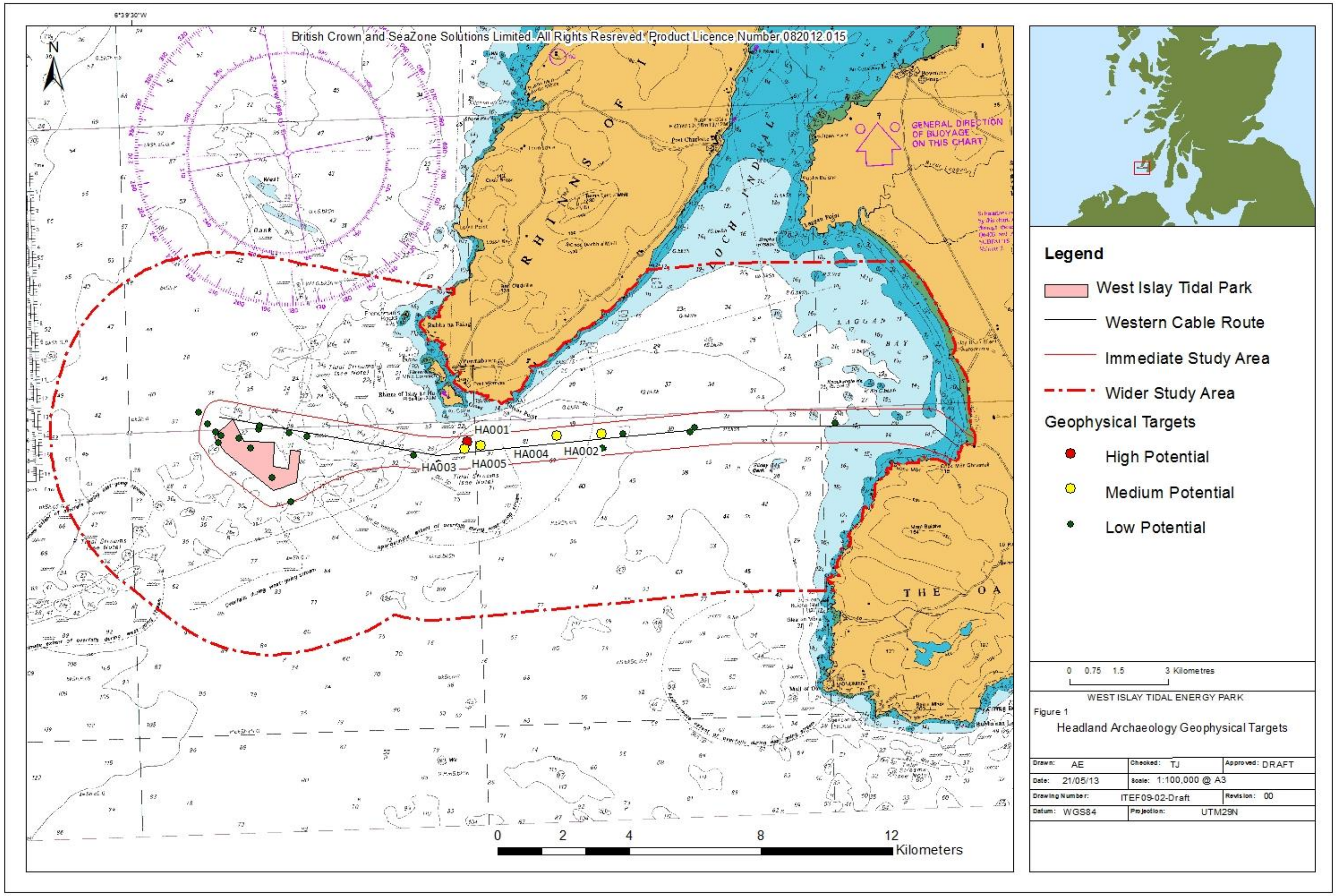
The total number of targets identified amounted to one high potential, four medium potential and 20 low potential targets. After reviewing internally as to the agreed level of potential of observed targets, for the purpose of this report the low potential targets are no longer considered of worthy enough significance for further discussion. Their details have been logged however in the gazetteer in Appendix 4. All positions below are in UTM29N and measurements are in metres.

High Potential Targets (1)

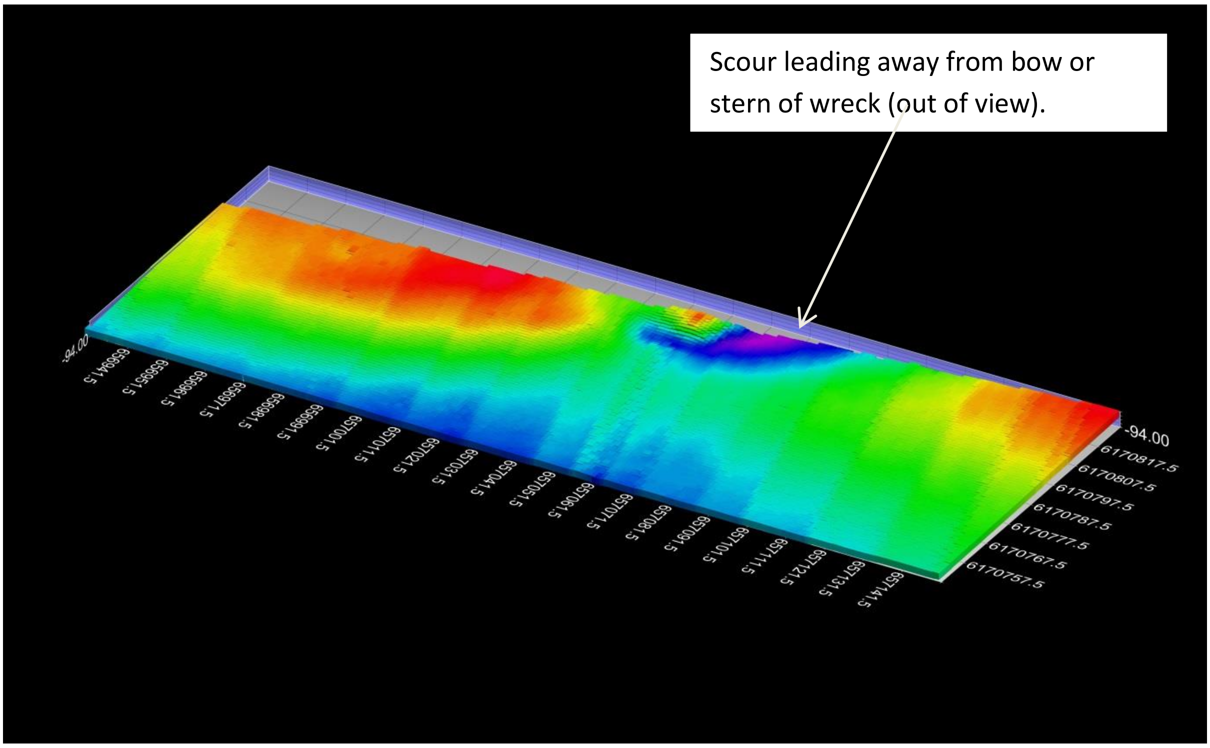
HA001 - Wreck



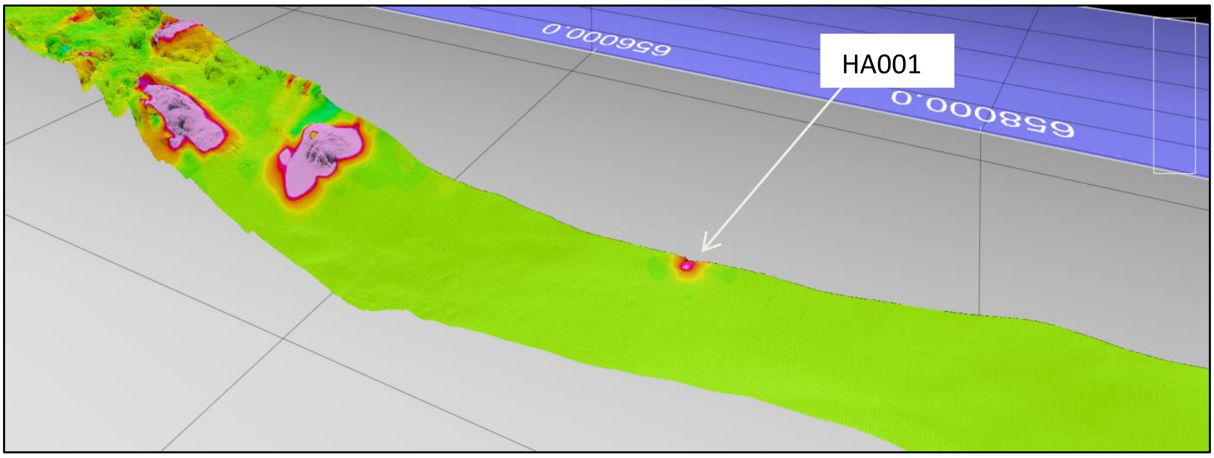
Sidescan image of HA001 from ESG file 76_202, facing 263^{o}.


