Watermark
aqua-environmental
ballywaltrim house
ballywaltrim bray
co wicklow ireland

Natura Impact Statement for a salmon farm installation at Deenish Island, Kenmare Bay County Kerry.

June 2012

Client:
Marine Harvest Ireland
Rinmore
Letterkenny
County Donegal

tel +353 (0) 1 2862000
mobile +353 (0) 872 481581
e-mail neilbass@iol.ie

Natura Impact Statement for a salmon farming facility at Deenish Island, Kenmare Bay, County Kerry

Executive Summary.

The completion of this Natura Impact Statement (NIS) has been requested by the Aquaculture Licence Appeals Board (ALAB) to consider the production strategy employed at Deenish Salmon Farm in Kenmare Bay by its owners, Marine Harvest Ireland (MHI). It should be further noted that legislation and guidelines require that only protected areas created (SAC's and SPA's) are considered in an NIS. Therefore this document only makes passing reference to other designations, created under national legislation or other EU directives.

As for many embayments along the Irish coast, the Natura process is as yet incomplete in Kenmare Bay, which is still designated as a Candidate SAC (cSAC). This is a critical issue for the progress of sustainable aquaculture development in Ireland, and indeed for the compiling of this NIS, because much of the information required for the assessment of the impacts of existing and proposed enterprises within the bay will not be available until the Natura process is complete and the licensing of enterprises within the bay can properly proceed.

A salmon farm has been operating at Deenish Island over the last 23 years. The farm was first licensed and deployed in 1989.

In 2011, in line with current best practice, an improved mooring and containment system was installed at the site, using a submerged grid with a total of 26 mooring ropes and anchors, to support the net pens. Twelve, 40m diameter, Aquiline-type pens were installed into the grid, in the existing site area. A feed barge, nominal length 25m, is now also moored west of the pens.

This is a large salmon farming unit by current standards and it is relevant to ask what risks there are of significant impacts on the environment, in both the near-field and the far-field. An NIS addresses these issues by considering the risk of impacts on protected areas around the site, created under the Habitats Directive (92/43/EC) and the Birds Directive (79/409/EEC).

The NIS considers risks of direct impacts on the two protected sites within which the salmon farm site is located, the Kenmare River cSAC 002158 and Deenish and Scariff Islands SPA 004175. The document also considers the possibility of indirect risks on all other protected sites within a 20km radius of the site.

Risk of direct impacts are considered on the habitats and species cited as being of special conservation interest in the two protected sites within which the farm is located. Of the rare and notable species that occur on the seabed within the cSAC, none mentioned in the site synopsis are known to occur close to the Deenish site. This has been indicated in benthic surveys conducted for two EIS's and a number of annual monitoring surveys.

In respect of mammals, Otter (*Lutra lutra*), the Common / Harbour Seal (*Phoca vitulina*) and the Lesser Horseshoe Bat (*Rhinolophus hipposideros*), all Annexe II species, occur within the SAC. However none are recorded as inhabitants of the vicinity of Deenish or Scariff Islands.

Regarding marine mammals, local haul-outs of Common and Grey seal are regarded as being too far away for the farm site for risks of direct impact to be significant

Although cetaceans will come within close range of the farm operation on an intermittent basis, these visits are not expected to be subject any significant or regular risk of impact.

The boundary of SPA 004175 is drawn 500m seawards around Deenish and Scariff islands. The boundary therefore encompasses the bulk of the licensed Deenish farm site area. The SPA also lies within the Kenmare River SAC. The SPA site is of special conservation interest for the following sea bird species: Fulmar (*Fulmarus glacialis*), Manx Shearwater (*Puffinus puffinus*), Storm Petrel , Lesser Black-backed Gull (*Larus fuscus*) and Arctic Tern (*Sterna paradisaea*). Shag (*Phalacrocorax aristotelis*), Herring Gull (*Larus argentatus*), Great Black-Backed Gull (*Larus marinus*) and Black Guillemot (*Cepphus grylle*) also breed there. Of terrestrial bird species, Chough (*Pyrrhocorax pyrrhocorax*), are recorded as breeding in small numbers on Scariff Island. All these species and some other seabird species mainly nest along or at the base of the sea cliffs of both islands.

The NIS finds that, although the farm site is located within the area of the SPA, it occupies no more than 3% of the marine area designated (and none of the island area designated) The nesting areas for projected species are on sea cliffs on the opposite sides of Deenish and Scariff Islands from the farm location. It is therefore concluded that there is no significant risk of impact on seabirds as a result of spatial obstruction, noise and activity, smell, waste discharges or any other cause, arising from the Deenish salmon farm.

It is further observed that the Deenish salmon farm has been in operation in the same location since 1989. The synopsis for the SPA, which was written in 2007, lists the historical threats to the breeding populations of protected bird species in the site as being sheep, feral goats and rabbits. The Deenish farm site is not mentioned as a historical, current or potential threat in the SPA synopsis.

In respect of risk of indirect impact, the five protected sites beyond the salmon farm boundaries but within a 20km radius of it, are considered. The forcing parameters that have a potential to carry particulate and soluble wastes, as well as sea lice and other potential contagions are considered. It is observed that, as the result of the active hydrography of the outer Kenmare Bay area, the potential for dispersal and dilution of all such agents is very significant indeed. In this sense, it is submitted that the Deenish farm site is far removed hydrographically from protected sites within a 20km (linear) radius of it.

The NIS develops growth, feeding and discharge models, based on company, in-house empirical data, for the Deenish farm operation, in order to project the likely soluble and solid waste inputs into outer Kenmare Bay and the uptake of oxygen by the fish and by discharges. Waste streams from the site are classified as waste feed and faecal solids, nutrients, carbon and medicines, the latter used in-feed, in in-pen bath treatments and in-well boat bath treatments. The report goes on to investigate the potential dispersal and dilution of soluble inputs by the use of a box model and the settlement of solid wastes on the seabed from empirical data and by reference to previous studies.

In respect of soluble nutrient wastes, the report concludes that, due to the high values for forcing parameters (based on empirical evidence) and consequent rates of dispersion and dilution, ambient Nitrogen and Phosphorus will only show marginal elevation as a result of the operation of the farm. Kenmare Bay is operating well within its carrying capacity as defined by established EQS levels, both before and after nutrient inputs from the Deenish farm operation. The potential impact of such small elevations on local protected areas is regarded as wholly insignificant, both in the near field and the far field. The nutrient dispersion model is regarded as conservative in that it takes no account of the reality of nutrient assimilation, through primary production and bacterial action in the water column.

In respect of Oxygen uptake through fish respiration and the BOD requirements for the assimilation of discharges, the model projects a total monthly Oxygen requirement of 0.74% of the oxygen available in the waters that flush the modelled $50km^2$ box model on every tide. No significant impact will result from this level of uptake. The oxygen model is regarded as conservative, because it makes no allowance for natural oxygen dissolution into the water column, either through primary production or through oxygen diffusion at the air water interface.

In respect of settled solids and their impact on the benthic infauna, empirical data is provided in the form of photographic plates, taken during a routine statutory benthic survey in July 2011. The plates show the seabed immediately under a net pen at the site, at its downstream edge and at other locations further downstream and away from the immediate under-pen area. Even the worst case (under the pen) indicates only a very sparse layer of solids on the seabed. Infaunal data collected at the same time indicates that the benthic infaunal community is only "changed" in the immediate under-pen area.

A dispersional model has yet to be completed for solutes and solids dispersion at the Deenish farm site but empirical observations at Deenish are compared with modelled data from another, broadly similar site. The model predicts that, even after one year of deposition at the maximum monthly deposition rate every month, (at maximum standing stock, based on an identical growth forecast to that applied to the Deenish site), maximum under-cage sediment depth would be no more than 13mm and the infaunal community would only be "changed" (ITI = 30) within this zone. The report concludes that, bearing in mind that bottom currents run at above the sediment resuspension speed of $9.5cmsec^{-1}$ for 17% of the production cycle, sediment loading will remain low and benthic communities will rapidly return to normal during the minimum 2 months fallowing period, every second year. The benthic survey infaunal lists provided as part of the 2011 benthic survey reveal no species indicated for special protection in the Kenmare River SAC or neighbouring SAC's. Generally, these are all found further to the east in the SAC area, in more sheltered conditions. The benthic data provided is regarded as conservative because no account is taken of the reduction of benthic loading as a result of grazing down of sediments by opportunist epifauna and infauna, or of the scouring effects of wave climate on exogenous benthic sediments. In conclusion the report finds no significant likelihood of impact on protected habitats or species as the result of the sedimentation or subsequent further dispersal of settled solids emanating from the Deenish farm site.

In respect of medication, the report concludes that such is the low deposition rate of solids per unit seabed area (aided by low stocking densities in the farm pens under organic certification, the use of highly digestible feeds, good feed management and a significant proportion of seabed currents over the required resuspension speed), that residues from in-feed treatments are unlikely to impact on the seabed or its infauna or epifauna. The only in-pen bath treatment now practiced by MHI is Hydrogen Peroxide treatment, against sea lice. The breakdown products of this treatment are environmentally neutral (water and oxygen) and lice dislodged by the treatment are collected, destroyed and removed from the site for onshore disposal. All other bath medication treatments are carried out in well boat tanks; this economises on treatment quantities and increases treatment efficacy. Once used, treatments can be discarded from the well boat tanks, well clear of sensitive areas. The report therefore concludes that no significant impact will arise on Natura-protected habitats or species as a result of medicine treatments at the Deenish farm site. This finding is in line with the findings of the Scottish Environmental Protection Agency (SEPA) and other Scottish authorities in the case of Scottish salmon farming.

Regarding sea lice, the historical record of statutory sea lice monitoring, conducted by Irish government officials over the last 15 years or so, indicates that ovigerous lice (*L. salmonis*) levels on fish sampled at the Deenish farm site have remained extremely low and have never breached the trigger level of 0.5 lice per fish, which applies during the sensitive spring period. Levels have only exceed the outside-spring period trigger level of 2.0 lice per fish on four occasions in 166 separate inspections. The data also indicate that new infestations of lice-free fish at the Deenish site have always tended to be low. Thus suggests that the hydrographic distance from sources of wild lice and local hydrography do not favour the infestation of farmed salmon at the site from natural sources.

The NIS proposes a simple arithmetic model to establish the order of magnitude of dilution of farm-origin infestive Copepodid lice larvae, if dispersing from the site. A tidal prism model is used to calculate the volume of water that will flush through a given box area at the site each month and this is used to dilute the concentration of Copepodids calculated to disperse from the site during the same period. The model is tested at three different trigger levels for on-farm ovigerous lice, at 0.5, 2.0 and 5.0 lice per fish, as the basis for the numbers of Copepodids hatched and dispersed. The model calculates that the density of surviving Copepodids at the limits of a 50km^2 box would be 0.04 to 0.004 Copepodids/m^3 water, or one Copepodid per 25 m^3 to 250m^3 water. This up to three orders of magnitude lower than the density of larvae at the point of hatch. The report concludes that, wherever potential host fish (Atlantic salmon, a protected species in freshwater in SAC 000365 for the Currane river system, 13km from the Deenish farm site, or sea trout, which is not protected) encounter such a density of lice, be it in a river estuary or on the high seas, such a density has no significant prospect of augmenting natural infestation levels, by wild-origin lice. This model is regarded as conservative because the numbers of lice dispersed include all Nauplii from the first four days of the larval dispersal, which is 28.5% of the total dispersion period used in the model.

Note that these observations apply to lice infestation dynamics at the Deenish site only and cannot necessarily be expected to apply to other farm sites in other locations, in particular where there is a more proximate relationship between the farm site and wild fishery rivers.

The NIS then investigates the potential for significant risks of impacts arising for Natura-protected habitats and species from escapes of stock from the Deenish farm site. The report concludes that, as a result of historical evidence, operational and mitigation measures taken by MHI, as well as the impending implementation of a certification protocol for fish farm containment structures in Ireland, the risk of such impacts is not a significant one.

Finally the NIS assesses the prospects of combination impacts, with other developments in the Kenmare River area and concludes that, as a result of the geographical remoteness of the Deenish farm site and the hydrography of outer Kenmare Bay, the significance of both direct and indirect impacts on Natura-protected habitats and species is unlikely to increase as the result of any combination of impacts between the Deenish farm site and any other developments.

In final conclusion, this NIS finds no grounds to believe that any significant impact, either direct or indirect, on Natura-protected habitats or species, will arise from any activity, or discharge, or infestation, infection or escape from the MHI Deenish salmon farm site. This conclusion is reached primarily as a result of the synergistic benefits of certified organic operation of the site, its remoteness from many protected areas in the outer Kenmare Bay area, including protected salmon rivers, the operational methodologies employed by MHI, the current best practice specifications of the containment system deployed at the site and the site location, in particular in respect of local hydrography and exposure to oceanic conditions.

Natura Impact Statement for a salmon farming facility at Deenish Island, Kenmare Bay, County Kerry

Contents

Tables.

Figures.

Plates.

Natura Impact Statement for a salmon farming facility at Deenish Island, Kenmare Bay, County Kerry.

Main Report.

Section 1.
Introduction.

1.1. The purpose of this document.

The Department of the Environment, Heritage and Local Government's (DoEHLG) guidelines[1] on Appropriate Assessment (AA), required under the terms of the EU Habitats Directive (92/43/EC) and Birds Directive (79/409/EEC), state that the duty to undertake an AA lies with the relevant Competent Authority, for example the National, Regional or Local Authority charged with decision-making in respect of the licensing of a project within a Natura Area. Where the Competent Authority requires information, in order to assist in the undertaking of an AA (e.g. an analysis of potential effects of the proposed project on Natura 2000 sites), this information must be obtained and presented by the applicant in a Natura Impact Statement (NIS).

The guidelines require that an NIS should fulfil the following requirements:-

- Description of the proposed development in terms of its scale and objectives.
- Description of baseline conditions, conservation objectives, and relevant ecological and environmental issues in relation to local Natura 2000 sites.
- Identification and estimation of the significance of potential adverse impacts, both direct and indirect, on local Natura 2000 sites.
- Consideration of combined impacts with other developments.
- Proposals to mitigate the possible impacts of the proposal if any.

In this case, the completion of an NIS has been requested by the Aquaculture Licence Appeals Board (ALAB) to consider a production strategy employed at Deenish Salmon Farm in Kenmare Bay by its owners, Marine Harvest Ireland (MHI). It should be further noted that legislation and guidelines require that only protected areas created under the Habitats and Birds Directives (SAC's and SPA's) are considered in an NIS. Therefore this document only makes passing reference to other designations, created under national legislation or other EU directives.

1.2. Legislative background.

The environment and wildlife in the EU are protected in the main through the Habitats Directive (92/43/EC) and the Birds Directive (79/409/EEC). The Habitats

[1] Department of Environment, Heritage and Local Government, 2009. Appropriate Assessment of plans and projects in Ireland. Guidance for planning authorities. DoEHLG 2009 84pp

Directive placed an obligation on Member States to establish a network of ecologically important sites, that require protection under legislation, entitled the Natura 2000 network. The Natura network is made up of Special Areas of Conservation (SAC's), established under the Habitats Directive and Special Protection Areas (SPA's), established under the Birds Directive.

Ireland has been slow to implement the terms of these Directives as evidenced by European Court judgments against it. However, full implementation is now progressing under the terms of the European Communities (Natural Habitats) Regulations; S.I. 94 of 1997 as amended by S.I. 233 of 1998 and S.I. 378 of 2005, and the European Communities (Birds and Natural Habitats) Regulations SI 477 of 2011, which transpose the EU directives into Irish national law.

Ireland's marine embayments encompass many habitats now protected under SAC and SPA designations. Further protection is afforded under national legislation[2], in Natural Heritage Areas (NHA's), Nature Reserves and National Parks. Designated Shellfish Areas have also been established around the Irish coastline under the Shellfish Waters Directive 2006/113/EC, transposed into Irish law by the European Communities (Quality of Shellfish Waters) Regulations 2006 (SI No 268 of 2006).

Many Natura designations await full ratification in Ireland. Many candidate sites (cSAC's) still await the completion and processing of their required assessment surveys and the publication of Conservation Plans and Objectives and Appropriate Assessments (AA), as required under Article 6 of the Habitats Directive.

Only bog NHA's, created under the Wildlife Acts, have been given the full protection in law. There are a further 617 proposed NHA's (pNHA's), which have been awaiting ratification since 1995. That said, the habitats and wildlife in many of these areas are already protected in that they overlap SAC and SPA designations.