British Crown and SeaZone Solutions Limited. All Rights Resreved. Product Licence Number 082012.015
HA001
HA002
HA003
HA004
HA005
GENERAL DIRECTION OF BUOYAGE ON THIS CHART
0
2
4
8
12
Kilometers
Legend
West Islay Tidal Park
Western Cable Route
Immediate Study Area
Wider Study Area
Geophysical Targets
High Potential
Medium Potential
Low Potential
0 0.75 1.5 3 Kilometres
WEST ISLAY TIDAL ENERGY PARK
Figure 1
Headland Archaeology Geophysical Targets
Drawn: AE
Checked: TJ
Approved: DRAFT
Date: 21/05/13
Scale: 1:100,000 @ A3
Drawing Number: ITEF09-02-Draft
Revision: 00
Datum: WGS84
Projection: UTM29N

HA001 appears to be a shipwreck lying in a sandy area roughly 250m north of the proposed cable route, to the south of the Rinns of Islay peninsula. No record exists for this location already, though numerous ships are known to have been lost particularly in this region, close to the headland. Scour is visible at one end of the hull, leading away at an angle, and one side of the wreck appears to be silted up over the hull and against the remaining superstructure – the shadows of which extend behind. The horizontal elements spanning the deck are likely to be structural members of the hull, though possibly striping in the sidescan data (a motion artefact). The centre of the wreck is at 657052E, 6170857N, and is approximately 80m long by 29m wide by 6.9m tall. It lies at a depth of 90m.

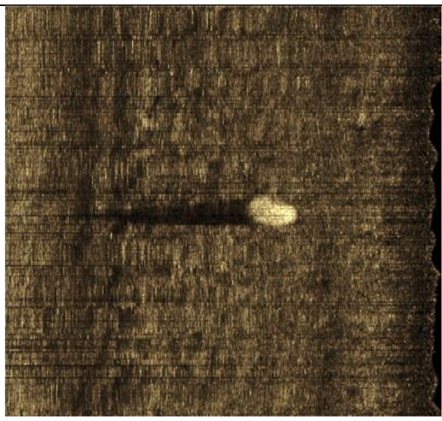
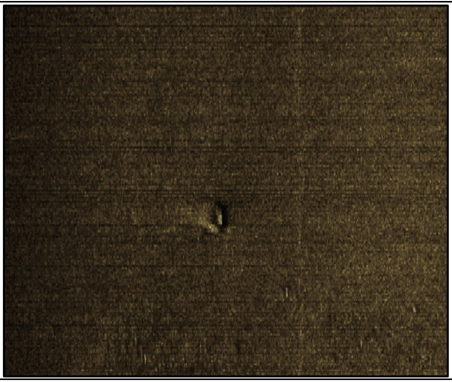
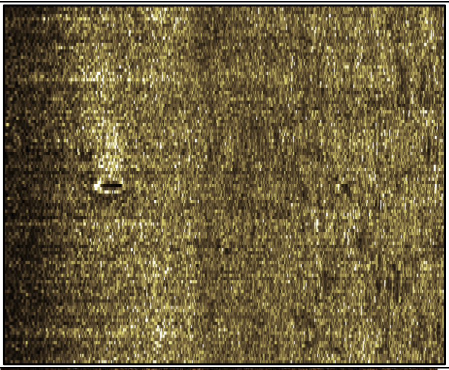
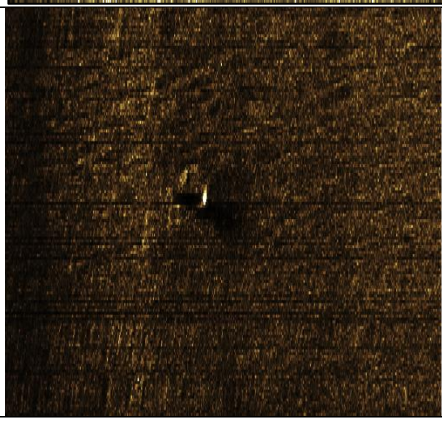


Bathymetry of HA001 – wreck itself was not covered in the dataset but the scour is recorded.



Magnetometry of site HA001 shown with x6 vertical exaggeration to bathymetry. Other anomalies are due to proximity to rock outcrops.

Medium potential targets (4)

HA002- Debris/ possible debris/ feature This is an oblong object with rounded ends, with tall profile. Isolated from other similar features. Possibly a mooring with a rising rope to the surface. No significant bathymetric imagery for this target, possibly having been filtered by the echosounder's detection algorithm (seabed is plotted as opposed to 'softer' features upon it. Feature is at 661132E, 6171119N, and measures 13.0 long x 10.1 wide x 6.9 high (m). *Sidescan image of HA002 from ESG file 76_202, facing 265°.*	
HA003 - Debris/ possible debris/ feature This small bright anomaly appears partially buried, with some scour. It lies close to wreck HA003, approx. 190m away and is possibly related. The feature appears to be too small to show in the bathymetric data.Feature is at 656992E, 6170639N, and measures 3.1 long x 1.7 wide (exposed) with unknown height. *Sidescan image of HA003 from ESG file 77_200, facing 082°.*	
HA004 - Debris/ possible debris/ feature Rounded object, possibly with hollow centre, such as ring-shaped item. No significant bathymetric image or associated magnetic anomaly. Feature is at 659770E, 6171050N, and measures 5.0 long x 4.2 wide with unknown height. *Sidescan image of HA004 from ESG file 76_202, facing 265°.*	
HA005 - Debris/ possible debris/ feature Small, very bright feature, likely to be metallic. Scouring around base, possibly extends into seabed. No significant bathymetric image or associated magnetic anomaly. Feature is at 657477E, 6170753N, and measures 2.2 long x 1.0 wide x 1.0 high. *Sidescan image of HA005 from ESG file 76_202, facing 263°.*	

WESTISLAY TIDAL

ENERGY PARK

volume 4 // appendix 14.1 // preliminary hazard analysis

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The Yachtsman's Pilot Clyde to Colonsay by Martin Lawrence and Imray Laurie Norie and Wilson Ltd.
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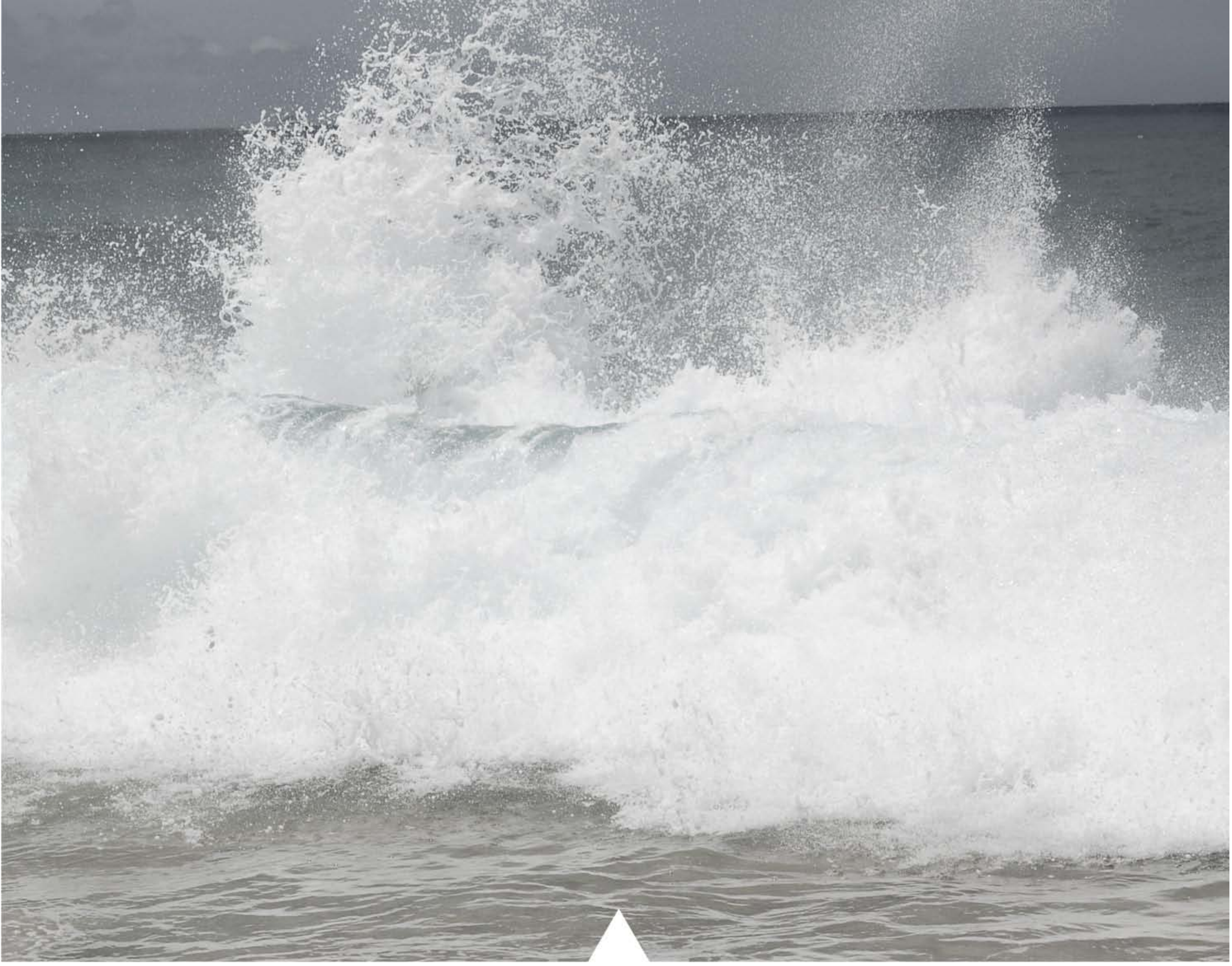

Islay Tidal Energy Park – Preliminary Hazard Analysis

DP Marine Energy Limited

May 2012

PMSS

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May 2012

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Abbreviations

ADCP	Acoustic Doppler Current Profiler
AHT	Anchor Handling Tug
AIS	Automatic Identification System.
Cable (as a measurement of distance)	1/10th of a nautical mile (approx 185 metres) and a standard measure of distance at sea
CHA	Competent Harbour Authority. A statutory authority responsible for a defined area of water in and around a port or harbour
Chart Datum	By international agreement, Chart Datum is a level so low that the tide will not frequently fall below it. In the UK, this is normally approximately the level of LAT
DP	Dynamic Positioning
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
ES	Environmental Statement
FMEA	Failure Modes and Effects Analysis
GT	Gross Tonnage. The total volume of a vessel, expressed in units of 100 cubic feet (gross ton), with certain open structures, deckhouses, tanks, etc., exempted. Also called Gross Registered Tonnage
HAT	Highest Astronomical Tide. HAT is the highest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. HAT is not the extreme level as storm surges may cause higher levels to occur. Determined by inspection over a period of years
IMO	International Maritime Organisation
Kn	Knot
kW	Kilowatt
LAT	Lowest Astronomical Tide. LAT is the lowest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. LAT is not the extreme level as storm surges may cause lower levels to occur. Determined by inspection over a period of years
LOA	Length Overall (of a vessel)
m	Metre
MCA	Maritime and Coastguard Agency
MHWN	Mean High Water Neaps.
MHWS	Mean High Water Springs.
MLWN	Mean Low Water Neaps.
MLWS	Mean Low Water Springs.
MoD RN	Ministry of Defence (Royal Navy)
MRCC	Maritime Rescue Coordination Centre
MSL	Mean Sea Level. The average level of the sea surface over a period (normally 18.6 years)
MV	Motor Vessel
MW	Megawatt
NLB	Northern Lighthouse Board
n mile	(International) Nautical Mile (1,852 metres).
NSRA	Navigational Safety Risk Assessment
OREI	Offshore Renewable Energy Installation
PHA	Preliminary Hazard Analysis
PMSS	Project Management Support Services
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SCADA	Supervisory, Control and Data Acquisition
SFF	Scottish Fishermen's Federation
T	Tonne
Tidal Stream	A distinction is drawn between tidal streams, which are astronomical in origin, and currents, which are independent of astronomical conditions and which, in the waters around the British Isles, are mainly of meteorological origin
VMS	Vessel Monitoring System

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References

1	Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371 (M+F)	Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues
2	DECC (DTI) Guidance on the Assessment of the Impact of Offshore Wind Farms	Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms
3	Admiralty Sailing Directions NP66	West Coast of Scotland Pilot
4	Admiralty Tidal Stream Atlas NP222	Firth of Clyde and Approaches
5	Admiralty Tide Tables NP201	Volume 1: UK and Ireland
6	RYA UK Atlas of Recreational Boating	Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast; 2005
7	"Dive Islay Wrecks" by Steve Blackburn	

1. Background

DP Marine Energy Ltd (DPME) is proposing to undertake the development of a Tidal Energy Farm located approximately 4.5 n miles west of the south-west tip of the island of Islay off the west coast of Scotland. The development area is centred on latitude 55 40.20N and longitude 006 38.50W and is illustrated at Figure 1 although a wider search area is being explored as shown in Figure 2

The farm, when fully developed, is expected to have an installed capacity of 400MW. However, it is intended to undertake the development in a phased programme. The first phase is intended to be a small array of some 15 - 30 turbines developing approximately 30MW using either a Rolls-Royce Tidal Turbines Limited (RR-TGL) or Marine Current Turbines (MCT) Seagen S turbine as shown in Figures 5 and 6. Other turbines have not been ruled out though the design envelop is likely to be covered by assessing the TGL or MCT turbines. A “technology neutral” approach is intended for the further development of the area which means that, at present, the device type is not known although, as defined in the scoping document, it is likely to feature a horizontal axis rotor - either a ducted or un-ducted and be either fully submerged or surface piercing..