Of the many Natura marine areas important for aquaculture in Ireland, only two have completed the full Natura ratification process to date, such that licensing and licence renewal of aquaculture operations in these areas can now proceed. In all other cases, licensing and renewal are at a standstill and new proposals cannot advance, whilst existing enterprises can only continue to operate under the terms of their former licences (as defined by the Sea-Fisheries and Maritime Jurisdiction Act 2006). Under these circumstances, expansion or even modification of existing operations, in order to achieve current best practice, even in respect of sustainability or animal welfare, is difficult to achieve. It is worthy of observation that the dilemma that such enterprises face (which has proved ruinous in some cases) is as a direct result of the failure of the Irish government to abide by the terms of European Law. The overall outcome in the last decade has been that, probably uniquely on a global scale, where aquaculture is by far the fastest growing food sector, Ireland has experienced considerable shrinkage in its aquaculture industry, with concomitant reductions in aquaculture employment (mainly in marginalised, rural, coastal areas,

2 Wildlife Acts 1976, as amended 2000 and 2010

where employment opportunities are limited) and export earnings. Indeed there are growing markets awaiting Irish produce where substitution is the only alternative and opportunities for Irish business are being lost.

Amongst those embayments where the Natura process is as yet incomplete is Kenmare Bay, which is still designated as a cSAC. This is a critical issue for the progress of sustainable aquaculture development, because the entirety of the bay, which has many different habitats and ecosystems within its shores, is designated as a single cSAC; see Section 3. As a result, much of the information required for the assessment of the impacts of existing and proposed enterprises within the bay will not be available until the Natura process is complete and the licensing of enterprises within the bay can properly proceed. It now seems likely that Kenmare Bay will be one of the last aquaculture areas to complete its Natura ratification. As far as is known, no date has yet been put forward for the completion of this process.

1.3. Salmon farming in Kenmare Bay.

See Figure 1. The first salmonid net pen system in Kenmare Bay was licensed almost 40 years ago, in Kilmackillogue Harbour. There are still two small sites in Kilmackillogue but they have been unoccupied for some years, awaiting the processing of a further licence application, at Kidney Rock, lodged in 2005.

Marine Harvest Ireland operates two sites in outer Kenmare Bay, one in the lee of Inishfarnard Island, in Coulagh Bay to the southern shore, the other in the lee of Deenish Island, west of Lamb's Head, to the northern shore. The site at Deenish Island is the subject of this study.

A site at Doonagh Point, 5km east of Inishfarnard, was licensed in 2000. This site is now owned by Murphy's Irish Seafood and is currently fallow.

1.4. Deenish salmon farm; overview.

1.4.1. History.

A salmon farm has been operating at Deenish Island over the last 23 years. The farm was first licensed and deployed in 1989. The first EIS was published for the operation in the same year, soon after the adoption of EIA Directive 85/337/EEC into Irish law in July 1988. The Deenish farm was wholly owned by Salmara Fisheries, an ESB subsidiary, from 1991, to join other salmon farming interests in Kenmare Bay, Bantry Bay, Donegal and elsewhere. However, in 1994, the ESB underwent a rationalised divestment of its non-core activities and the bulk of the Salmara enterprise was disposed of. Salmara's former sites in Kenmare and Bantry Bays changed hands a total of three times before coming into the ownership of Marine Harvest Ireland (MHI), now the country's only significant salmon farming company, in 2010. MHI uses the site for the production of certified organic salmon.

Figure 1
Deenish Salmon Farm Natura Impact Statement
Kenmare Bay location of salmon farm licences and licence applications

Key
Approximate location of salmon farm licences and applications

Map scale 1:200 000
(1 square = 5km x 5km)

In 2001, a new EIS and Aquaculture Licence application was submitted for the Deenish site, to the then DCMNR, by its then owners, Beara Atlantic Salmon Ltd. Much of the information in this EIS is still valid and it is referred to in this document. Figure 2 shows an aerial view of the Deenish site, in 2000.

Until 2010, the pens used at the site were individually moored, 40m diameter, octagonal Bridgestone type, with 15m deep nets (as seen in Figure 2). In 2011, in line with current best practice, an improved mooring system was adopted, using a submerged grid with a total of 26 mooring ropes and anchors, to support the net pens. Twelve, 40m diameter, Aquiline-type pens were installed into the grid, in the existing site area. A feed barge, nominal length 25m, is also moored west of the pens. This layout is shown in Figure 3, which also shows the boundary of the licensed site area.

1.4.2. Site dimensions and layout.

The seabed area of the licensed site is 14ha (35 acres). Mean depth under the pens is 22m to 27m (MLWST). The structures visible above the surface (pen rings with central bird net supports and bird nets, grid buoys and a feed barge) occupy a sea surface area of 1.6ha (4 acres), spread over a total sea surface area of some 240m x 180m or 4.3ha (10.6 acres). The tallest items on the site are the feed barge at 5.5m, including superstructure and the bird net supports in each pen, at 4m; see Plates 1 and 2. To all intents and purposes, the site structures described are permanently moored at the site, although the stock will be harvested out of the site biennially, leaving the site fallow for a minimum of two months in every two-year production cycle.

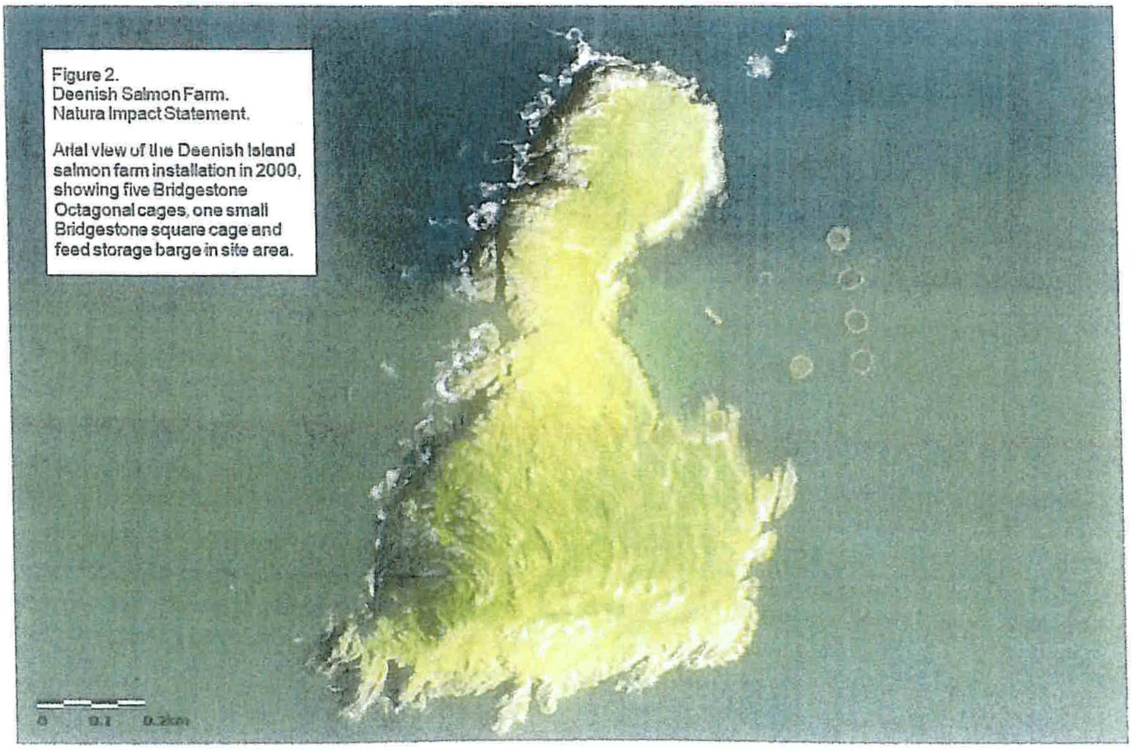


Figure 2.
Deenish Salmon Farm.
Natura Impact Statement.

Arial view of the Deenish Island salmon farm installation in 2000, showing five Bridgestone Octagonal cages, one small Bridgestone square cage and feed storage barge in site area.

Plates 1 and 2
Deenish Salmon Farm
Natura Impact Statement
Views across the farm site with pens and feed barge deployed in 2011

Plate 1 View across new net pens and Deenish salmon farm. showing pen rings and bird net supports. a grid buoy is visible mid-frame.

Plate 2 View across a net pen at Deenish salmon farm with feed barge and Deenish Island in the background

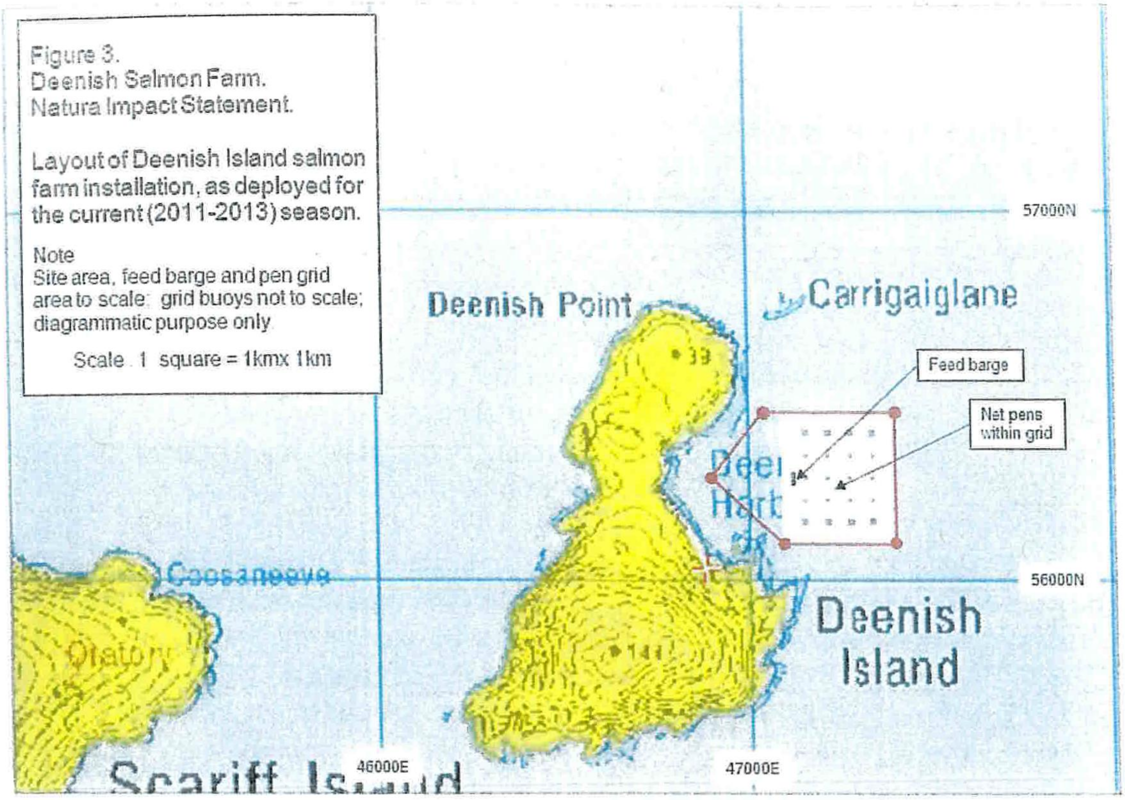


Figure 3.
Deenish Salmon Farm.
Natura Impact Statement.

Layout of Deenish Island salmon farm installation, as deployed for the current (2011-2013) season.

Note
Site area, feed barge and pen grid area to scale; grid buoys not to scale; diagrammatic purpose only

Scale 1 square = 1km x 1km

Section 2
Potential targets for Impacts from the proposed Deenish Salmon Farm operation in Natura 2000 sites.

Figure 4 shows the Natura 2000 sites within a 20km radius of the Deenish Island site. Natura sites open to possible Impacts from any development can be segregated into:-

- Natura sites where <u>direct</u> impacts may be possible, that is where there is spatial overlap between the development site in question and Natura sites, or with species protected by such sites

- Natura sites where <u>indirect</u> impacts may be possible, that is where there is no spatial overlap between the development site in question and Natura sites, but where the degree of adjacency between the two is such that impacts dispersing from the development site may be experienced at the Natura site, or where wildlife foraging or otherwise dispersing from the Natura site and may enter a zone of impact or effect around the development site. Natura sites up to 20km distant from the Deenish site are considered in the assessment of possible indirect impacts in this study.

2.1. Natura sites where direct impacts may be possible.

With reference to Figure 4, it can be seen that the Deenish Salmon Farm site lies within the Kenmare Bay cSAC 002158 and also within the Deenish and Scariff Islands SPA 004175. Thus significant direct impacts may be experienced within these two protected areas. These two sites are described in Sections 2.1.1 and 2.1.2 whilst their site synopses can be found in Appendix I.

2.1.1. Kenmare River cSAC 002158.

Whilst the Conservation Plan and Objectives, and Appropriate Assessment, have not yet been compiled and published for the Kenmare River cSAC and are therefore not available for reference, a considerable number of studies have been conducted within the cSAC area over the years[3, 4, 5, 6, 7]. These have been useful in the compilation of this NIS.

The Kenmare River cSAC 002158 encompasses the entirety of Kenmare Bay, from its head, at Kenmare town, to its mouth, just west of Deenish and Scariff Islands. It is a large, shallow inlet with bays, a habitat in Annex I of the EU Habitats Directive. The Deenish and Scariff Islands SPA 004175, which includes the area of the Deenish farm site, also lies within the Kenmare River cSAC; see below. By virtue of its size (434km^2), the cSAC contains a high diversity of marine habitats and communities, with very exposed marine conditions towards its western end (including the Deenish site area) and ultra-sheltered marine to estuarine conditions towards its head.

The cSAC contains two other marine habitats on Annex I of the EU Habitats Directive, namely reefs and sea caves. However neither of these occur close to the Deenish farm site. They are therefore not open to impact from the site. The cSAC provides habitats for 24 rare or notable marine species. The periphery of the cSAC also includes many shoreline / terrestrial habitats listed in Annexe I of the Habitats Directive. The nearest to the farm site are the sea cliffs to the south and west of Deenish and Scariff Islands, within SPA 004175, and also within the Derrynane Bay area, on the Iveragh Peninsula, some 8km NE of the Deenish. This area includes dry heath, fixed dunes, marram dunes, sea cliffs and salt meadow habitats.

3 National Research Vessel MV Lough Beltra Surveys 1987

4 De Grave S and Whitaker A. 1999. A census of maërl beds in Irish waters. Aquatic conserv: Mar. Freshw. Ecosyst. 9, 303-311.

5 Picton, B.E.; Costello, M.J. (Ed.) 1999. The BioMar biotope viewer: a guide to marine habitats, fauna and flora in Britain and Ireland. Environmental Sciences Unit, Trinity College: Dublin

6 Anon. 2003. The Kenmare River SAC broad scale mapping project

7 Anon 2009. Surveys of sensitive sublittoral benthic communities in Kenmare River SAC Site Code 002158, Tralee Bay and Maharee Islands West to Cloghane SAC Site Code 002070. MERC Consultants for NPWS.