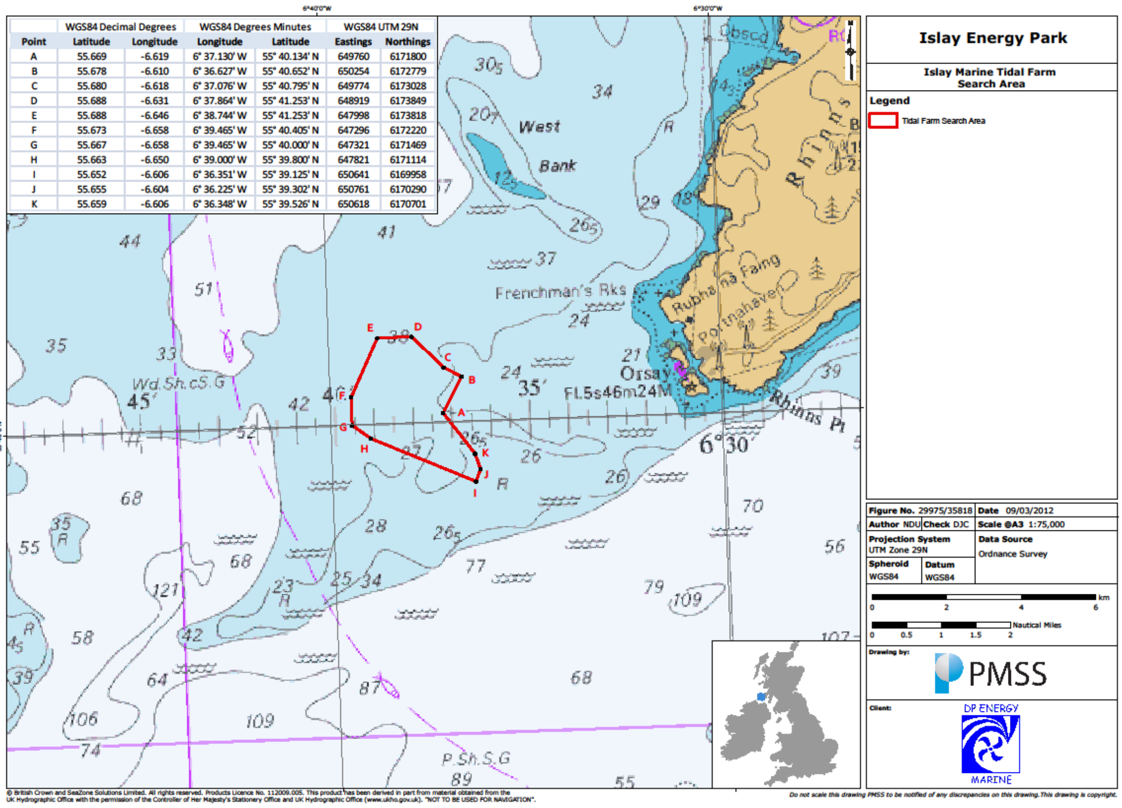
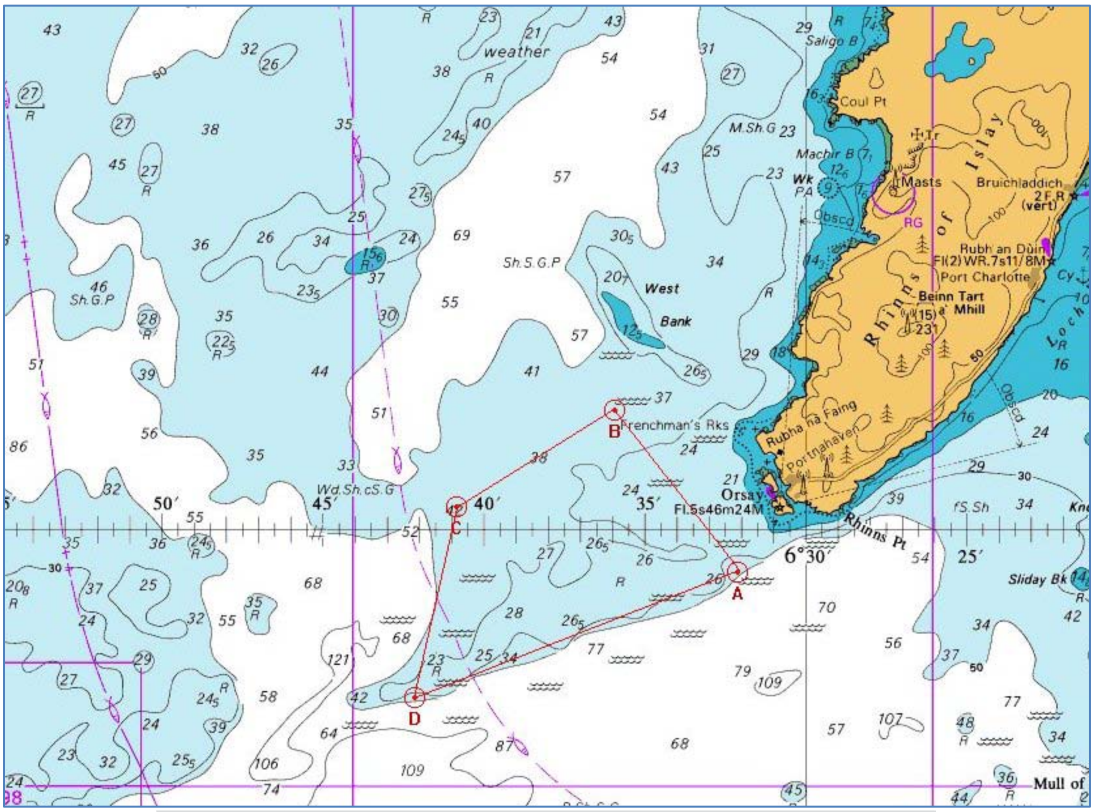


Figure 1 Proposed Development Area



A	55 39.256N	6 32.135W	WGS84
B	55 42.099N	6 35.950W	WGS84
C	55 40.403N	6 40.861W	WGS84
D	55 37.052N	6 42.159W	WGS84

Figure 2 Search Area and Coordinates

As part of the consents process there is a requirement to undertake an assessment of the navigational safety issues arising from the establishment of an Offshore Renewable Energy Installation (OREI). This is required to be conducted in accordance with the Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371(M+F) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues. (Reference 1). The methodology for this assessment follows that for assessing the Marine Navigational Safety Risks of Offshore Wind Farms contained in the DTI/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2).

The assessment will be taken into account in the preparation of the Environmental Impact Assessment (EIA) study report and the resulting Environmental Statement (ES) to be submitted to Marine Scotland.

The first stage of the navigational safety risk assessment process methodology, in accordance with Reference 2, is to undertake a Preliminary Hazard Analysis (PHA) prior to conducting the Navigational Safety Risk Assessment (NSRA). This is to ensure that the NSRA is appropriate to the nature and scale of the development and employs suitable techniques and methodology which have been agreed with the MCA. This report comprises that PHA.

1.1. Aim

The aim of this PHA report is to identify the major hazards presented by the proposed development and to recommend the appropriate tools and methodology for the assessment of the consequent risks to be used in the subsequent NSRA.

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1.2. Scope

The scope of the PHA covers the identification of the hazards to shipping and other marine activities presented by the installation, operation, maintenance and decommissioning of the proposed array and to recommend tools and methodologies, appropriate to the scale and nature of the proposed installation, to be used in the assessment of the risks to navigational safety. It does not, at this stage, attempt to estimate the risks arising from those hazards or to propose control measures as that is the purpose of the subsequent NSRA.

1.3. Stakeholders

Marine organisations and individuals whose safety of navigation could be affected by the establishment of such a facility have been identified and a consultation letter sent to them requesting their comments regarding the potential impacts on navigational safety. A list of stakeholders is at Appendix A.

2. Description of the Marine Environment

The source of much of the data in the following section is derived from:

- Admiralty Charts 2168, 2798 and 1770;
- Admiralty Sailing Directions NP 66 – The West Coast of Scotland Pilot (Reference 3);
- The Admiralty Tidal Stream Atlas NP222– Firth of Clyde ad the Approaches (Reference 4);
- Admiralty Tide Tables NP 201 – Volume 1: UK and Ireland (Reference 5).

2.1. Harbours and Anchorages

The following harbours and anchorages are marked on Admiralty Charts 2168:

- Portnahaven – small craft anchorage
- Port Charlotte – Good anchorage for vessels in 10m.
- Bowmore - alongside berth for small craft
- Bruichladdich – alongside berth for small craft

2.2. Wrecks

There are no charted wrecks within the area of interest itself, although the wreck of the SS Norman (sunk May 1900) is reportedly within the area some 6.5 n miles WSW of the Rhinns of Islay Light. There are a number of wrecks are present along the coast. One is situated 0.5n miles north east of Frenchman's Rock (the "Agios Minas") and the other in Kilchiaran Bay (the "Floristan"). Both these, along with five others, are identified in "Dive Islay Wrecks" by Steve Blackburn as dive sites.

2.3. Submarine Cables

There are no charted cables within the search area or in the vicinity of the cable routes.

2.4. Aquaculture

A number of marine farms are charted on the south east side of the Rhinns of Islay. Such operations are usually supported by service craft of various types and sizes and, occasionally, diving operations.

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2.5. Tidal Stream

Tidal streams run strongly around Islay. These streams set very strongly and attain a rate of 8kn during spring tides off Orsay. Overfalls, with eddies, are created off Orsay. With opposing winds these overfalls are dangerous to small craft.

2.6. Tidal Height

Tidal height data for Orsay, the closest secondary port adjacent to the proposed site, is shown at Table 1.

	LAT	MLWS	MLWN	MSL	MHWN	MHWS	HAT
Standard Port – (Oban)	0.0	+0.7	+1.8	+2.4	+2.9	+4.0	+4.5
Secondary Port Differences (Orsay)		-0.2	-0.5	No Data	-0.6	-1.4	
Heights relative to Chart Datum		**+0.5**	**+1.3**		**+2.3**	**+2.6**	
			Mean Range (Neaps) 1 metre				
		Mean Range (Springs) 2 .1 metres					

Table 1 Tidal Height Data

2.7. Hydrographic Survey

Charted bathymetric data covering the proposed deployment area is derived from British Government Surveys undertaken in 1985. Data for inshore waters in the vicinity of the potential cable routes is from surveys between 1956 and 1972.

Additional data, digitised from Fairsheet data from a 1985 Oil and Gas survey, has been used by DPME for initial site selection purposes.

2.8. Weather Data

Weather data for Orsay from Reference 3 compiled over 20 years from 1983 shows that wind direction is predominantly (67%) from between South East and West with mean speeds over the year of 16.5 kn. Data on the number of days with gales and fog from observations over a period of 12 years show that there are 49 and 23 days respectively.

2.9. Marine Environmental High Risk Zones (MEHRAs)

The proposed development area lies off an area designated as a High Category MEHRA.

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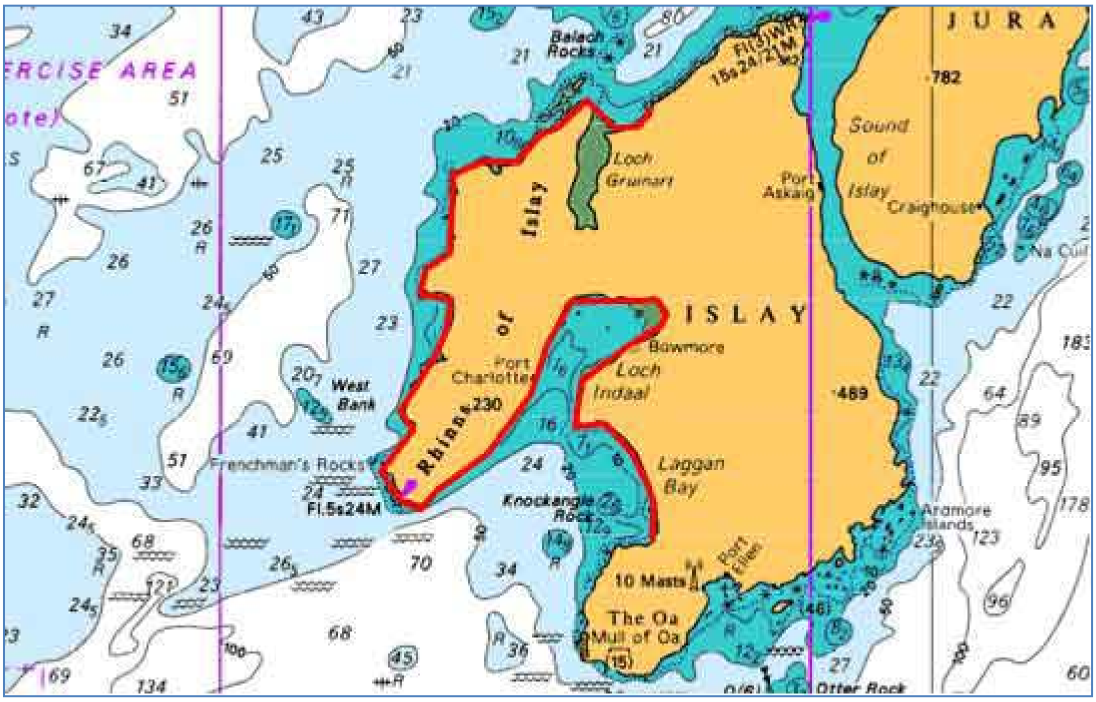

Figure 3 MEHRA

3. Description of the Proposed Development

3.1. Site Selection

A number of Scottish sites were identified as possible candidates to fulfil the criteria deemed necessary for potential development of tidal devices. The south west coast of Islay was identified as one of these sites for, amongst others, the following reasons:

- It has a high tidal resource peaking at 3.5m/s (mean peak spring);
- The bathymetry (between 25 and 50m) and sea bed profile matches the general requirements of leading tidal turbine devices;
- An area large enough to deliver in excess of 300MW is present;
- Shipping activity is relatively low in the immediate area.

The criteria for the site include appropriate depths of water to accommodate the potential tidal devices which may be considered for the site. In general, the devices being considered require water depths of greater than 25m. A review of existing bathymetric data was undertaken to assist with site selection.

The preferred area for deployment was determined as the area off the west coast of Islay covering an area of 8.5 km^2 (see Figure 1) though a wider search area has been identified as shown in Figure 2

3.2. Array Description

In order to minimise development and device risks it is proposed to develop the tidal farm in three phases. This reflects both the relative immaturity of tidal devices in commercial operation, and facilitates the infrastructure upgrades which will be necessary for construction of the 400MW project.

Phase 1
The first phase is likely to consist of an array of some 30 tidal turbine devices. This is likely to consist of surface piercing tidal devices.

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The initial proposed array will consist of up to 30 turbines arranged in three rows. Devices would be interconnected by mid-water cables with a single, seabed power export cable back to shore and connected to the grid at a shore point to be agreed with the grid owner. The three landing points being considered are shown at the inset to Figure 3.

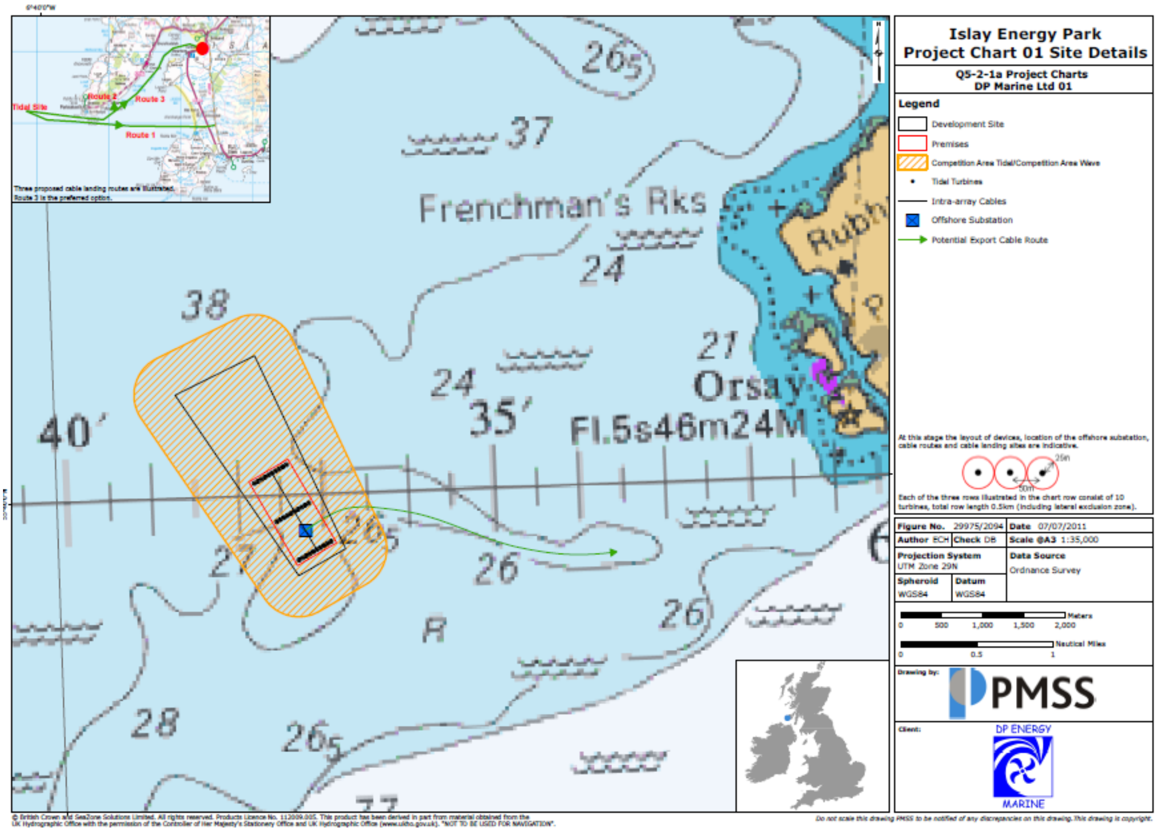

Figure 4 Phase 1 Array

Phase 2 - Approximately 50MW Installed Capacity
This phase featuring in excess of twenty devices is dependent on progress towards resolving electrical grid access and recognises potential supplier chain issues with respect to the availability of devices and infrastructure to support installation and commissioning.