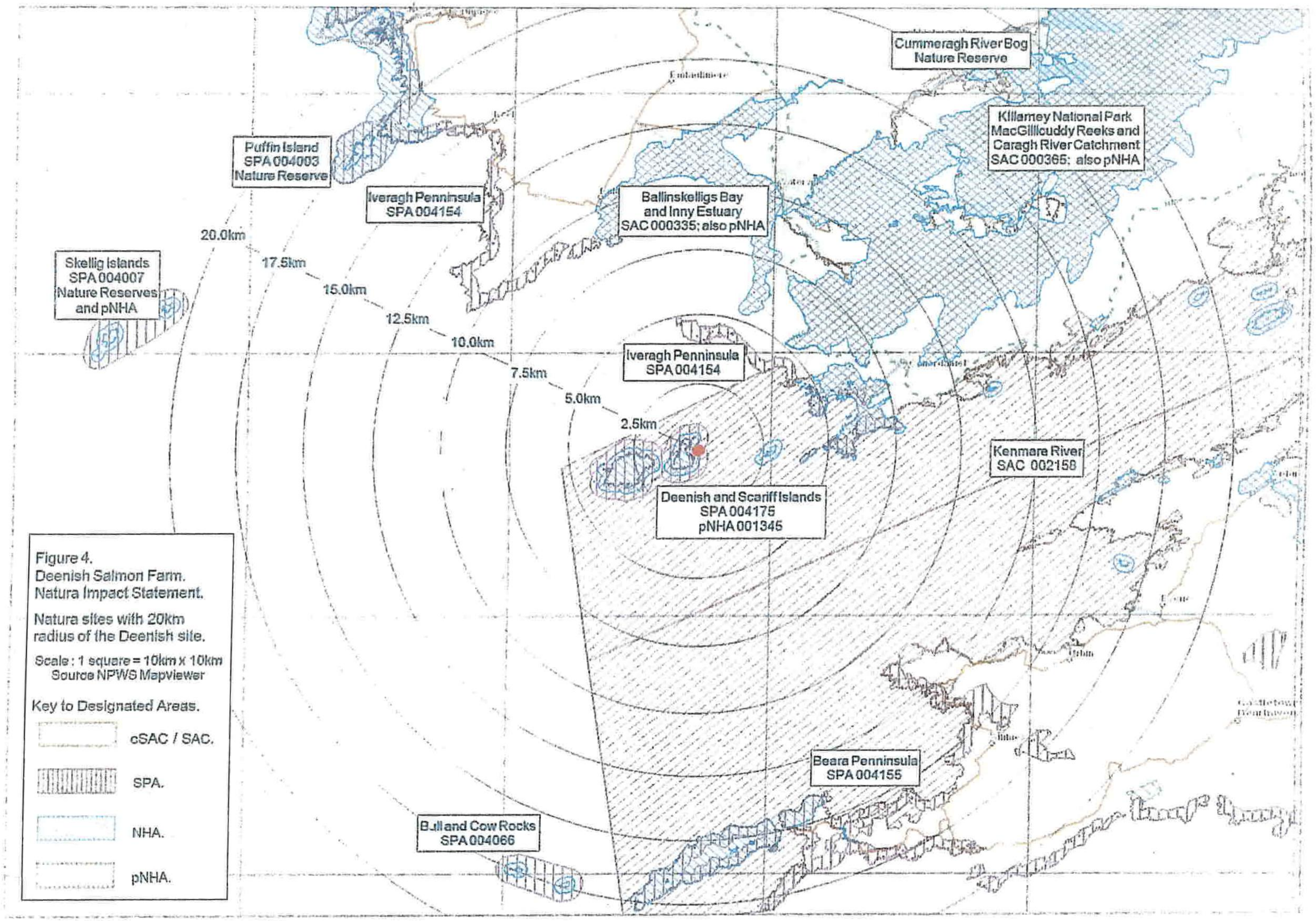


Figure 4.
Deenish Salmon Farm.
Natura Impact Statement.

Natura sites with 20km radius of the Deenish site.

Scale : 1 square = 10km x 10km
Source NPWS Mapviewer

Of the rare and notable species that occur within the cSAC, none mentioned in the site synopsis are known to occur close to the Deenish site. This has been indicated in benthic surveys conducted for two EIS's and number of annual monitoring surveys, carried out as a condition of the Deenish site's Aquaculture Licence (see Section 4), as well as by numerous survey reports referenced herein. For example, Kenmare Bay is the only known Irish site for the Northern Sea fan, *Swiftia Pallida* where it can also co-exist with the Southern sea fan, *Eunicella verrucosa*. However the known distribution of these two species is in more sheltered waters, on rocky ground in the mid-bay area, the closest being just east of Rossdohan Island, 25km to the east of Deenish Island [7].

Much the same is true of the burrowing anemone, *Pachycerianthus multiplicatus* and the main maërl beds (generally *Lithamnion sp*, although the rarer *Lithophyllum dentatum* also occurs, in Ardgroom Harbour[8]). These occur at least 15km east of the Deenish farm site, towards the north shore.

A check of the epifauna and infauna identification lists from the two Deenish EIS's and annual monitoring benthic surveys reveals none of the marine invertebrate species mentioned in the synopsis for the site. Nonetheless a varied range of infauna and epifauna is present within the licensed seabed area of the site (see Figure 3). This document considers the potential for impacts on infauna and epifauna local to the Deensih site in Section 4.2.3.

In respect of mammals, Otter (*Lutra lutra*), the Common / Harbour Seal (*Phoca vitulina*) and the Lesser Horseshoe Bat (*Rhinolophus hipposideros*), all Annexe II species, occur within the SAC. However, none are recorded as inhabitants of the vicinity of Deenish or Scariff Islands. Since they do not inhabit the islands, mainland populations of these species are regarded as being too far removed for either bats or otters to visit the site.

Regarding marine mammals, over one third of the Irish national minimum population estimate for the Common Seal use terrestrial haul-out sites in southwest Ireland, most of these being within Kenmare and Bantry Bays[9]. There are a 11 haul-out sites within the Kenmare River SAC, with a maximum recorded total population of some 310 individuals[10]. Most sites are occupied throughout the year, albeit to different extents seasonally[11].

---

8 Anon 2009. Surveys of sensitive sublittoral benthic communities in Kenmare River SAC Site Code 002158, Tralee Bay and Maharee Islands West to Cloghane SAC Site Code 002070. MERC Consultants for NPWS.

9 Cronin, M et al. 2004. An assessment of population size and distribution of harbour seals (*Phoca vitulina vitulina*) in the Republic of Ireland during the moult season in August 2003. Biological Conservation (in review)

10 Harbour seal population monitoring 2009-2012: Report No. 1. Report on a pilot monitoring study carried out in Southern and Western Ireland, 2009. National Parks & Wildlife Service June 2010

11 Roycroft D. et al. Risk assessment for marine mammal and seabird populations in South-Western Irish waters (R.A.M.S.S.I.), CMRC, University College Cork, March 2007.

All haul-outs lie well to the east of Deenish Island, the nearest being at Westcove, some 10km distant; see Figure 5. Therefore, whilst not completely absent in summer months, common seals would be very infrequent visitors to the Deenish salmon farm site. The fact that there are no haul-outs within closer range is thought to be a result of the exposure of the Deenish area. As in Bantry Bay, the Common Seal haul-outs in Kenmare Bay are well landward of the outer bay area, in more sheltered areas.

The Grey Seal (*Halichoerus grypus*) prefers more exposed conditions than Common Seal. However their only haul-out in Kenmare Bay in not in the Kenmare River SAC but in Ballinskelligs Bay, protected under SAC000335; see Section 2.2.

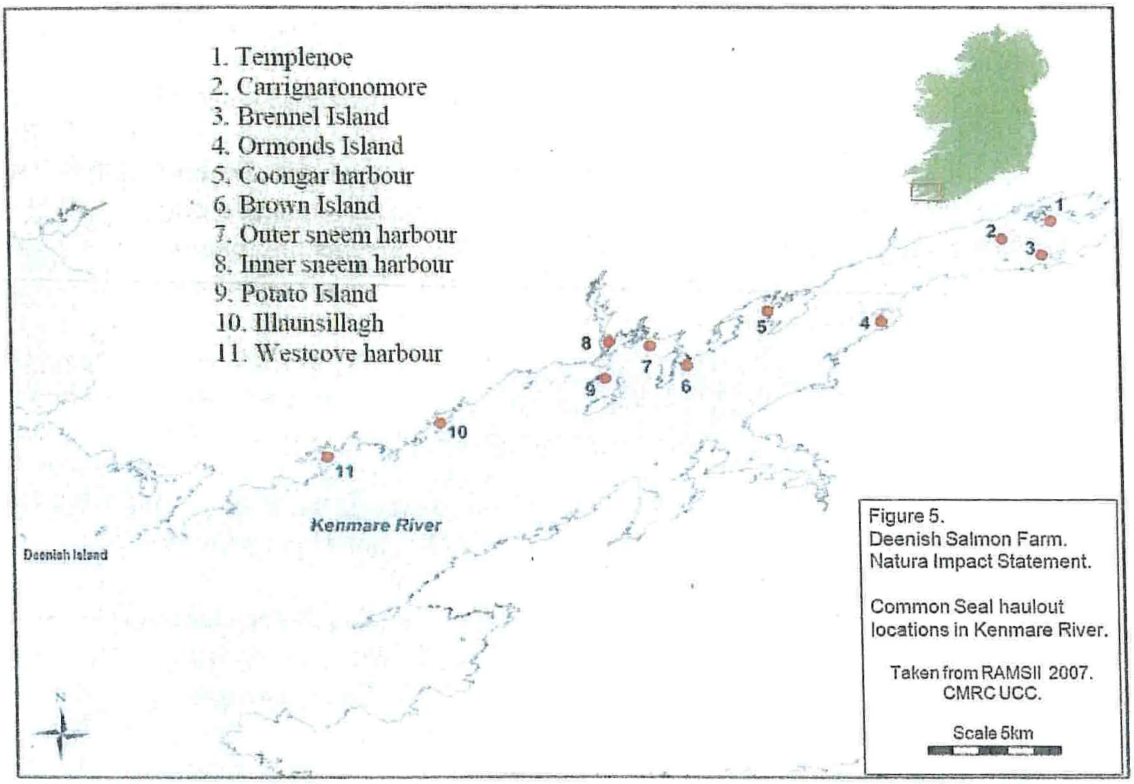


Figure 5.
Deenish Salmon Farm.
Natura Impact Statement.

Common Seal haulout locations in Kenmare River.

Taken from RAMSII 2007. CMRC UCC.

Of other marine mammals, over 100 cetaceans were sighted in Derrynane Bay between 1987 and 2011[12] (within, say 7km of the Deenish farm site) Forty of these were identified as "dolphin species" with the balance comprising common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*) and striped dolphin (*Stenella coeruleoalba*), as well as harbour porpoise (*Phocaena phocaena*) and minke whale (*Balaenoptera acutorostrata*). Over 150 further cetacean sitings were recorded Kenmare River over the shorter time span of 2002 to 2010[12], including, in this case, a

---

12 Irish Whale and Dolphin Group; www.iwdg.ie.

humpback whale (*Megaptera novaeangliae*). All porpoise, dolphin, whale and seal species (and the Leatherback Turtle, a reptile, which is seen on very rare occasions in SW Ireland) are amongst those species protected under the Wildlife Acts as well as being listed in Annex IV of the Habitats Directive. As such they are regarded as being species requiring special protection wherever they occur, over and above their status under Annex II. Whilst there have been many sightings of cetaceans around the farm site since it began operations in 1990, none have actually been sighted from the site itself. However common dolphins in particular are regularly seen in the wake of service vessels, by staff en route from Derrynane Pier to the farm site. It is therefore to be expected that cetaceans will come within close range of the Deenish salmon farm operation on an intermittent basis.

It is perhaps notable that five basking sharks (*Cetorhinus maximus*) were also sighted in the Kenmare River area between 2002 and 2010[12]. However; these are currently not protected within the SAC or within the Annexes of the Habitats Directive.

2.1.2. Deenish and Scariff Islands, SPA 004175.

See Figure 4. The boundary of SPA 004175 is drawn 500m seawards around the islands. It therefore encompasses the bulk of the Deenish farm site area. The SPA also lies within the Kenmare River SAC. Scariff Island is the more rugged of the two islands, rising to a peak of 252m to its southern side, from which cliffs along its southern to south-western sides drop to sea level. Deenish Island reaches a peak of 144m in its southern half, with sea cliffs present from the south east to south west of the island.

The site is of special conservation interest for the following sea bird species: Fulmar (*Fulmarus glacialis*), Manx Shearwater (*Puffinus puffinus*), Storm Petrel , Lesser Black-backed Gull (*Larus fuscus*) and Arctic Tern (*Sterna paradisaea*). Shag (*Phalacrocorax aristotelis*), Herring Gull (*Larus argentatus*), Great Black-Backed Gull (*Larus marinus*) and Black Guillemot (*Cepphus grylle*) also breed there. Of terrestrial bird species, Chough (*Pyrrhocorax pyrrhocorax*), are recorded as breeding in small numbers on Scariff Island. All these species and some other seabird species mainly nest along or at the base of the sea cliffs of both islands. Oystercatcher (*Haematopus ostralegus*), Skylark (*Alauda arvensis*), Wheatear (*Oenanthe oenanthe*), Stonechat (*Saxicola rubicola*), Rock Pipit (*Anthus petrosus*) and Raven (*Corvus corax*), have also been recorded on Deenish and Scariff Islands. Chough, Storm Petrel and all Tern species are listed on Annex I of the EU Birds Directive[13], indicating that they are in danger of extinction, rare, vulnerable to specific changes in their habitat or requiring particular attention for reasons of the specific nature of their habitat.

---

[13] Kingston N. 2012. Checklist of protected & rare species in Ireland. Unpublished NPWS Report. Feb 2012.

The habit of species of special conservation interest in this SPA are described below[14], [15]. Their populations within the SPA are summarised in Table 1, whilst a summary of their characteristics, amongst those of other bird species that occur in other SPA's around Kenmare Bay, are shown in Table 4.

- Fulmar (*Fulmarus glacialis*).
  Northern populations of Fulmar are migratory, moving south as the sea freezes over at the north of their range, in the Arctic. Populations further south range widely, but rarely reach zones of warmer water. Young birds may make transoceanic crossings and generally range further than adults. Fulmar typically breeds on cliffs and rock faces and nests within colonies on narrow ledges or in hollows. Occasionally Fulmar breed on flatter ground up to 1km inland. Diet comprises variable quantities of fish, squid and zooplankton, fish offal and carrion. Northern Fulmars regularly commute long distances to reach discrete feeding habitats. Their maximum foraging range is over 600km and mean range of about 70km.

- Manx Shearwater (*Puffinus puffinus*).
  The Manx Shearwater is a nocturnal species and a transequitorial migrant, with most birds wintering off the east coast of South America. It mainly occupies marine habitats, occurring on waters over the continental shelf. It breeds on sea cliffs on offshore islands or promontories or, occasionally inland, in mountainous terrain. It nests in burrows within a colony. The species mainly feeds on small shoaling fish, crustaceans, squid and offal and forages widely, to a maximum of 400km with a mean foraging range of some 170km. Land-based counts carried out at Cape Clear in late summer, suggest that Manx Shearwaters nesting at several large colonies on islets off the coast of Kerry, such as in SPA 004175, were probably feeding primarily east of Cork, where they would spend up to 24 hours foraging. Breeding Manx Shearwaters regularly form aggregations at sea (called rafts), up to 10km from the colony shore in the evening, prior to coming ashore to feed the chicks after night-fall. Although the function of rafting is not known for certain, it is clearly an important behaviour, given the number of birds that engage in it, and the fact that rafts are regularly formed around the colony. As is the case with other SPA's which include Manx Shearwater colonies, the boundary of SPA 0041750 is extended 500m seawards of the islands, in order to accommodate this behavioural pattern when the flock is close inshore[16].

---

[14] http//:seabird.wikispaces.com/

[15] BirdWatch Ireland (2011) Action Plan for Marine & Sea Cliff Birds in Ireland 2011-2020. *BirdWatch Ireland's Group Action Plans for Irish Birds*. BirdWatch Ireland, Kilcoole, Co. Wicklow.

[16] McSorley, C.A., Wilson, L.J., Dunn, T.E., Gray, C., Dean, B.J., Webb, A. and Reid, J.B. 2008. Manx shearwater *Puffinus puffinus* evening rafting behaviour around colonies on Skomer, Rum and Bardsey: its spatial extent and

- Storm Petrel (*Hydrobates pelagicus*)
  The Storm Petrel is just larger than a sparrow and nocturnal in habit. It feeds offshore but sometimes in inshore waters, on a diet of crustaceans, molluscs, medusa, squid, fish and offal. It nests in rocky crevices and burrows on sea cliffs, walls and ruins. It is a migratory species, breeding in summer in western Ireland. Although some overwinter in the North Atlantic, the majority migrate south into subtropical and tropical waters.

- Lesser Black-backed Gull (*Larus fuscus*).
  This species breeds in colonies, often associated with other gull species. It nests in a variety of habitats including sea cliffs on offshore islands, such as SPA 004175. Its diet is omnivorous / pisciverous and it tends to feed in open-sea conditions. The species can migrate as far south as North Africa, whilst many overwinter in Europe.

- Arctic Tern (*Sterna paradisaea*).
  The Arctic Tern is a long distance migrant, between breeding grounds as far North as the high Arctic and wintering grounds in the Antarctic. In Britain and Ireland it is a coastal breeder, favouring nesting sites on immediate shoreline, including the base of sea cliffs. They are a gregarious species and tend to forage in open waters close to their nesting sites, with a mean foraging range of abut 11km. They have a diet of small fish, crustaceans, zooplankton and offal.

Table 1.
Deenish Salmon Farm.
Natura Impact Statement.
Deenish and Scariff Islands, SPA 004175.
Status of indicated bird species in SPA; bird surveys 1995 to 2000.

Bird species	Breeding pair counts		Status
	Deenish Island	Scariff Island	
Fulmar	-	385	
Manx Shearwater	351	1,960	5% of national total
Storm Petrel	Several hundred	1,000 to 10,000	
Lesser Black-backed Gull	-	97	
Arctic tern	54	-	

2.2. Natura sites where indirect impacts must be considered.

With reference to Figure 4, it can be seen that two SAC's and five SPA sites lie within a 20km radius of the Deenish Salmon Farm site. The site synopses are appended in Appendix 1. It is possible that indirect impacts from the Deenish operation could arise at any of these sites for the following reasons. This is further reviewed in Section 4:-

implications for recommending seaward boundary extensions to existing colony Special Protection Areas in the UK. JNCC Report No. 406.

- As a result of the drift of solutes or solids dispersing from the farm site, in tidal or wind-driven currents, into SAC's or SPA's "within range". However note that the greater the hydrographic distance that inputs disperse from a given point, the more dilute and therefore less significant they become, as potential causes of impact.

- As the result of noise, smell, refuse or other physical disturbance travelling, either through air or through the water column from the site into SAC's or SPA's within "range".

- As the result of infesting or infective organisms, drifting in tidal or wind-driven currents from the site into SAC's or SPA's within "range".

- As the result of farmed fish escapes, swimming into SAC's or SPA's within "range".

- As the result of protected (wild) species swimming, flying or drifting from SAC's or SPA's within "range" into a zone of effect around the site area and becoming a possible impact target.

The two SAC's that lie within the selected range of 20km of the Deenish farm site are:-

- Killarney National Park, McGillicuddy Reeks and the Caragh River Catchment, SAC 000365

- Ballinskelligs Bay and Inny Estuary SAC 000335

County Kerry accounts for approximately one fifth of the length of sea cliff habitat[17] in Ireland[18] and a proportion of these are designated within SPA's around the Kenmare River. As well as Deenish and Scariff Islands SPA 004175 (see Section 2.1.2), the following SPA's lie within 20km of the Deenish farm site (see Figure 4) and should reviewed as possible targets for indirect impacts from the farm:-

- The Iveragh Peninsula SPA 004154.
- Puffin Island SPA 004003.
- The Skellig Islands SPA 004007.
- Bull and Cow Rocks SPA 004066.
- The Beara Peninsula SPA 004155.

---

17 A sea cliff is defined as steep or vertical slope located on the coast, benerally at least 3m high (soft substrate cliff or 5m high (hard rock cliff) and generally at least 100m long, the base of which is in either the intertidal (littoral) or subtidal (sublittoral) zone.

18 Barron S et al. 2011. National survey and assessment of the conservation status of Irish sea cliffs. Irish Wildlife Manuals, No. 53, NPWS, Department of the Environment, Heritage and Local Government, Dublin, Ireland. October 2011.

2.2.1. Killarney National Park, McGillicuddy Reeks and the Caragh River Catchment, SAC 000365.

In respect of possible indirect impacts, the qualifying features of the very large Killarney National Park, McGillicuddy Reeks and the Caragh River Catchment SAC 000365 (765km^2) are only those associated with its closest seaward boundary to the Deenish farm site, which is at a distance of some 13km from the site, at the debouchment of the Currane River, where the site is contiguous with the Ballinskelligs Bay and Inny Estuary SAC 000335. However Lough Currane and the Cummeragh River system, which are part of the SAC, are not specifically identified in the site synopsis although Atlantic Salmon and Sea Lamprey in freshwater are qualifying species for the SAC as a whole. Both these species are anadromous so spend their adult life in sea water (the sea lamprey primarily as an ectoparasite on a wide range of marine fish species) and return to freshwater to breed during spring, or into early summer in the case of sea lamprey. Whilst it is well known that salmon breed within the Cummeragh system, the SAC synopsis is not specific regarding the presence of Sea Lamprey. However, for the sake of completeness, this document considers whether there is any possibility that the freshwater stocks of either species could be indirectly impacted, either if adults pass close to the Deenish site in their marine migration to or from the SAC rivers or if the drift of solutes or infective or infesting organisms or fish escapes could impact in any way on their freshwater status.

Small numbers of Chough and Common Tern within this SAC area have high protection status but, like other birds mentioned in the synopsis, are unlikely to be impacted from the Deenish site.

2.2.2. Ballinskelligs Bay and Inny Estuary SAC 000335

There is no qualifying interest for any fish species in the Ballinskelligs Bay and Inny Estuary SAC 000335, which includes the marine waters of the bay out to the 5-fathom line, to protect Atlantic and Mediterranean salt meadows within the site, which are both listed on Annex 1 of the Habitats Directive. Of passing interest, although not strictly relevant to this NIS, is the fact that there is a Blue Flag Beach in Ballinskelligs Bay, 10-12km from the farm site. There are nationally important populations of both Ringed Plover and Common Scoter in the Ballinskelligs SAC area but, like other bird species mentioned in the SAC synopsis, have a habit which renders them unlikely to be significantly impacted from the Deenish site

2.2.3. The Iveragh Peninsula SPA 004154.

The Iveragh Peninsula SPA covers some 75km of coastline sections, from Rosbehy on the southern side of Dingle Bay at its northern limit, via of Valencia Island and Bolus Head (excluding Ballinskelligs Bay) to Derrynane and Lambs Head to the south. The southern side of Dingle Bay is not shown in Figure 4, being considerably further than 20km from the Deenish farm site. The primary features of the SPA comprise vegetated sea cliffs and high coast adjacent to the cliff edge to 300m inland (to protect breeding and foraging ground for Chough), as well as dunes at Derrynane (there is also a blue flag beach at Derrynane) and Beginish, to the north of the site. Beginish is over 20km from the farm site whilst Derrynane is some 7km away in linear terms. The special conservation interests of the site are for Chough (*Pyrrhocorax pyrrhocorax*), Peregrine (*Falco peregrinus*), Guillemot (*Uria aalge*), Fulmar (*Fulmarus glacialis*) and Kittiwake (*Rissa tridactyla*). These species are distributed amongst scattered, suitable habitat throughout the SPA and nest out of the range under consideration of possible indirect impacts, although sea-foraging may bring specimens into range.

The site is also designated for a number of other protected habitats, including dry heath, wet heath, upland acid grassland, bracken semi-improved and improved grassland, dune grassland, streams, bedrock shores and islets. These are out of range of, or otherwise of little relevance to indirect impacts from the Deenish farm site, bearing in mind their terrestrial locations.

Table 2.
Deenish Salmon Farm.
Natura Impact Statement.
Iveragh Peninsula , SPA 004154.
Status of indicated bird species in SPA; bird surveys 1995 to 2000.

Bird species	Bird counts	Site Status	Species status
Fulmar	700+ pairs	Important	
Guillemot	Up to 3,000 pairs	Nationally important	
Kittiwake	1150 pairs	Nationally important	
Peregrine	Up to 6 pairs	High importance	Annex I
Chough	100+ breeding pairs	2nd most important national site	Annex I + Red data book
Great black-backed gull	63 pairs	Nationally important	
Black Guillemot	118	Nationally important	
Razorbill	90 pairs		
Herring gull	30 pairs		
Cormorant	33 pairs		
Shag	11 pairs		

2.2.4. Puffin Island SPA 004003, The Skellig Islands SPA 004007, Bull and Cow Rocks SPA 004066, The Beara Peninsula SPA 004155.
All these sites are between 15km to over 20km distant form the Deenish farm site, as Figure 4 shows. The bird species protected by their designations at these four sites are summarised in Table 3.

The characteristics of <u>all</u> the bird species of special conservation interest in <u>all</u> the SPA sites within a 20km radius of the Deenish farm site are summarised in Table 4.

Table 3.
Deenish Salmon Farm.
Natura Impact Statement.
Puffin Island SPA004003, Skellig Islands SPA004007, Bull and Cow Rocks SPA004066
and Beara Peninsula SPA004155.
Status of indicated bird species in SPA; bird surveys 1995 to 2000 unless otherwise indicated.

Bird species	Bird counts	Site Status	Species status
Puffin Island SPA004003	One of most important seabird sites nationally; >20,000 breeding seabirds		
Fulmar	477 pairs	Nationally important	
Manx Shearwater	6,329 pairs	2nd largest colony nationally	
Storm Petrel	5,177 pairs	Internationally important	Annex I Amber listed
Lesser Black-backed Gull	139 pairs	Nationally important	
Razorbill	800 pairs (1982 count)	Nationally important	
Puffin	5,125 individuals	Largest colony in Ireland	
Great Black-backed Gull	72 pairs	Nationally important	
Chough	Up to 3 pairs (1992-2000)		Annex I + Red data book
Skellig Islands SPA004007	One of most important seabird sites nationally; >80,000 breeding seabirds		
Fulmar	806 pairs	Nationally important	
Manx Shearwater	2,370 pairs	Nationally important	
Storm Petrel	4,000 to 6,000 pairs	Internationally important	Annex I
Gannet	26,436 pairs (1994)	2nd largest colony globally	Amber listed in Ireland
Razorbill	454 individuals	Nationally important	
Puffin	4,000 individuals (1999)	Nationally important	
Kittiwake	944 pairs	Nationally important	
Guillemot	2,551 indivduals	Nationally important	
Chough	At least one pair		Annex I + Red data book
Peregrine	Breeds some years		Annex I
Bull and Cow Rocks SPA004066			
Storm Petrel	2-5,000 pairs (pre-1987)	Nationally important	Annex I
Gannet	1,815 pairs (1990)	3rd largest nationally	
Puffin	200 individuals	Nationally important	
Great black-backed gull	280 pairs	Nationally important	
Beara Peninsula SPA004155			
Fulmar	575 pairs	Nationally important	
Chough	54 pairs (2002-2003)	Nationally important	Annex I + Red data book
Black Guillemot	87 individuals (1999)	Nationally important	
Peregrine	4 pairs 2002		Annex I

Table 4.
Deenish Salmon Farm.
Natura Impact Statement.
Summary characteristics of indicated bird species in SPA's within 20km of Deenish farm site.
Sources; Birdwatch Ireland, RSPB, www.wikispaces.com; www.wikipedia.com

Bird species	Migration	Irish nesting / breeding grounds	Behaviour etc	Max foraging range Mean foraging range	Max foraging depth Mean foraging depth
Fulmar *Fulmarus glacialis*	Some transoceanic (young birds); move south to breed.	Mainly sea cliffs and rock faces in colonies on narrow ledges or in hollows.	Oceanic; spends much of time at sea; can be seen on the coast year-round	664km 70km	<2m
Manx Shearwater	Migrate to east coast of South America to overwinter.	Mainly on sea cliffs on offshore islands and promonotores	Nocturnal. Exhibit rafting behaviour	400km 170km	Surface
Storm Petrel *Hydrobates pelagicus*	Majority overwinter in tropics / subtropics in South Atlantic	Rocky crevices and burrows on sea cliffs, walls and ruins	Nocturnal. Sometimes feeds inshore. Open waters and shallow bays.	N/A	Surface
Northern Gannet *Morus bassanus*	Adults overwinter at sea but resident in Ireland throughout year.	Ground nesting in large colonies, on sea cliffs and offshore islands.	Feed by plunging from a height, frequently in large flocks.	640km 140km	34m 6.8m
Razorbill *Alca torda*	Resident; winters offshore fairly close to breeding grounds.	Rocky coastal regions on cliffs and offshore islands	Small multispecies flocks can drive fish towards surface to aid feeding.	51m 10m	140m 41m
Atlantic Puffin *Fratercula arctica*	Overwinters in wide-ranging offshore and pelagic habitat. Needs clarification.	Cavities in grassy maritime slopes and sea cliffs and boulder fields; sometimes flattish ground.	Feeds by pursuit diving.	200km 30km	70m 37m
Actic tern *Sterna paradisaea*	Long distance migrant; can breed in High Arctic and overwinter in Antarctic.	Tend to nest in colonies on immediate shoreline including base of sea cliffs.	Gregarious; forage close to nesting sites. Open waters shallow bays.	Mean range 11km	Surface
Black-legged Kittiwake *Rissa tridactyla*	Migratory, pelagic, remainng on wing, out of site of land	Mainly on high, steep sea cliffs with narrow ledges and freshwater access	Often forages in association with black guillemots or razorbills.	200km 25km	Surface
Guillemot *Uria aalge*	Winters offshore within the breediing range.	Breeds on wide or narrow ledges on steep cliff faces or on low flat islands	Can form large rafts just offshore from nesting colonies	200km 24.5km	200m 90m
Black Guillemot *Cepphus grylle*	Resident; pelagic in winter close to breeding grounds.	Breed in cracks and crevices on sea cliffs close to areas of shallow water.	Feed in shallow waters in breeding season but more offshore in winter.	55km 5km	50m 30m
Cormorant *Phalacocorax carbo*	Irish stocks sedentiary or locally dispersive	On the coast nests on inshore islands on seacliffs or stacks in mixed species colonies	Can form large feeding flocks to school prey	50km 8.5km	35m 12m
European Shag *Phalacocorax aristotelis*	Sedentiary once mature, immatures may disperse over short distances	Breeds on coast or offshore island , in crevices and caves on sea cliffs, sea level to 100m.	Colonial when breeding, mainly in colonies of >1,000 pairs	20km 6km	80m 33m
Lesser Black-backed Gull *Larus fuscus*	Can overwinter as far south as North Africa but many stay in Europe	Breeds in colonies often with other gull species; various habitats including offshore islands.	Mainly open sea feeder relative to other gull species	86km 64km	<1-2m
Great Black-backed Gull *Larus marinus*	Partially migratory; birds arrive in Ireland from UK, Iceland, Norway	Colonial ground nester on vegetated sea cliffs on offshore islands and other isoloated areas.	Found all around Irish coast.	N/A	<1-2m
Herring gull *Larus argentus*	Irish breeding birds resident found all around coasts and sometimes inland.	Breeds in colonies on sea cliffs, stacs and islets and sometimes on buildings in coastal towns	90% descline in breeding population 1969 to 2002	N/A	<1-2m
Chough *Pyrrhocorax pyrrhocorax*	Resident; mostpairs stay near breeding siters all year round	Prefer undisturbed cliffs for nesting	Prefer coastal short cropped grassland for feeding	-	-
Peregrine Falcon *Falco peregrinus*	Resident	Breeds on coastal and inland cliffs; nests in a scrape on a ledge, generally under an overhang.	Can swoop on prey and 320kph	-	-

Section 3.
The potential for impacts from the Deenish site; *forcing parameters*.

A *forcing parameter* is a force which has the potential to modify an impact generated by a development and, thereby, helps to define the potential impact zone of effect. In the case of marine salmon farms, the *forcing parameters* are all ambient forces, namely wind and tide and consequent hydrographic regime, in terms of both currents and wave climate.

3.1. Wind climate in outer Kenmare Bay.

In the SW Ireland, the prevailing wind blows from the south-westerly sector, which is also the sector from which the highest duration of strongest winds arise. In an average year, winds blow at over Force 4 on the Beaufort Scale (5.5 metres/sec) for 50% of the time in this area, irrespective of direction. Winds of Force 4-6 (5.5-13.8m/sec) blow from the south to west for 33% of the time and from the north to east for 16.2% of the time. Winds of over Force 7 (>13.9m/sec) blow for 3% of the time from the south to west and for 1% of the time from the north to east[19].

Winds blowing at over Force 4 can induce increased tidal current, in particular in surface waters, in the direction of the wind. This, in turn, increases the rate of current-driven dispersal and dilution of waterborne impactors; see Section 3.2.

Both local winds over local fetches (that is over distances of sea surface within Kenmare Bay in this case) and offshore storm winds can induce an increase in wave climate in the Deenish site area and in Kenmare Bay in general, subject to wind direction and strength; see Section 3.3.

Primarily through its influence on current and wave climate, wind can therefore be defined as a potential *forcing parameter* in the dispersal of potential impactors.