Phase 3 – Approximately 400MW Installed Capacity
The intent is to exploit fully the tidal resource in the development area. This could result in a Tidal Farm 400MW of around capacity. Such a development would require significant grid infrastructure improvements.

4. Tidal Energy Device

4.1. Phase 1 Turbines

The intended device type for the first phase development is likely to be the SeaGen S turbine developed by Marine Current Turbines it is a surface piercing type device in which the rotor and nacelle are attached to a monopile structure which protrudes above sea-level. (See Figure 5.) With a 20m rotor it will operate in 28m minimum depth (5m below and 3m above rotor). The Rolls-Royce TGL unit is also a 20m rotor but operates in minimum water depths of 35m. (See Figure 6.)

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Figure 5 MCT SeaGen S Tidal Device

Figure 6 RR-TGL Tidal Device

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Power from each device will be exported via an umbilical cable to a junction on the sea bed. Several devices can be connected together and linked to shore through a single seabed cable.

4.2. Phase 2 Turbines

Whilst the device selected for the second phase development has yet to chosen, an enveloping design has been developed based on a general design philosophy of:

- Horizontal axis tidal turbine (HATT) using either closed or open rotor;
- Seabed sited by drilling / piling or gravity;
- Surface or non-surface piercing structures.

Rotor diameters will be limited by the depths of water available. A general design criteria of a 5m minimum clearance between the rotor and the seabed and a 5m clearance between the top of the rotor swept arc and Lowest Astronomical Tide (LAT).

Surface piercing designs, similar to the Marine Current Turbines (MCT) SeaGen turbine, may be considered for the second phase of the development.

4.3. Foundations

Notwithstanding the device types chosen for each phase, substantial foundation works would be required. The turbine foundations, whether drilled monopile, gravity structures or pinned tripods for instance, would require to be installed from a moored barge or Dynamically Positioned (DP) vessel.

4.4. Ancillary Equipment

Mechanical and electrical switchgear and control equipment and electrical connection including transformers to the grid system would be housed in a protective enclosure either above or below the surface of the water.

4.5. Power Export Cable

For the 30MW phase, turbines will be linked to a single 33kV subsea cable which will landfall on one of the routes shown in Figure 3, most likely Route 1 running due east to landfall. A route selection assessment is currently ongoing but the route is likely to follow that as shown in Figure 7 from Islay to the Scottish mainland.

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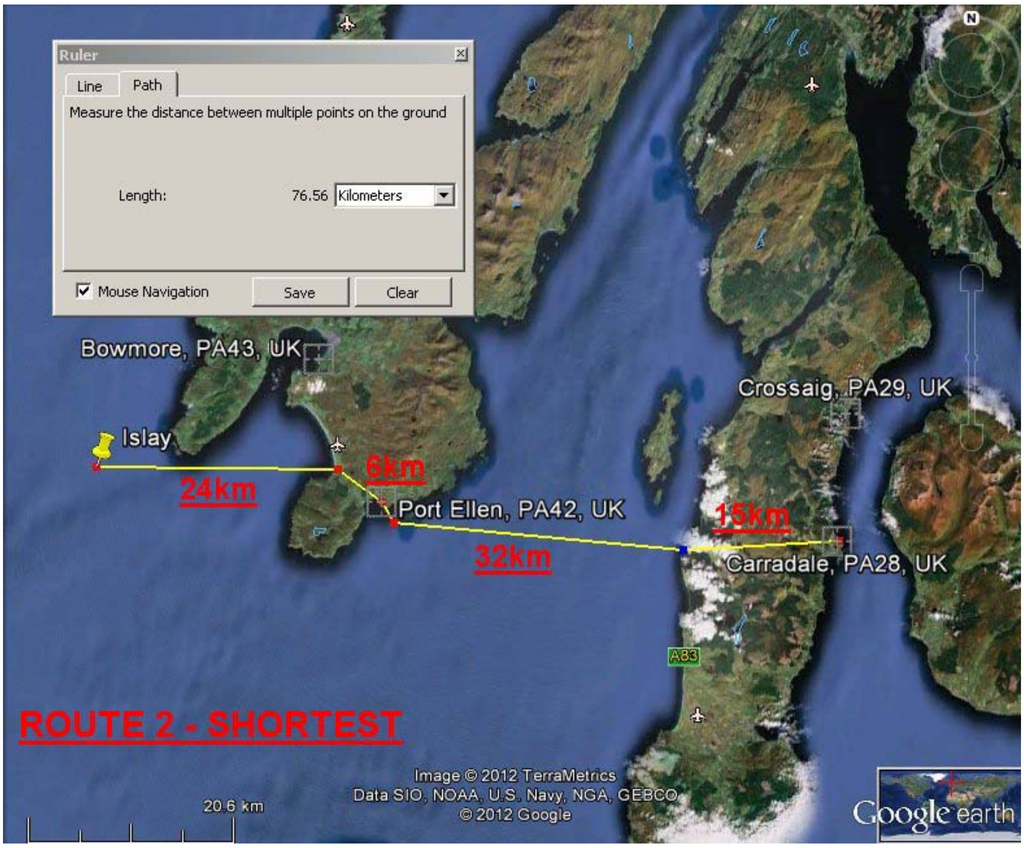

Figure 7 Indicative Cable Route

For the 400MW phase it is probable that several offshore developments will be interlinked by HVDC subsea cable direct to Hunterston. It is assumed that low to medium voltage step up transformers will be installed in each tidal device, and these will then be linked by subsea cable to a number of larger transformer/control rigs for connection to the HVDC hub

4.6. Lifecycle

It is assumed that the offshore development will operate for a full design life of approximately 25 years. At the end of this period, the site would be decommissioned and the devices removed to a standard meeting industry best practice at the time. Alternatively, a fresh application may be made to extend the life of the site or to replace the existing devices.

4.7. Design Verification

The devices would be designed and independently verified to comply with relevant sections of existing offshore codes and standards for a service life of 20 years.

4.8. Installation and Commissioning

The details of the array construction programme for each phase have not yet been determined. However, the offshore construction activities (including the installation of the moorings and the connection of the devices) would be carried out over a period of approximately 6months. The timescale will depend, to an extent, on the availability of suitable installation vessels, and available weather windows. Ideally the array would be installed during the summer period (May to September) when conditions are most favourable (avoiding the equinoctial tides and periods of high winds).
The installation of the array is achieved with a variety of vessels which can include moored barges and Anchor Handling Tugs (AHTs) according to the prevailing conditions and the type of activities.

Prior to installing the devices, cardinal marker buoys will be installed, to mark the boundaries of the offshore development area and direct passing marine traffic (subject to consultation with marine navigation authorities and stakeholders). During construction and operation the array will also have one or two wave rider buoys/ADCP systems installed around the site.

4.8.1. Subsea Cable

The position and landfall of the cable has yet to be determined and is subject to further survey work and assessment. The duration of the activity has also yet to be determined. It would probably be undertaken in a period of neap tides and at a time of the year when meteorological conditions are most favourable.
Interconnector Cables are installed after the mooring spreads are complete and are then connected to the export cable. Once connected, the subsea cable network can be commissioned and tested for integrity from the substation, prior to machine installation.

4.9. Operations and Maintenance

4.9.1. Operations

The individual machines and the array would be monitored from a remote shore control facility via a Supervisory, Control and Data Acquisition (SCADA) system which also provides a degree of control over the machine systems in order to optimise performance to the prevailing conditions. Normal operational mode of the turbines requires no further on-site interventions.

4.9.2. Maintenance

Typical planned maintenance intervals for sub-sea, non-surface piercing devices are as follows:

- Turbine: 2 years (minor), 10 years (major)
- Foundation: not required

The ease of deployment/retrieval of the RR-TGL allows all maintenance to be carried out on shore, significantly reducing the need for potentially costly marine operations. The design life of both turbine and foundation is usually around 25 years.

The MCT turbines are maintained in-situ by raising the turbine nacelles clear of the water. Workboats are typically used but larger vessels may be required for major component changes.