3.2. Hydrography in outer Kenmare Bay.

A Recording Doppler Current Profiler (RDCP) was deployed at the Deenish farm site under the standard protocol, for 15 days during April to May 2010[20, 21]. This study is referred to in the Watermark submission to ALAB on behalf of MHI of February 2011. Data graphs abstracted from the survey report are shown in Figures 6 to 9.

---

19 EIS Deenish Salmon Farm, 2001; Watermark for Murpet Salmon Limited.

20 Regulation and Monitoring of Marine Cage Farming in Scotland; a Procedures Manual. Attachment VIII Site and Hydrographic Survey Requirements. Version 2.7, 31st October 2008. Scottish Environmental Protection Agency. www.sepa.org, as adopted by Marine Institute, Ireland.

21 An RDCP is deployed on the seabed and is capable of measuring both vertical and horizontal currents at intervals from just above its sensors (say 2m from the seabed) to the water surface, in a vertical series of adjustable measurement cells. Current speed (or vector speed) datasets for required depths can then be selected for the total data record held on the profiler.

Figure 6.

Deenish Salmon Farm; Natura Impact Statement.

Hydrographic survey using RDCP meter.

RDCP position ING Grid ref 047398.050E 056313.255N.

Rolling average current speed (cm/s-1) at at 27.2m, 17.3m, and 2.0m from seabed.

Period 00:00 17th April 2010 to 00:00 2nd May 2010 (GMT); 15 days.

Figure 6.1. Rolling average current speed cmsec^{-1}; 26m from seabed.

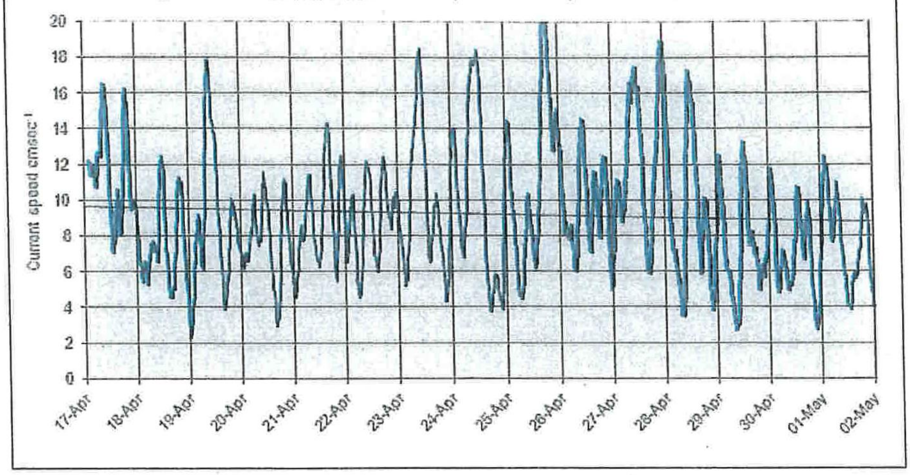


Figure 6.2. Rolling average current speed cmsec^{-1}; 17m from seabed.

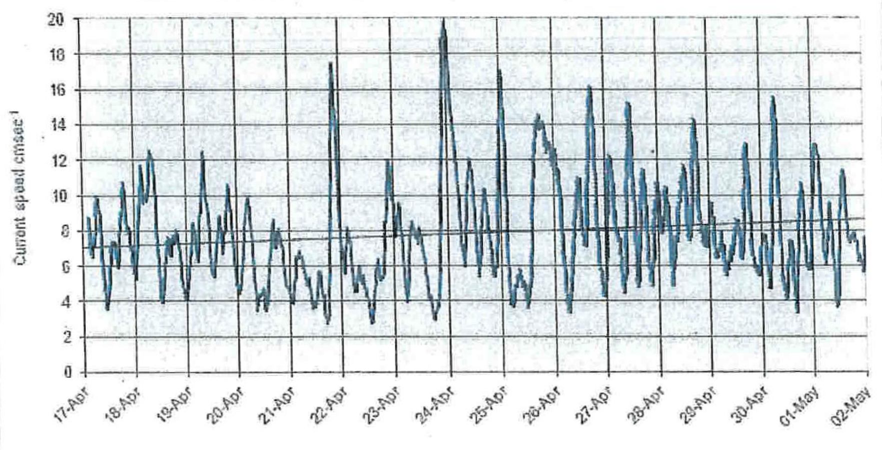


Figure 6.3. Rolling average current speed cmsec^{-1}; 2m from seabed.

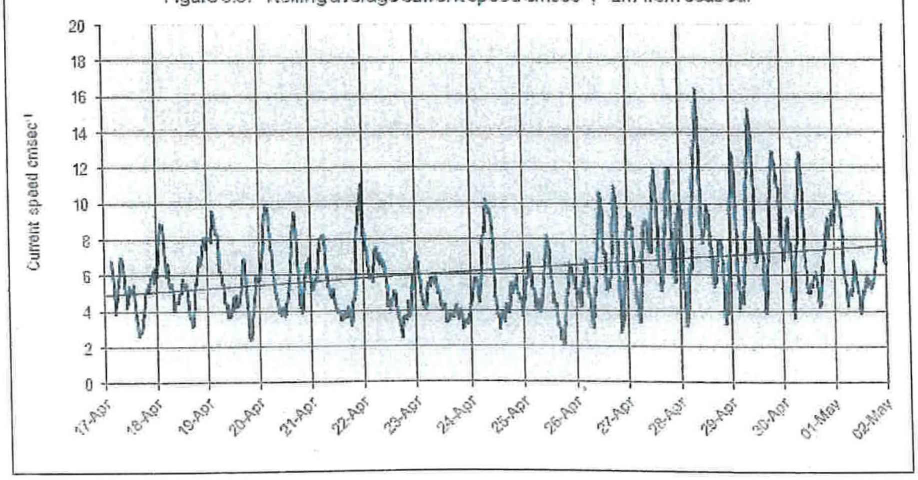


Figure 7.
Deenish Salmon Farm; Natura Impact Statement.
Hydrographic survey using RDCP meter.
RDCP position ING Grid ref 047398.050E 056313.255N.
Current cumulative vector plots (m); at at 27.2m, 17.3m, and 2.0m from seabed.
Period 00:00 17th April 2010 to 00:00 2nd May 2010 (GMT); 15 days.

Figure 7.1. Current cumulative vector plot; 26m from seabed.

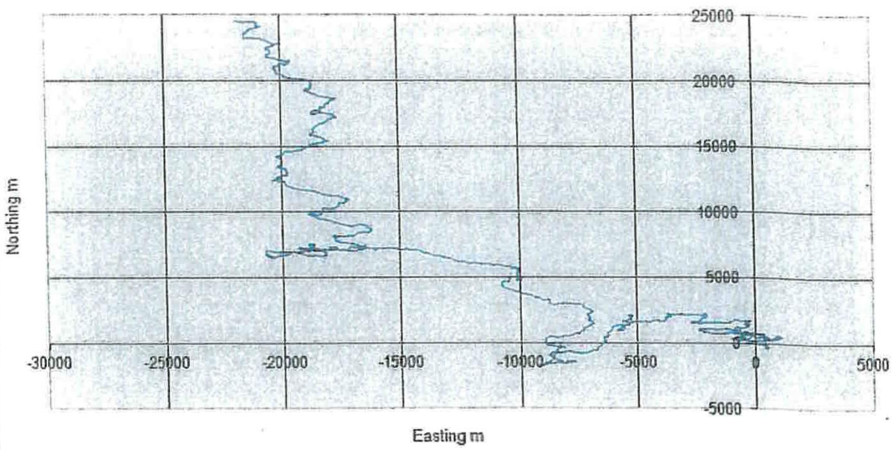


Figure 7.2. Current cumulative vector plot; 17m from seabed.

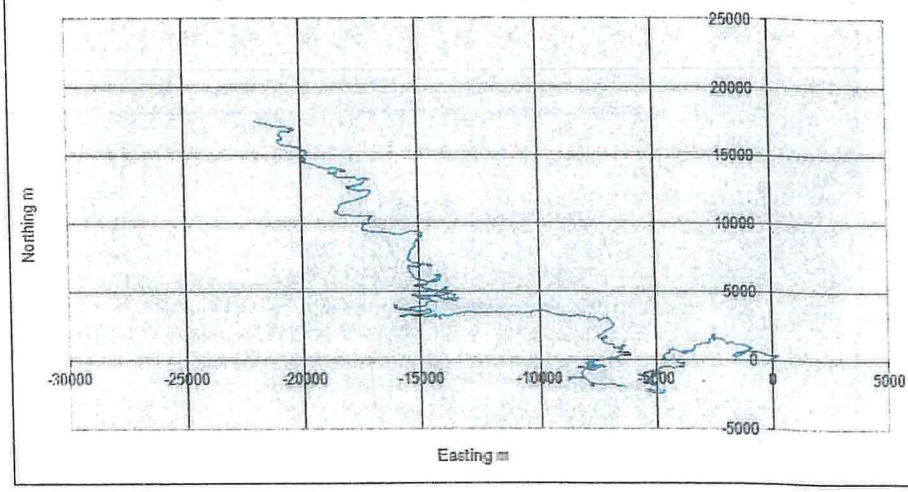


Figure 7.3. Current cumulative vector plot; 2m from seabed.

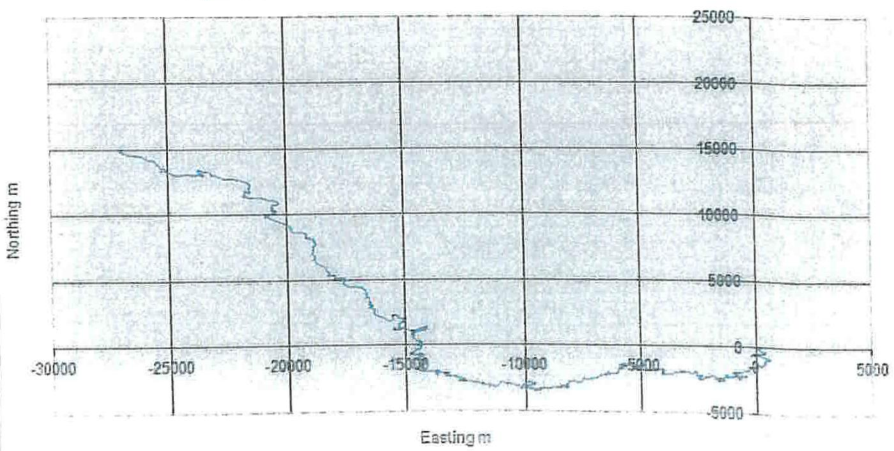


Figure 8.
Deenish Salmon Farm; Natura Impact Statement.
Hydrographic survey using RDCP meter.
RDCP position ING Grid ref 047398.050E 056313.255N.
Tide height at RDCP station, as water depth to seabed, m.
Period 00:00 17th April 2010 to 00:00 2nd May 2010 (GMT); 15 days.

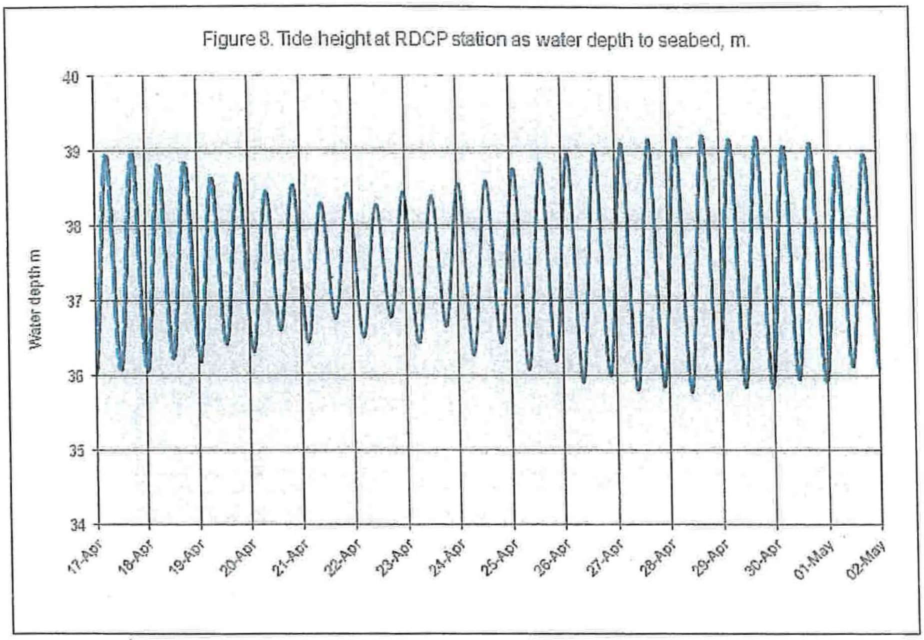
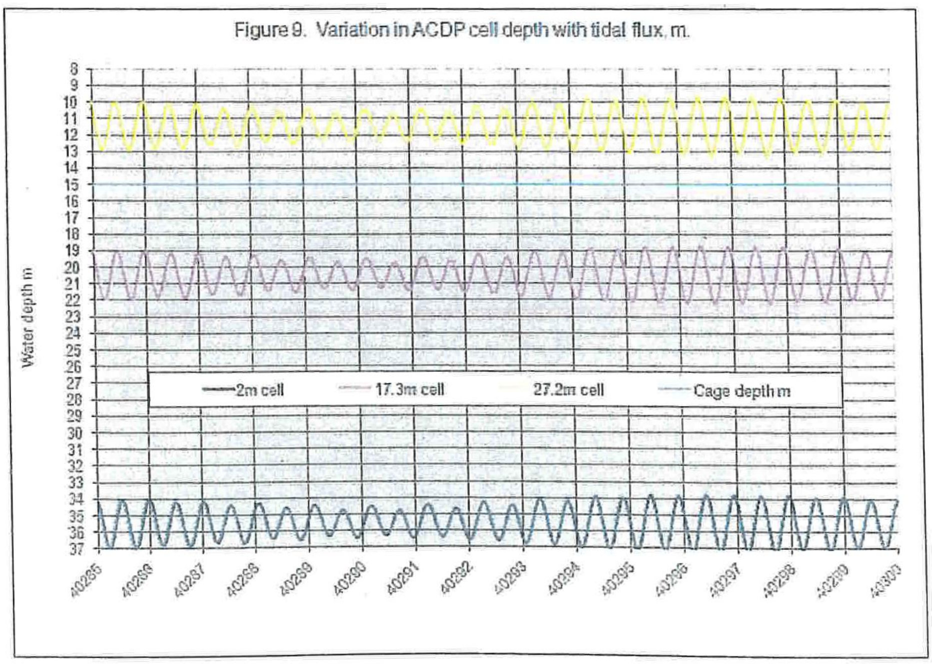


Figure 9.
Deenish Salmon Farm; Natura Impact Statement.
Hydrographic survey using RDCP meter.
RDCP position ING Grid ref 047398.050E 056313.255N.
Variation in depth of RDCP cells from water surface, m, with tidal flux.
Period 00:00 17th April 2010 to 00:00 2nd May 2010 (GMT); 15 days.



In summary, the findings of the study indicate that:-

- The mean current was 6.3cmsec^{-1} close to the seabed, 7.9cmsec^{-1} in mid-water and 9.2cmsec^{-1} in surface waters, for the deployment period, within a current range, based on 3-hour rolling average data, of some 2 to 15cmsec^{-1} near the seabed, 3 to 19cmsec^{-1} in midwater and 3 to 20cmsec^{-1} in surface waters. As shown by the trend line through the graphs in Figure 6, in relation to Figure 8, mean current was greater during the spring cycle than during the neap cycle except at the surface, where the opposite was the case, very likely due to the effects of wind on surface waters during the period.

- Mean residual currents and direction for the deployment period (in effect the difference between the flood and the ebb current) were 2.4cmsec^{-1} close to the seabed, 2.2cmsec^{-1} in mid-water and 2.5cmsec^{-1} in surface waters,. Whilst waterborne particles and solutes are dispersed and diluted by the ebb and flood of successive tides, residual current indicates the net movement of the input plume away from the input point.

- Mean residual current direction was found to be 299° (about WNW) near to the seabed, 308° (WNW to NW) in mid-water and 318° (approx NW) in surface waters, for the deployment period.

- Maximum tidal range was 3.41m, between 39.21m and 35.80m, on Spring tide. Minimum tidal range was 1.44m, between 38.25m to 36.81m, on Neap tide, for the deployment period.

Table 5 shows the overall profile of currents in percentage frequency terms at the Deenish site, as well as the percentage of the period when the current was less than 4.5cmsec^{-1} and greater than 9.5cmsec^{-1}. These latter data are relevant because, in the context of the settlement and dispersal of salmon farms solid wastes, 4.5cmcec^{-1} was derived by SEPA[22] as the critical deposition speed of such wastes and 9.5cmsec^{-1} was derived as their critical re-suspension speed (measured 1.8m from the seabed); see Section 4.

The range of wastes and other solutes and particles that can be released from marine salmon farm sites is described and quantified in Section 4. In marine systems, tidal (still weather) current is the predominant *forcing parameter* in the dispersal and dilution of inputs into the water column. All such inanimate discharges are at their most concentrated at the instant of their release, after which point they are progressively dispersed and consequently diluted, by tidal forces, both horizontally and vertically. Thus the further they travel, in terms of hydrographic distance[23] (rather than linear distance), the more dispersed and dilute they become.

[22] The Scottish Environmental Protection Agency who have carried out a number of studies on solids dispersion and have also cooperated in the development of a depositional model for use in the Scottish aquaculture industry.

[23] Hydrographic distance is the total distance travelled by particles between two points, in the ebb and flood of the tide. Thus, generally speaking, hydrographic distance is greater than the linear distance between the same two points.

Table 5.
Deenish Salmon Farm; Natura Impact Statement.
Deenish farm site hydrography.
Percentage frequency of occurence of current speed cmsec^{-1}, over the period 00:00 17th April 2010 to 00:00 2nd May 2010 (GMT).

Current speed cmsec^{-1}	Current frequency % at distance from seabed m		
	2.0m	17.3m	27.2m
< 3.0	17.6%	11.7%	9.7%
3.0 to 5.0	23.0%	16.9%	13.0%
<4.5	35.9%	24.1%	19.3%
5.0 to 7.5	28.6%	24.5%	19.2%
7.5 to 10.0	16.1%	18.0%	18.7%
>9.5	17.0%	32.4%	42.7%
10.0 to 12.5	7.8%	13.0%	14.3%
12.5 to 15.0	3.8%	8.8%	10.7%
> 15.0	3.1%	6.9%	14.3%

3.3. Wave climate in outer Kenmare Bay.

Due to its exposure to prevailing wind conditions, outer Kenmare Bay is relatively prone to storm conditions, resulting in an increase in wave climate, expressed as significant wave height and wavelength (frequency). Increased wind strength across local fetches, within the bay, cause the development of a short wavelength choppy wave climate, which increases in intensity with increase in wind speed. Offshore winds induce Atlantic storm waves, which can approach the west coast of Ireland and penetrate embayments such as Kenmare Bay, subject to wind and storm wave direction. Atlantic storms induce large waves of long wavelength. Since the bays of the SW of Ireland are open towards the prevailing and strongest wind conditions, storms are a common feature of the waters of outer Kenmare Bay. A combination wave climate, where the effects of local winds and offshore winds combine, is also a regular feature of outer bay sea conditions.

Table 6 compares storm conditions at the centres of a variety of salmon farm and candidate salmon farm sites, where wave climate has been modelled in recent years. The table shows the predicted maximum storm waves for storms with a return period of one year (1:1 year) and 50 years (1:50 years). In fact, sites 1 and 2 are in extremely exposed locations, found to be unsuitable for salmon farming as a result of their extreme wave climate. Although the Deenish farm site is sheltered from prevailing conditions by Deenish and Scariff Islands, the wave climate for the site indicates considerable exposure to Atlantic storm conditions. However wave climate out of the shelter of the islands would be closer to that exemplified by sites 1 and 2. The point is made that outer Kenmare Bay is extremely exposed to Atlantic conditions. Wave climate makes a considerable contribution to the mixing, dispersal and dilution of inputs to the water column. This is perhaps best exemplified by the prominent wave patterns seen on the seabed in such areas, indicating that the effects of wave climate can penetrate the water column as far as the seabed. For these reasons, wave climate qualifies as a *forcing parameter* in the fate of inputs from the Deenish salmon farm site.

Table 6.
Deenish Salmon Farm; Natura Impact Statement.
Wave climate analysis.
Comparison of storm waves by site.

Exposure order	Site centre	Location	Return period years	Mean wind direction°	Significant wave height, Hs m	Wave period Tm secs
1	Doonbeg Bear Island	Outer Bantry Bay	1:50 years 1:1 year	210°	13.90 9.40	15.45 13.20
2	Tralong	South coast	1:50 years 1:1 year	210°	9.04 6.06	12.44 10.70
3	Smolt site Clare Island	Clew Bay	1:50 years 1:1 year	285° 270°	6.18 4.46	14.20 12.17
4	Shot Head	Outer Bantry Bay	1:50 years 1:1 year	240°	4.86 3.29	15.82 12.84
5	Portlea site Clare Island	Clew Bay	1:50 years 1:1 year	285°	4.41 2.96	14.33 12.04
6	Kidney Rock	Kenmare Bay	1:50 years 1:1 year	255°	4.12 3.25	14.29 12.82
7	Deenish	Outer Kenmare Bay	1:50 years 1:1 year	248°	3.90 3.10	15.20 15.20
8	Doonagh Point	Kenmare Bay	1:50 years 1:1 year	255°	3.79 3.05	14.15 12.73
9	Roancarrig	Bantry Bay	1:50 years 1:1 year	210°	2.80 2.00	12.00 10.50
10	Dooanmore	Lough Swilly	1:50 years 1:1 year	15°	2.86 2.22	9.19 8.10
11	Inishfarnard	Kenmare Bay	1:50 years 1:1 year	280°	2.20 1.70	15.20 15.20
12	Anny Point	Lough Swilly	1:50 years 1:1 year	345°	1.83 1.46	10.33 5.84

Section 4.
Potential impactors from the Deenish farm site; quantification.

4.1. Site traffic and potential sources of obstruction and disturbance.

4.1.1. Spatial obstruction.

Section 1.4.2 describes the site dimensions and layout of equipment at the Deenish farm site. The licensed seabed area at the site is 14ha (35acres) of which 4.3ha (10.6 acres) can be considered to be fully obstructed by equipment deployed at intervals within it (see Figures 2 and 3). Note that to all intents and purposes, this area can be considered to be fully within the 500m wide sea surface boundary around the islands that is included in the SAC area, to allow space for foraging and for the rafting behaviour of some seabird species, in particular Manx Shearwater (see Figure 4 and the site synopsis, in Appendix 1). However it is estimated that the area considered to be obstructed by site equipment occupies less than 3% of this space, in an area which at the opposite end of the SPA to the main sea cliff areas where the shearwaters and other protected seabird species roost.

Seabirds of many species use the structures within the farm installation to perch almost constantly, even when there are staff on site. Indeed the purpose of bird nets over the pens is to prevent birds of many species, but in particular gulls and cormorants from taking stock.

The underwater elements of the farm, to a depth of 15m in the case of the pens and to the seabed in the case of the 26 mooring / anchor assemblies, are considered to present an inconsequential (and readily visible) obstruction to swimming species (fish, cetaceans etc), relative to the volumes of open water provided by Kenmare Bay and the ocean beyond it.

4.1.2 Activity and noise.

As with all net pen systems, small numbers of personnel and vessels move around the site on a daily basis throughout the production cycle. At certain times, heavy equipment, such as service vessels with cranes or well boats with deck-mounted cranes, fish pumps and grading equipment visit the site for short periods. Noise on the site emanates from the following sources:-

- From fixed equipment, in particular the generator on the feed barge. This is housed in a heavily insulated container which greatly limits noise transfer into the environment. Other noise from fixed equipment emanates from the feed dosers, on the feed barge, from the pipes, which lie on the water surface, and distribute feed to the pens and from the feed spreader plates, which distribute the food to the fish within the pens.

- From moving equipment such as outboard and inboard engines and other plant on service vessels, including the well boat.

Whilst noise can travel some distance over the sea surface in calm weather conditions, the noise profile of net pen farm operations is regular, low in register and is rapidly attenuated, thereby creating little disturbance. Thus noise is not a significant feature of such an operation, or as an environmental impactor.

4.1.3. Smell and other considerations.

No smell arises from the operation. No feed or other commodity is left uncovered or exposed on site. Mortalities are removed from the pens on regular diving checks, as they occur and, in all events, are inaccessible to wildlife, enclosed as they are between the pen nets, fence nets and bird nets.

4.2. The production cycle; feeding, metabolism and waste.

Quantification and qualification of the majority of potential waterborne impactors can be derived from the generation of growth and discharge models for the production processes at the Deenish site and the development of a tidal prism box model. This technique was also used in a study commissioned by MHI for submission to ALAB as part of the ongoing Deenish appeal process in February 2011. Some parts of this study are now abstracted and others expanded in order to quantify and qualify possible direct and indirect effects, from all possible impactors that may arise from the site, on habitats and wildlife species protected under SAC and SPA designations, within 20km of the Deenish farm site.

At the beginning of each production cycle (once every 24 months), young fish (smolt) are transferred to the site by well boat. These are grown using proprietary, organic dry feed until harvest size is reached. Harvesting takes place over months 14 to 22 of the cycle. It is projected that 836,000 smolt of mean weight 75g will be transferred to the site in February / March every in alternate years. These would grow to a peak standing stock of 2,800 tonnes prior to harvest. Accounting for a cycle mortality of 19.5% of the stock transferred (see Table 7), the projected harvest would be 673,170 fish, mean weight 5.2kg, giving a biennial harvest of 3,500 tonnes. Once the stock has all been harvested, the generation of all potential impactors ceases and the site is left fallow for a minimum of two months, or until the start of the next cycle.

The pathways involved in feeding, metabolism, growth and waste on a salmon farm are summarised in Figure 10. Table 7 shows the projected growth model for production at the Deenish site, whilst Table 8 quantifies the nutrients expected to be discharged from the farm, as a result of feeding and metabolism, on a monthly basis. Table 8 data for the two main nutrients discharged, Nitrogen and Phosphorus, are shown in graphical format in Figure 11.

Table 8 also quantifies the Biological Oxidation Demand (BOD5), of the discharges, their solids content (SS) as well as the settleable solids and carbon content of the discharges on a tonnes per month basis. These are discussed in Section 4

Figure 10.
Deenish Salmon Farm: Natura Impact Statement.
Feeding, metabolism, growth and waste.
Sources and fate of wastes (after Gowan R).

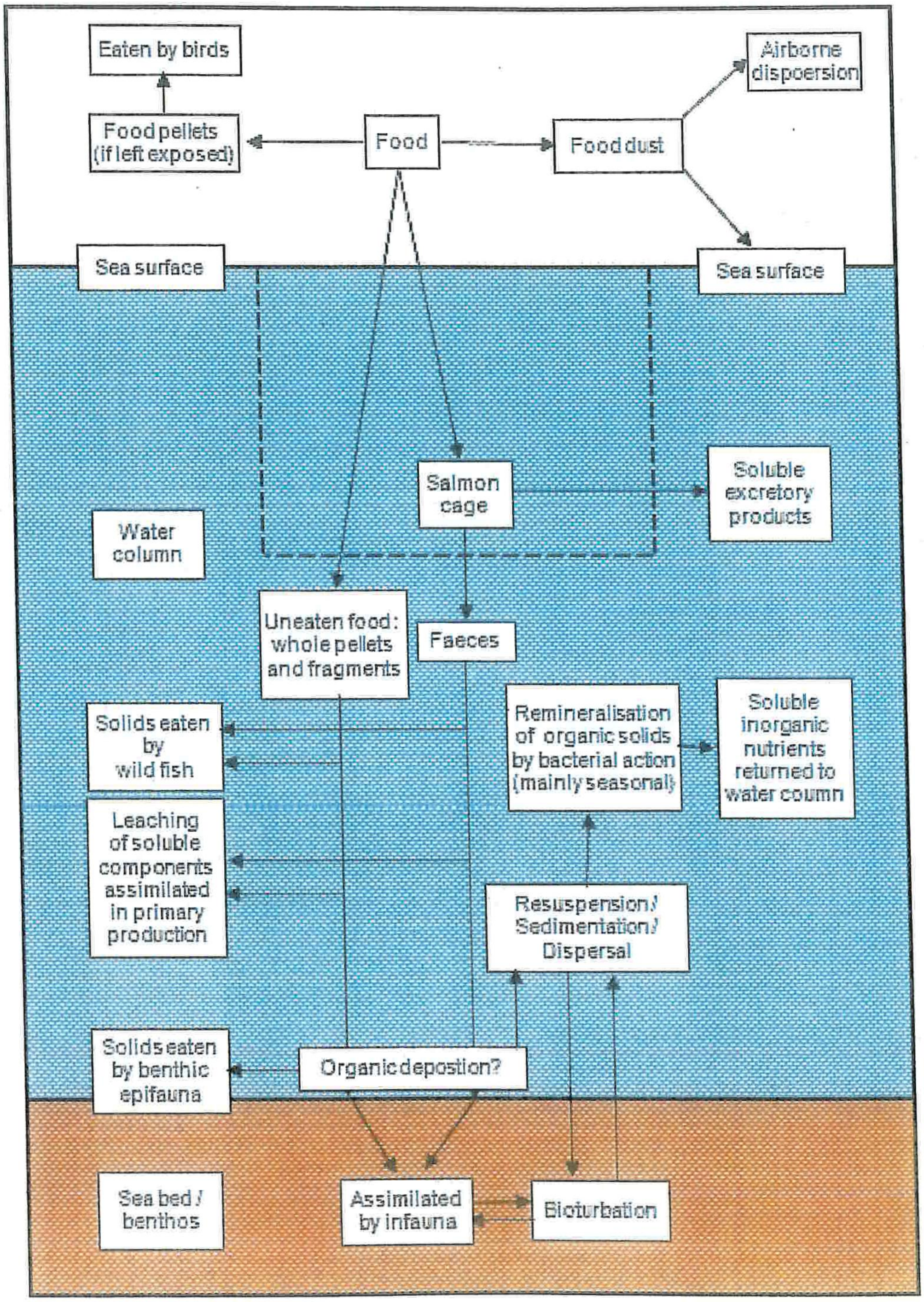


Table 7.

Deenish Salmon Farm. Natura Impact Statement.

Projected base grow-out model for proposed Deenish site; current best practice.

Notes
1. License application is for maximum standing biomass of 2,800 tonnes per 24-month cycle.
2. Proposed transfer biomass is 61.5 tonnes and estimated maximum harvest is 3,500 tonnes per 24-month cycle. Thus biogain per cycle = 3,436.9 tonnes.
3. See summary boxes under spreadsheet for proposed production overview.
4. Stocking density data given assumes Deenish mean cage volume is 20,000m^3; thus maximum total cage volume = 14 x 20,000 = 280,000m^3.

Key
- Data used for calculation of discharge budget.
- Individual peak site biomass (that is approx 2,800 tonnes in each cycle).
- Stocking density data assumes that all cages will be used throughout the cycle. However in practice cage numbers will increase with total standing stock.