4.10. De-Commissioning

At the end of the project lifecycle, the machines will be decommissioned. The decommissioning of machines involves a reversal of the installation process and is expected to have a reduced timescale.

5. Marine Traffic and Activities

5.1. Data Sources

A key requirement of the PHA is to establish the types of vessels and marine activities to which the proposed development may present a hazard to navigation. In order to establish these hazards, various data sources were consulted. These included:

- Direct stakeholder consultation
- Automatic Identification System (AIS) data
- Admiralty Sailing Directions (Reference 3)
- RYA UK Coastal Atlas of Recreational Boating – Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast. (Reference 6)
- SeaZone hydrospatial data

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5.1.1. Stakeholder Consultation

DPME has identified all interested groups and stakeholders in order to determine their concerns, including navigational safety. A list of navigational stakeholders is included in Appendix A.

Responses to an initial outline scoping letter have been received from:

- Northern Lighthouse Board (NLB);
- Clyde Fishermen's Association;
- Marine Scotland;
- MCA;
- RYA
- British Chamber of Shipping

5.1.2. Automatic Identification Systems (AIS) Data

Adequate AIS data for this site was unavailable at the time of this draft. However, arrangements for AIS data gathering and analysis are being considered as part of the baseline data gathering for the project.

5.1.3. Admiralty Sailing Directions

The Admiralty Sailing Directions (Reference 3) comprise a description of the area, a description of the hazards and recommended routes for passage through the area and into and out of the ports and anchorages. It also describes the main uses and users of the area.

5.1.4. RYA Cruising Routes

Details of recreational boating activities were obtained from the RYA UK Coastal Atlas of Recreational Boating (Reference 6). (See Figure 8.) The routes shown are designated as "Light recreational use".

5.2. Current Marine Traffic

A number of marine users have been identified using the areas around Islay.

5.2.1. Commercial Traffic

There is a significant amount of commercial traffic using the North Channel. Much however uses the Traffic Separation Scheme (TSS) and, therefore, remains to the south of the proposed development area. Traffic intending to head north up the west coast of Scotland does, to great extent, use the Inshore Traffic Route which passes through the Sound of Islay in order to avoid the open sea to the west of Islay.

5.2.2. Military Usage

The Ministry of Defence, Defence Estates Safeguarding department has indicated that they have concerns about both surface and subsurface navigation within defined Practice and Exercise Areas (PEXAs). Further consultation with the naval staff responsible for such matters (Flag Officer Scotland Northern Ireland and Northern England (FOSNNI)) has indicated that such issues may be able to be managed and that the proposed development can be accommodated. There remains, however, concern about noise from devices and its impact on sub-surface navigation and picture compilation.

5.2.3. Ferries

CalMac run ferry services between Port Ellen and the mainland. There are, however, no ferry routes which directly impinge on the proposed deployment area.

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5.2.4. Fishing vessels

The waters around the west coast of Scotland support a variety of fin and shellfish industries including salmon, mussels, trout, cod, halibut, scallops and oysters. Further analysis of fishing activity and the potential impacts will be required to determine the risks to such fishing activities.

5.2.5. Recreational Activities

Given the exposed nature of the west coast of Islay, recreational traffic levels are generally low. The RYA UK Atlas of Recreational Boating (Reference 6) show the west coast of Islay as a "Medium" to "Light" density areas

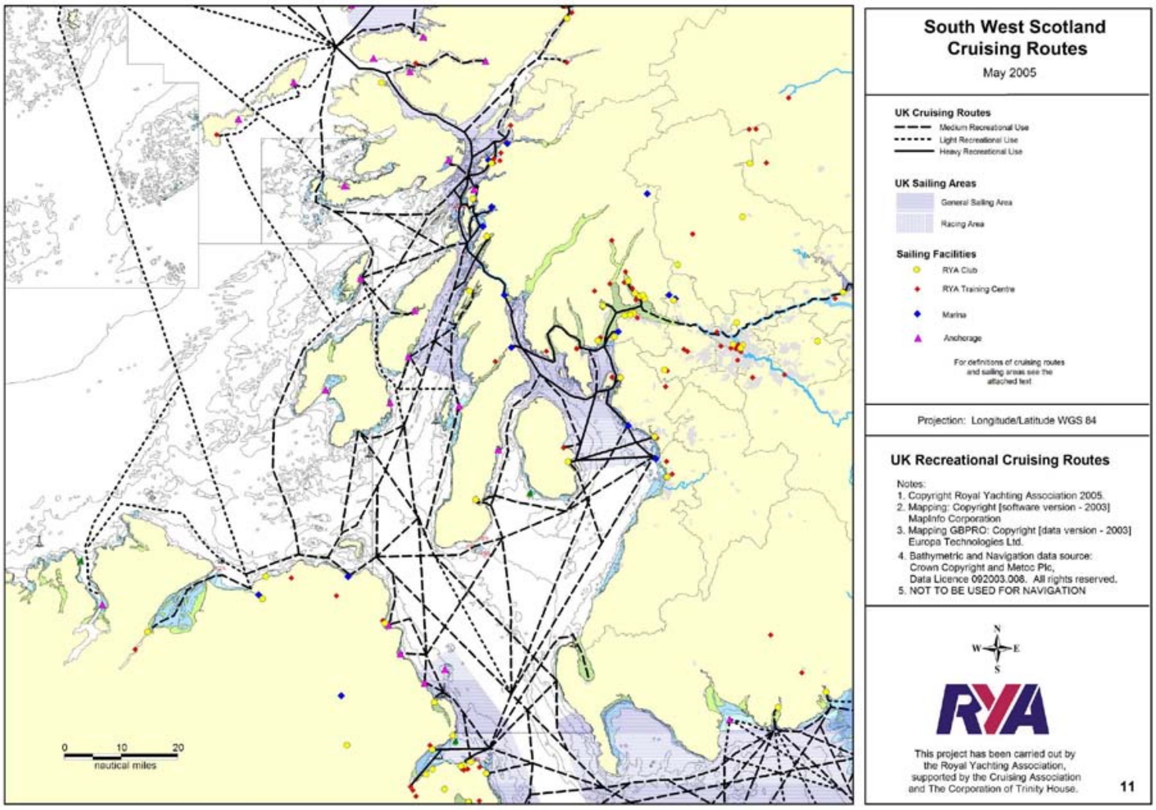

Figure 8 Recreational Boating Routes

5.2.6. Diving

Recreational diving takes place in various locations around Islay. A number of wrecks are identified by diving publications in the immediate vicinity of the proposed site and potential cable routes. These include the wrecks of the:

- Agios Minas
- "Frenchman's Wreck" (Historic Wreck)
- Blythville
- Thomas

The Floristan, Cormoran and Dalton are dived wrecks further along the north west coast of the Rhinns. (Reference 7.)

5.2.7. Aquaculture

A number of marine farms are charted on the south east side of the Rhinns of Islay. Such operations are usually supported by service craft of various types and sizes and, occasionally, diving operations. The current status of these marine farms requires investigation as such

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facilities may be added to and removed on a continuous basis. Marine farm operations are generally supported by service craft (various types and sizes) and, occasionally, by diving operations.

5.2.8. Marine Aggregate

The British Marine Aggregate Producers Association have indicated there are no current or planned marine aggregate interests in the proposed development area and therefore, indications are that the proposal may be considered acceptable subject to review of the final array design and position.

5.2.9. Oil and Gas Industry Support

There is no oil and gas related activity in the area.

5.2.10. Other OREI Developments

In the light of the recent seabed lease agreements between The Crown Estate and marine renewable energy developers in the North of Scotland, there are several other marine renewable energy installations proposed in the surrounding areas of the Western Isles. These include the SSE Islay Wind Farm the proposed south east corner of which is approximately 3 n miles to the north west. This will affect traffic levels, as maintenance and support vessels of various types and sizes may be deployed from various local ports/harbours to install or service marine energy projects. Traffic levels/patterns may also be affected by the displacement of traffic from existing shipping routes in the area affected by OREI developments.
It will be necessary to understand any cumulative and in-combination impacts of such developments on navigational matters. DPME and SSE have already agreed to data sharing, cooperation, coordination and regular review with neighbouring developers and an awareness of the potential cumulative impacts when communicating with the regulatory authorities.