Year	Month	Months growth	Fish number begin month	Fish number end month	Mortality per month %	Mortality number/ month	Mean weight gms begin month	Mean weight gms end month	Total Biomass T begin month	Total Biomass T end month	Mean SD @ cage volume 280000m^3	Biogain / month T	Harvest Number	Harvest MW kg	Harvest Tonnes	FCR	Feed used T / month
2011	Mar	1	835,884	814,987	2.50	20,897	75	101	62.7	82.3	0.3	19.6	0	0	0	0.95	18.6
2011	Apr	2	814,987	802,762	1.50	12,225	101	141	82.3	113.2	0.4	30.9	0	0	0	0.95	29.3
2011	May	3	802,762	796,340	0.80	6,422	141	198	113.2	157.7	0.6	44.5	0	0	0	1.00	44.5
2011	Jun	4	796,340	792,358	0.50	3,982	198	275	157.7	217.9	0.8	60.2	0	0	0	1.10	66.2
2011	Jul	5	792,358	788,397	0.50	3,962	275	375	217.9	295.6	1.1	77.8	0	0	0	1.20	93.3
2011	Aug	6	788,397	784,455	0.50	3942	375	505	295.6	396.1	1.4	100.5	0	0	0	1.20	120.6
2011	Sep	7	784,455	777,394	0.90	7060	505	670	396.1	520.9	1.9	124.7	0	0	0	1.23	152.8
2011	Oct	8	777,394	768,066	1.20	9,329	670	880	520.9	675.9	2.4	155.0	0	0	0	1.25	193.8
2011	Nov	9	768,066	756,545	1.50	11,521	880	1,130	675.9	854.9	3.1	179.0	0	0	0	1.27	227.3
2011	Dec	10	756,545	739,144	2.30	17,401	1,130	1,417	854.9	1,047.4	3.7	192.5	0	0	0	1.27	244.4
2012	Jan	11	739,144	725,840	1.80	13,305	1,417	1,745	1,047.4	1,266.6	4.5	219.2	0	0	0	1.27	278.4
2012	Feb	12	725,840	721,485	0.60	4,355	1,745	2,120	1,266.6	1,529.5	5.5	263.0	0	0	0	1.27	334.0
2012	Mar	13	721,485	712,827	1.20	8,658	2,120	2,550	1,529.5	1,817.7	6.5	288.2	0	0	0	1.27	366.0
2012	Apr	14	712,827	707,124	0.80	5,703	2,550	3,025	1,817.7	2,139.1	7.6	321.3	0	0	0	1.27	408.1
2012	May	15	707,124	702,174	0.70	4,950	3,025	3,540	2,139.1	2,485.7	8.9	346.6	0	0	0	1.27	440.2
2012	Jun	16	702,174	693,748	1.20	8,426	3,540	4,036	2,485.7	**2,800**	10.0	314.3	0	0	0	1.27	399.1
2012	Jul	17	693,748	600,423	1.20	8,325	4,036	4,534	**2,800**	2,722.3	9.7	304.9	85,000	4.500	382.50	1.27	387.2
2012	Aug	18	600,423	475,620	0.80	4,803	4,534	4,975	2,722.3	2,366.2	8.5	207.9	120,000	4.700	564.00	1.27	264.0
2012	Sep	19	475,620	336,815	0.80	3,805	4,975	5,248	2,366.2	1,767.6	6.3	110.1	135,000	5.250	708.75	1.27	139.9
2012	Oct	20	336,815	229,794	0.60	2,021	5,248	5,420	1,767.6	1,245.5	4.4	44.9	105,000	5.400	567.00	1.27	57.0
2012	Nov	21	229,794	118,645	0.50	1,149	5,420	5,544	1,245.5	657.8	2.3	28.3	110,000	5.600	616.00	1.27	35.9
2012	Dec	22	118,645	0	0.40	475	5,544	5,600	657.8	0.0	0.0	4.0	118,170	5.600	661.75	1.27	5.1
2013	Jan	Deenish site fallow															
2013	Feb																
Totals						162,714						3,437.3	**673,170**	**5.20**	**3,500.00**		4,305.8

Fish numbers / percent summary		
Fish transferred to grower site Nov	835,884	%
Grower site mortality allowance / %	162,714	19.5
Total fish number harvested	673,170	

Harvest / biogain summary tonnes	
Total weight harvested	3,500.0
Transfer weight in, Nov	62.7
Total biogain	3,437.3

Feeding and feed conversion rate summary	
Growout cycle feed	4,305.8
Biogain	3,437.3
Thus overall feed conversion rate	1.25

Table 8.

Deenish Salmon Farm; Natura Impact Statement.

Deenish proposed 2011 discharge model.

Projected combined maximum monthly soluble nutrient discharge and solids depostion budgets.

Notes.

Model uses Biomar Ecolife Pearl organic ration; see proximate analaysis data given, taken from manufacturer's literature.

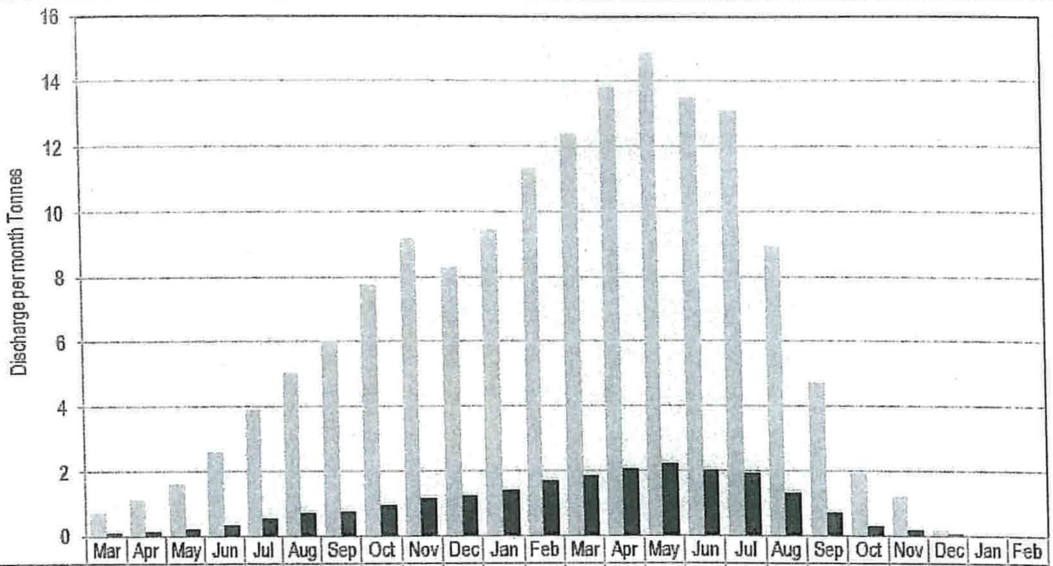
8.1 Projected feed quantities and specifications for one production cycle.

Month ending	Biogain Tonnes	Fish mw g month end	Feed specification: Protein %	Oil %	Phos. %	Size mm	FCR	Feed / nutrients Tonnes / month: Feed	Protein	NO_3 N	PO_3 P
Mar	19.62	101	46.0	22.0	1.0	3.0	0.95	18.64	8.57	1.37	0.19
Apr	30.88	141	46.0	22.0	1.0	3.0	0.95	29.33	13.49	2.16	0.29
May	44.49	198	44.0	24.0	1.0	4.5	1.00	44.49	19.57	3.13	0.44
Jun	60.22	275	44.0	24.0	1.0	4.5	1.10	66.25	29.15	4.66	0.66
Jul	77.75	375	44.0	24.0	1.0	4.5	1.20	93.30	41.05	6.57	0.93
Aug	100.50	505	44.0	24.0	1.0	4.5	1.20	120.60	53.06	8.49	1.21
Sep	124.70	670	42.0	26.0	0.9	6.5	1.23	152.76	64.16	10.27	1.37
Oct	155.04	880	42.0	26.0	0.9	6.5	1.25	193.80	81.40	13.02	1.74
Nov	179.00	1,130	42.0	26.0	0.9	6.5	1.27	227.33	95.48	15.28	2.05
Dec	192.47	1,417	37.9	32.5	0.9	9.0	1.27	244.44	92.64	14.82	2.20
Jan	219.22	1,745	37.9	32.5	0.9	9.0	1.27	278.41	105.52	16.88	2.51
Feb	262.96	2,120	37.9	32.5	0.9	9.0	1.27	333.96	126.57	20.25	3.01
Mar	288.16	2,550	37.9	32.5	0.9	12.0	1.27	365.96	138.70	22.19	3.29
Apr	321.34	3,025	37.9	32.5	0.9	12.0	1.27	408.10	154.67	24.75	3.67
May	346.65	3,540	37.9	32.5	0.9	12.0	1.27	440.24	166.85	26.70	3.96
Jun	314.27	4,036	37.9	32.5	0.9	12.0	1.27	399.12	151.27	24.20	3.59
Jul	304.85	4,534	37.9	32.5	0.9	12.0	1.27	387.16	146.73	23.48	3.48
Aug	207.89	4,975	37.9	32.5	0.9	12.0	1.27	264.02	100.06	16.01	2.38
Sep	110.15	5,248	37.9	32.5	0.9	12.0	1.27	139.89	53.02	8.48	1.26
Oct	44.88	5,420	37.9	32.5	0.9	12.0	1.27	57.00	21.60	3.46	0.51
Nov	28.28	5,544	37.9	32.5	0.9	12.0	1.27	35.92	13.61	2.18	0.32
Dec	3.99	5,600	37.9	32.5	0.9	12.0	1.27	5.06	1.92	0.31	0.05
Jan	0.00	0	37.9	32.5	0.9	12.0	0.00	0.00	0.00	0.00	0.00
Feb	0.00	0 ·	37.9	32.5	0.9	12.0	0.00	0.00	0.00	0.00	0.00

8.2. Projected nutrient discharge budget for one production cycle; Tonnes per month.

Month ending	Deenish max 12 cages, 15m deep, 128m circumference												
	BOD5 T pm	Suspended solids Tpm	Settled solids: Feed waste T pm	Faeces T pm	Settled carbon: Feed waste T pm	Faecal C T pm	Total C T pm	Nitrogen discharge T / month: Total N T pm	Settleable N T pm	Soluble N T pm	Phosphorus discharge T / month: Total P T pm	Settleable P T pm	Soluble P T pm
Mar	3.70	0.79	0.53	2.32	0.23	1.02	1.25	0.70	0.08	0.63	0.09	0.03	0.05
Apr	5.82	1.25	0.84	3.65	0.37	1.61	1.97	1.11	0.12	0.99	0.14	0.05	0.09
May	9.12	2.05	1.27	5.53	0.56	2.44	2.99	1.62	0.18	1.44	0.22	0.08	0.14
Jun	14.75	3.80	1.89	8.24	0.83	8.06	8.89	2.62	0.29	2.33	0.36	0.14	0.22
Jul	22.74	6.82	2.66	11.61	1.17	11.35	12.52	3.92	0.43	3.49	0.54	0.21	0.34
Aug	29.39	8.82	3.44	15.00	1.51	14.67	16.18	5.07	0.56	4.52	0.70	0.27	0.44
Sep	38.07	11.85	4.35	19.00	1.92	18.58	20.50	6.03	0.66	5.36	0.75	0.29	0.47
Oct	49.36	15.93	5.52	24.11	2.43	23.57	26.00	7.75	0.85	6.90	0.97	0.37	0.60
Nov	58.89	19.55	6.48	28.28	2.85	27.65	30.50	9.19	1.01	8.18	1.15	0.44	0.71
Dec	63.33	21.03	6.97	30.41	3.07	29.73	32.80	8.28	0.91	7.37	1.24	0.47	0.77
Jan	72.13	23.95	7.93	34.64	3.49	33.87	37.36	9.43	1.04	8.39	1.41	0.54	0.87
Feb	86.52	28.73	9.52	41.54	4.19	40.62	44.81	11.31	1.24	10.07	1.69	0.64	1.05
Mar	94.81	31.48	10.43	45.53	4.59	44.52	49.10	12.39	1.36	11.03	1.85	0.70	1.15
Apr	105.73	35.10	11.63	50.77	5.12	49.64	54.76	13.82	1.52	12.30	2.07	0.79	1.28
May	114.05	37.87	12.55	54.77	5.52	53.55	59.07	14.91	1.64	13.27	2.23	0.85	1.38
Jun	103.40	34.33	11.38	49.65	5.01	48.55	53.55	13.52	1.49	12.03	2.02	0.77	1.25
Jul	100.30	33.30	11.03	48.16	4.85	47.09	51.95	13.11	1.44	11.67	1.96	0.74	1.22
Aug	68.40	22.71	7.52	32.84	3.31	32.11	35.43	8.94	0.98	7.96	1.34	0.51	0.83
Sep	36.24	12.03	3.99	17.40	1.75	17.02	18.77	4.74	0.52	4.22	0.71	0.27	0.44
Oct	14.77	4.90	1.62	7.09	0.71	6.93	7.65	1.93	0.21	1.72	0.29	0.11	0.18
Nov	9.31	3.09	1.02	'4.47	0.45	4.37	4.82	1.22	0.13	1.08	0.18	0.07	0.11
Dec	1.31	0.44	0.14	0.63	0.06	0.62	0.68	0.17	0.02	0.15	0.03	0.01	0.02
Jan	No discharges; Deenish site fallow												
Feb													

Figure 11.
Deenish Salmon Farm; Natura Impact Statement.
Monthly farm Nitrogen and Phosphorus discharge budget; Tonnes per month.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tonnes N	0.7	1.11	1.62	2.62	3.92	5.07	6.03	7.75	9.19	8.28	9.43	11.3	12.4	13.8	14.9	13.5	13.1	8.94	4.74	1.93	1.22	0.17	0	0
Tonnes P	0.09	0.14	0.22	0.36	0.54	0.7	0.75	0.97	1.15	1.24	1.41	1.69	1.85	2.07	2.23	2.02	1.96	1.34	0.71	0.29	0.18	0.03	0	0

4.2.1. Nutrient production and dispersal.

In order to assess the possible impacts of these two nutrient inputs, discharged from the farm site at the rates shown in Table 8.2 and Figure 11, a simple tidal prism model[24] was used to estimate the tidal flux and nutrient and oxygen flux for a box area enclosing the salmon farm. The box area selected is shown in the map in Figure 12 and 13. A box area of $50m^2$ was selected, with a mean tidal low water depth of 45m, estimated from Figure 13. The mean spring and neap tide depths used for the tidal prism calculation were 3.0m and 1.4m, estimated form annual tidal data for the port of Casteltownbere, in Bantry Bay, The calculation of the flushing rate through the selected box is shown in Table 9 whilst Table 10 and Figure 14 show the monthly fluxes of nutrients and oxygen in the tidal flow, derived using the calculated mean monthly flow and the physico-chemical water dataset, collected at the Lambs Head control site used for water chemistry and nutrient monitoring since the Deenish farm began operations.

Based on the calculations shown in Table 9, the tidal flux through the box area is estimated at $6.34 \times 10^9 m^3$ of seawater per month. This flushing rate flushes the box area by tidal flow every 8.0 days (on spring tides) to 16.57 days (on neap tides), in still weather conditions. As might be expected, the oceanic waters that flush the selected box carry their own very substantial load of nutrients and oxygen, both in and out of the bay, with the tide.

[24] Edwards A., Sharples F. 1986. Scottish sea lochs; a catalogue. SMBA / NCC 110pp.

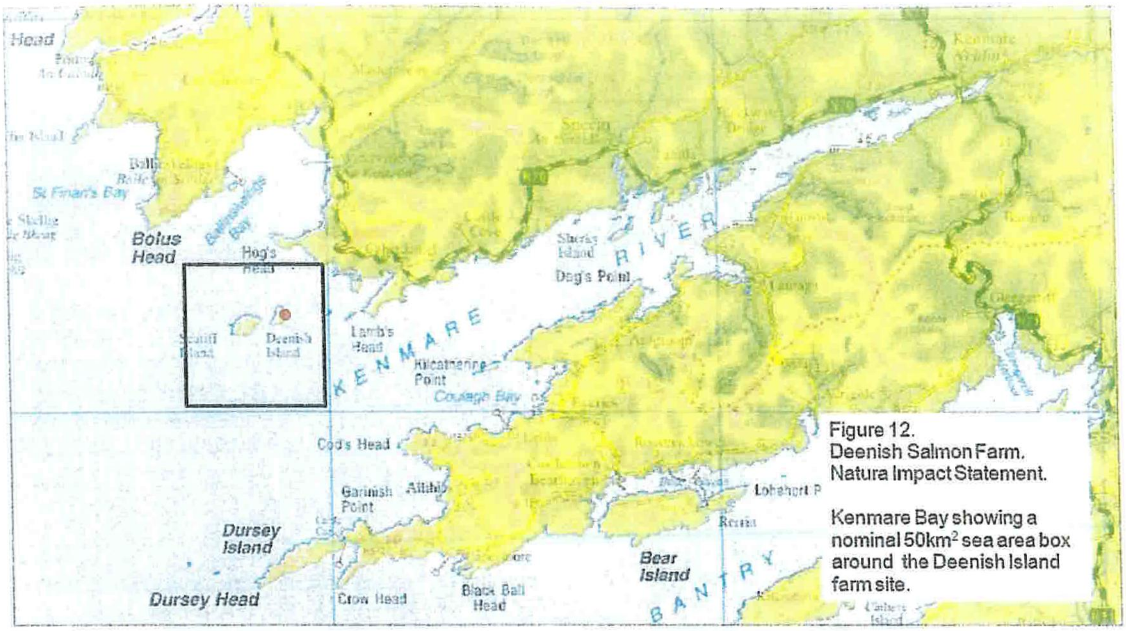


Figure 12.
Deenish Salmon Farm.
Natura Impact Statement.

Kenmare Bay showing a nominal 50km² sea area box around the Deenish Island farm site.