5.2.11. Search and Rescue

The proposed location area is within the Maritime Rescue Coordination Centre (MRCC) based at Greenock on the Clyde. There is an RNLI all-weather lifeboat stationed in the Sound of Islay at Port Askaig. There is also a search and rescue helicopter based at Prestwick Airport.

6. Conclusions

The conclusions of the Preliminary Hazard Analysis are:

- The devices proposed to be installed could represent a hazard to surface and subsurface navigation given the charted depths within the proposed development area and the likely clearances (i.e. in the region of 5m) above the potential devices. In the case of surface piercing structures, e.g. transformer platforms or turbine support structures, the hazard would exist at all times.
- Whilst initial discussions have indicated that impacts on MoD RN surface and sub-surface navigation can be managed satisfactorily, there is potential for underwater noise to present issues to MoD RN submarine activities.
- Vessels engaged in fishing would be at risk of entanglement of their gear with the devices.
- The pre-installation activities (i.e. surveys) and installation could have an impact on present marine activities in the proposed array area and cable route.
- Vessels engaged in subsea cable installation activities could have an impact on marine operations at Port Ellen harbour if vessels were to use facilities at this location.
- Failure of an individual device could result in parts becoming a hazard to shipping outside the proposed deployment area.

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- The maintenance facility would generate additional traffic from supporting workboats that would increase the risks of navigational incident in the waters between the array and the maintenance facility.

7. Proposed Methodology for Navigational Safety Risk Assessment

The DTI/BERR guidance (Reference 2) recognises that there are a wide range of assessment techniques available to estimate the risks presented by OREI developments. The selection of the appropriate techniques should be, according to that guidance:

- Proportionate to the scale of the development and magnitude of the risk;
- Acceptable to the Government.

The MCA in their scoping response have stated that, "*as 400MW installed capacity, this development would be considered as a high risk or Large Scale development within the context of the DECC/DfT/MCA Guidelines on the Assessment of the Impact of Offshore Wind Farms*." The following paragraphs present the proposed methodology for undertaking the navigational safety risk assessment for the array development.

7.1. Understanding Base and Future Case Traffic Densities and Types

The NSRA will require to be based on a thorough understanding of the traffic densities and types. This will, therefore, require data from a number of sources:

- Radar and AIS traffic data plots and analysis for traffic over specified periods meeting the requirements of MGN 371 (i.e. at least 28 days of data demonstrating seasonal variation);
- VMS data for fishing vessels;
- Local expert knowledge e.g. reports and observations by users of the area such as fishermen, recreational users, MoD (RN), CalMac Ferries;
- Chamber of Shipping.

The gathering of such data will be undertaken as part of the baseline data gathering activities. This will include by identifying and verifying current stakeholders (marine users) and engaging with them at an early stage.

Consideration will be given to future traffic levels based on discussions with the appropriate industry representatives and companies or organisations.

7.2. In-combination and Cumulative Effects

The proximity of the proposed SSE wind farm to the north west of the proposed Tidal site will require close cooperation and data sharing between both developers particularly with regard to impacts on navigational safety. This has already commenced at appropriate levels both with SSE and with the contractor engaged to undertake their navigational safety risk assessment. MCA and Northern Lighthouse Board (NLB) engagement in this process will be undertaken at the earliest opportunity.

7.3. Stakeholder Engagement

Early identification of marine users and their representatives is key to ensuring that hazards presented to marine users are identified and addressed. DPME will verify that all potential stakeholders have been identified and included within the consultation process.

7.4. Hydrographic Survey

In order to establish a baseline and confirm the navigable depths, monitor seabed mobility and identify underwater hazards a detailed hydrographic survey will be undertaken. This will extend

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500m beyond the proposed search area. In accordance with MGN 371 (Reference 1), consideration will be given to any re-routing measures resulting from the proposed development and whether it is appropriate to undertake the survey to include any areas into which traffic would be routed. This requirement would be established at an early point in the risk assessment process in discussion with the MCA. Any such survey work would meet the International Hydrographic Organisation (IHO) Standard Order 1a.

7.5. Search and Rescue

The implications for SAR activities will be discussed with the MCA and the RNLI in order to ensure that any impacts are identified and the SAR organisations responsible for the area are included in any mitigation planning. The development of an appropriate Emergency Response Cooperation Plan (ERCoP) will take into account the size and location of the proposed development and be agreed with the MRCC at Greenock.

7.6. Risk Assessment

In order to assess the risks associated with the proposed development further detail of the processes involved in the pre-installation, installation, operation (including maintenance) and decommissioning of the farm would be required as outlined below:

7.6.1. Pre-installation Activities

Pre-installation activities, such as geo-technical surveys, bird surveys, need to be considered for their impact.

7.6.2. Installation

For the installation phase it would be necessary to establish, for example:

- Details of the installation methodology – e.g. vessels to be used for the foundations and cable laying activities;
- Duration of installation procedure;
- Environmental limitations for installation operation;
- Mobilisation and out-load ports/harbours to be used.

7.6.3. Operations

For the operational phase it is required to know:

- Layout and disposition of devices;
- Operating modes and means of control including emergency operating procedures;
- The intended maintenance support facilities to be used for the routine and non-routine maintenance and repair;
- Planned intervention requirements and methodologies e.g. maintenance/inspection of device, vessels required, time on task;
- Unplanned interventions – possible failures and frequencies based on Reliability, Availability and Maintainability Studies using Failure Mode and Effects Analysis (FMEA) or similar technique.

7.7. Risk Assessment Methodology

Assessment of the risks resulting from the hazards presented by the proposed development will be undertaken using the following techniques:

- Analysis of the likelihood of collision between surface vessels in transit and the individual devices of the array taking into account vessel traffic densities and types;
- Discussions with MoD (RN) with regard to sub-surface navigation and noise.
- Expert judgement on the likelihood of physical interaction (entanglement) between fishing vessels and the array devices or cables;

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- Expert judgment on the likelihood of physical interaction (collision) between vessels in transit and vessels engaged in pre-installation, installation, operations/maintenance and de-commissioning activities.
- An assessment of the theoretical possibility of vessels transiting the area (whether intended or unintended) and collision with sub-surface devices as a result of reduced under-keel clearance (UKC).
- Assessment of any third party verification of the structures, foundations and any moorings associated with the devices or construction vessels.

Given the proposed wind farm developments adjacent to the tidal farm it will be necessary to undertake an element of vessel traffic modelling to determine the impacts of any re-routing caused by the combination of the two arrays. This will need to be conducted in cooperation with SSE Renewables as the wind farm developer.

7.7.1. Hazard and Control Log

A hazard log will be created which will:

- Identify the hazards and assess the risks using an IMO Style Criticality Matrix;
- Assess risk tolerability using a matrix based on that in Reference 2;
- Identify appropriate controls and stipulate the required level of risk tolerability on successful implementation of the controls;
- Identify the responsible person responsible for closing out the hazard log entry.

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Appendix 1. Marine Stakeholders

Argyll & Bute Council
British Chamber of Shipping
British Marine Aggregate Producers Association
Caledonian Maritime Assets Ltd (CMAL)
Caledonian MacBrayne Ferries (CalMac)
Clyde Fishermen's Association (CFA)
Clyde Yacht Clubs Association (CYCA)
Diving - BSAC
Local Fishermen - Port Ellen
Inshore Fisheries Group (IFG) - Small Isles and Mull IFG
Islay Dive Centre
Islay Marine Charter
Marine Scotland
Mallaig & Northwest Fishermen's' Association (MNWFA)
MCA
MoD Defence Estates (Safeguarding)
MoD RN FOSNNI
MoD RN QHM Clyde
Northern Lighthouse Board
RNLI Islay Lifeboat Station
RNLI Scotland
RYA Scotland
Scottish Fishermen's Federation
Scottish Canoe Associations
West Highland Anchorages and Moorings Association

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Record of Changes

Rev #	Date	Description	Approved
A	2012-03-12	Draft for Internal review	D CANTELLO
B	2012-03-12	Draft for Client Review	N CHIVERS
C	2012-04-10	Draft for Client Review	N CHIVERS
D	2012-04-17	Draft for Client Review	N CHIVERS
E			
F			
G			
0	2012-04-20	Issue	B Marnie
1	2012-05-04	Revised to address comments from MCA	B Marnie
2			
3			
4			
5			
6			

Distribution List

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