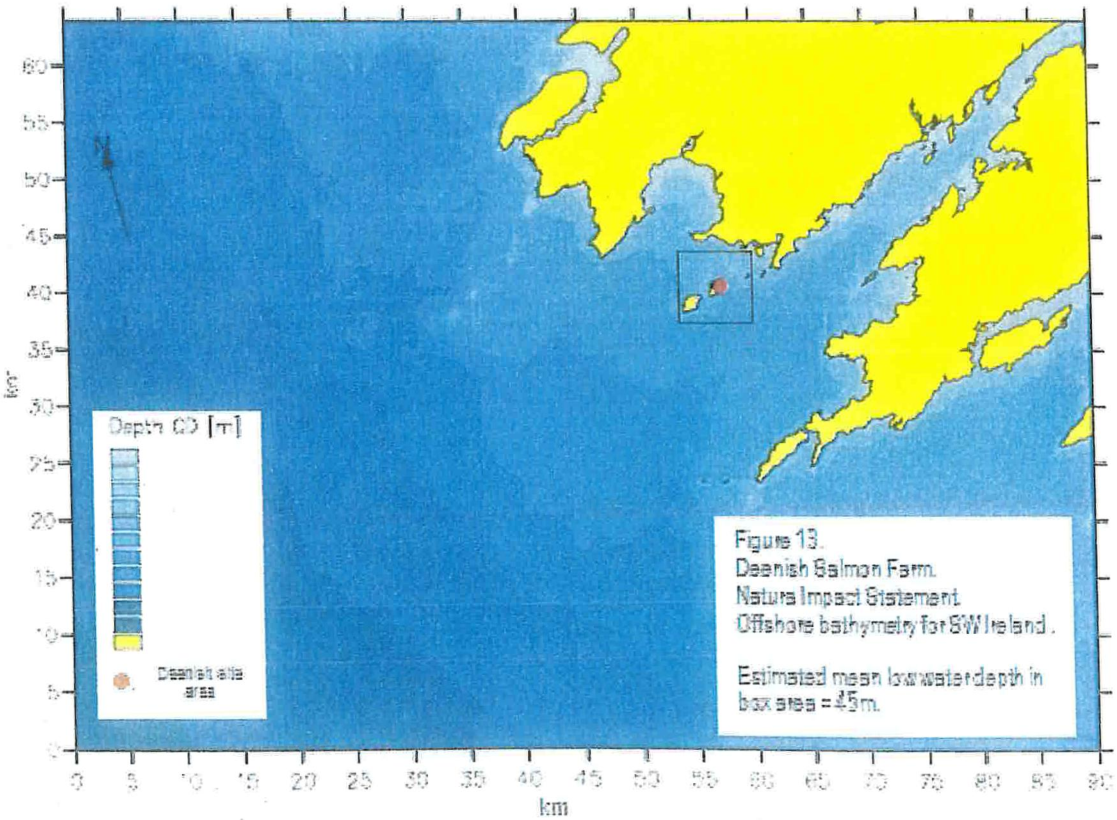


Figure 13.
Deenish Salmon Farm.
Natura Impact Statement.
Offshore bathymetry for SW Ireland.

Estimated mean low water depth in box area = 45m.

Table 9.

Deenish Salmon Farm; Natura Impact Statement

Deenish Island site; 50km^2 box model; estimated flushing time.

Parameter	Notation	Data	Units
Notional box low water sea area	A	50,000,000	m^2
Notional box mean low water depth	D	45.00	m
Thus notional box mean low water volume	V = A x D	2,250,000,000	m^3
Mean tidal range neap tide	Rn	1.40	m
Mean tidal range spring tide	Rs	3.00	m
Thus mean neap tidal volume	Pn = A x Rn	70,000,000	m^3
Thus mean spring tidal volume	Ps = A x Rs	150,000,000	m^3
Mean neap flushing time (tidal cycles)	Tn = (V + Pn) / Pn	33.14	tidal cycles
Thus mean neap flushing time (days)	Dn = Tn / 2	16.57	days
Mean spring flushing time (tidal cycles)	Ts = (V + Ps) / Ps	16.00	tidal cycles
Thus mean spring flushing time (days)	Ds = Ts / 2	8.00	days
Mean neap daily flushing rate	Fn = V / Dn	135,775,862	m^3 / day
Mean spring daily flushing rate	Fs = V / Ds	281,250,000	m^3 / day
Mean monthly water flux for 50km^2 Deenish box	W = ((Fn + Fs) / 2) x 30.4167	6,342,275,269	m^3/month

Table 10.

Deenish Salmon Farm; Natura Impact Statement

Deenish Island site; 50km^2 box model

Total estimated monthly and annual fluxes of nutrients and oxygen.

Month	Mean ambient concentration (10m control data)			Monthly flux tonnes		
	Inorganic N µg/l	Inorganic P µg/l	DO mg/l	Inorganic N tonnes pm	Inorganic P tonnes pm	Oxygen tonnes pm
Jan	88.00	23.35	9.22	558	148	58,484
Feb	63.00	21.89	9.48	400	139	60,152
Mar	96.00	20.46	9.32	609	130	59,115
Apr	40.54	9.92	9.06	257	63	57,479
May	10.34	7.37	8.81	66	47	55,891
Jun	4.67	4.48	8.35	30	28	52,950
Jul	16.60	5.48	8.39	105	35	53,201
Aug	3.76	6.13	8.25	24	39	52,338
Sep	23.12	10.99	8.26	147	70	52,369
Oct	37.74	11.37	8.58	239	72	54,437
Nov	72.92	15.88	8.96	463	101	56,822
Dec	80.00	20.67	9.09	507	131	57,661
Total flux of Deenish box, tonnes per annum				3,403.8	1,001.9	670,899.0

Figure 14. Deenish flushing model; oceanic fluxes of nutrients and oxygen; T pm.

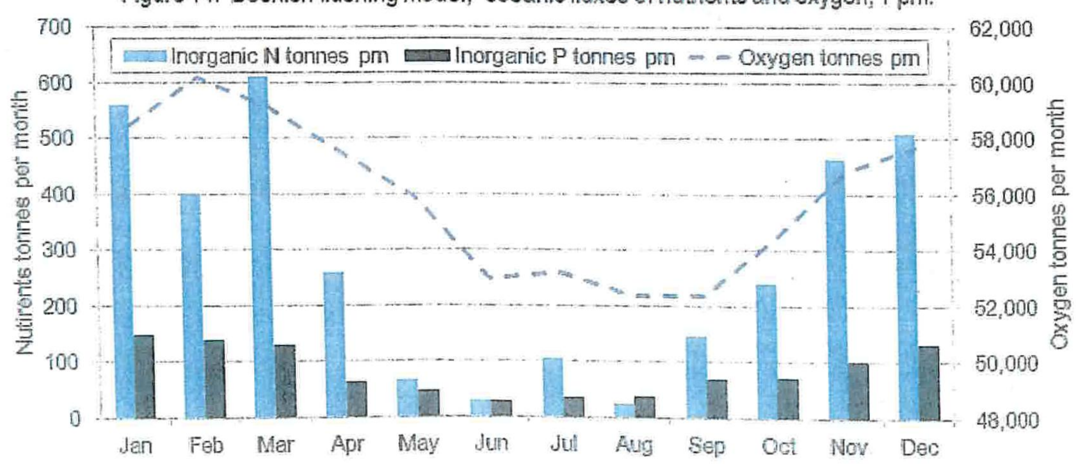


Table 11 and Figure 15 extend the data shown in Table 10 and Figure 14 to show oceanic flux data versus farm discharge data in tonnes, taken from Table 9, for a full farm production cycle, whilst Table 12 and Figure 16 shows the ambient data as concentration in µg/l and their elevation (ECE[25]) as a result of farm nutrient additions. Overall, Figures 15 and 16 illustrate the annual cyclical nature of ambient nutrient levels, as a consequence of natural primary production in spring / summer and decay in autumn / winter, alongside the biennially cyclical nature of farm-origin discharges. This is illustrated in tabular form in Table 9.2.

The data show that the monthly oceanic nutrient flux into the hypothetical box area around the Deenish farm site peaks in the winter months, reaching up to 609 tonnes NO_3N and 148 tonnes PO_4P. Most importantly, these figures far outweigh monthly farm discharges, which peak at 14.91 tonnes NO_3N and 2.23 tonnes PO_4P in May in alternate years. Table 12 and Figure 16 show that nutrient inputs from the Deenish will cause the peak ambient N concentration (Lambs Head control site data) to rise from 96.0µgNO_3N/l to 97.95µgNO_3N/l and the peak ambient P concentration to rise from 23.40µgPO_4P/l to 23.64µgPO_4P/l, both in the early months of alternate years.

There are Environmental Quality Standards (EQS) set for a variety of substances which can be present in lough and bay waters where marine farms are present, which are summarised by SEPA[26]. In marine systems the EQS set for the winter value for nitrate nitrogen is 168µgNO_3N/l. The EQS for Nitrate Nitrogen is the most important in the marine context because it is the first limiting nutrient for marine algal (primary) production. This EQS value is superimposed on Figure 16, which shows ambient NO_3N and its projected elevation by the Deenish farm nitrate discharges. It can be seen that, even in winter months, when ambient nitrate levels are at their seasonal peak, the EQS level is not even approached. Thus combined farm nitrate discharges will make little difference to ambient nitrate levels in the bay.

OSPAR has set an EQS for Phosphate Phosphorus for Irish inshore and coastal waters of 119µg/l[27]. It can be seen from Figure 16 that the ECE reached has negligible impact on ambient phosphorus levels around the farm and, therefore, further afield and that the EQS level is not even approached.

25 ECE; Elevation of Concentration Equilibrium; meaning elevation of ambient parameters by fish farm wastes; a term coined in Scotland in the context of Gillibrand PA, Gubbins MJ, Greathead C and Davies IM. 2002. Scottish Executive locational guidelines for fish farming: predicted levels of nutrient enhancement and benthic impact. Scottish Fisheries Research Report **63.**

26 SEPA Fish Farm Manual www.sepa.org.

27 SEPA refers to the OSPAR EQS standard for total phosphorus, of 119µg P/l in Atlantic and Irish Sea coastal waters. A phosphorus EQS is rarely applied because nitrogen and phosphorus have a common source. Thus, if the nitrogen standard is met, the phosphorus standard, which is more liberal, will also be met. The EQS includes both the background ambient (SEPA's Equilibrium Constant) and discharge (SEPA's Equilibrium Constant Elevation) levels.

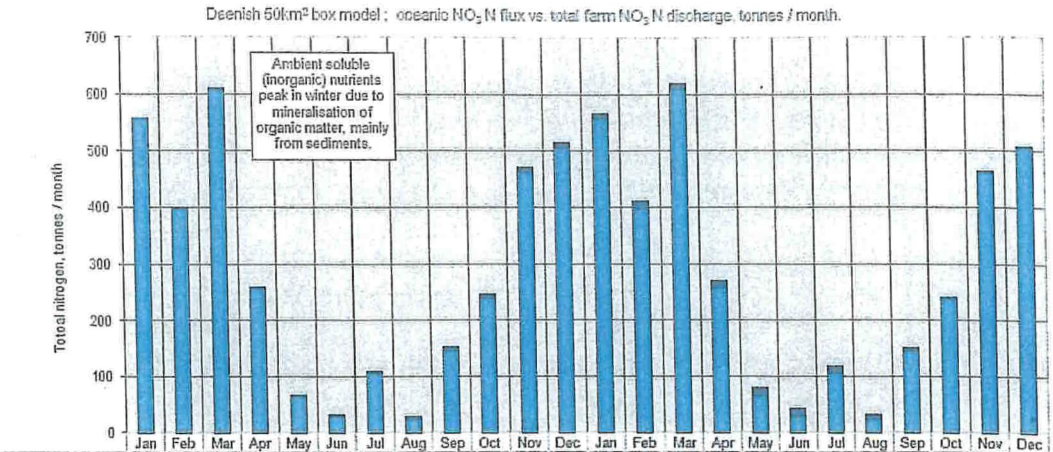
Table 11.
Deenish Salmon Farm; Natura Impact Statement.
Monthly nutrient fluxes vs. monthly nutrient discharges; Tonnes per month.

Month	Oceanic N flux Tonnes per month	Farm N discharge Tonnes per month	Oceanic P flux Tonnes per month	Farm P discharge Tonnes per month
Jan	558.12	0.00	148.11	0.00
Feb	399.56	0.00	138.83	0.00
Mar	608.86	0.70	129.76	0.09
Apr	257.10	1.11	62.92	0.14
May	65.61	1.62	46.75	0.22
Jun	29.60	2.62	28.40	0.36
Jul	105.27	3.92	34.73	0.54
Aug	23.88	5.07	38.89	0.70
Sep	146.61	6.03	69.69	0.75
Oct	239.34	7.75	72.09	0.97
Nov	462.51	9.19	100.71	1.15
Dec	507.38	8.28	131.07	1.24
Jan	558.12	9.43	148.11	1.41
Feb	399.56	11.31	138.83	1.69
Mar	608.86	12.39	129.76	1.85
Apr	257.10	13.82	62.92	2.07
May	65.61	14.91	46.75	2.23
Jun	29.60	13.52	28.40	2.02
Jul	105.27	13.11	34.73	1.96
Aug	23.88	8.94	38.89	1.34
Sep	146.61	4.74	69.69	0.71
Oct	239.34	1.93	72.09	0.29
Nov	462.51	1.22	100.71	0.18
Dec	507.38	0.17	131.07	0.03

Table 12.
Deenish Salmon Farm; Natura Impact Statement.
Monthly ambient nutrient concentration vs. monthly elevation due to farm nutrient discharges; µg/l.

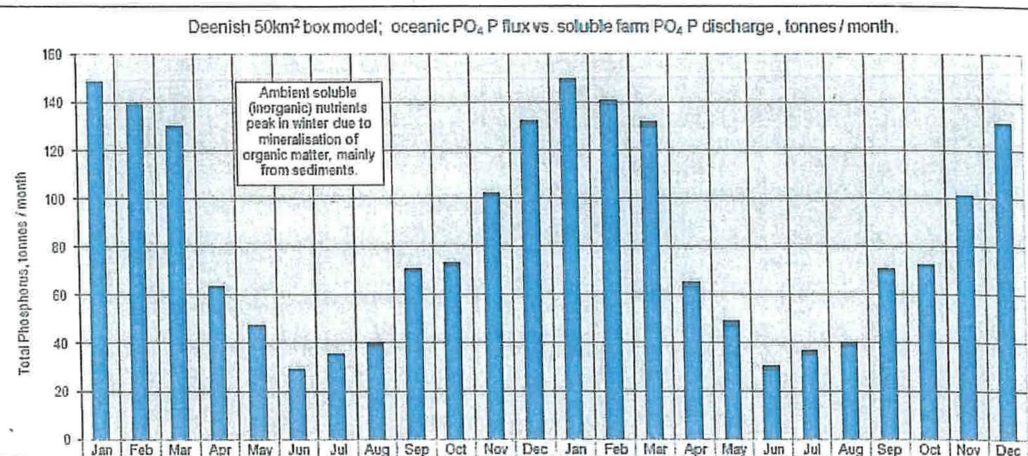
Month	Ambient NO_3 N µg/l	NO_3 N elevation µg/l	Ambient PO_4 P µg/l	PO_4 P elevation µg/l
Jan	88.0	0.00	23.4	0.00
Feb	63.0	0.00	21.9	0.00
Mar	96.0	0.11	20.5	0.01
Apr	40.5	0.17	9.9	0.02
May	10.3	0.26	7.4	0.04
Jun	4.7	0.41	4.5	0.06
Jul	16.6	0.62	5.5	0.09
Aug	3.8	0.80	6.1	0.11
Sep	23.1	0.95	11.0	0.12
Oct	37.7	1.22	11.4	0.15
Nov	72.9	1.45	15.9	0.18
Dec	80.0	1.31	20.7	0.20
Jan	88.0	1.49	23.4	0.22
Feb	63.0	1.78	21.9	0.27
Mar	96.0	1.95	20.5	0.29
Apr	40.5	2.18	9.9	0.33
May	10.3	2.35	7.4	0.35
Jun	4.7	2.13	4.5	0.32
Jul	16.6	2.07	5.5	0.31
Aug	3.8	1.41	6.1	0.21
Sep	23.1	0.75	11.0	0.11
Oct	37.7	0.30	11.4	0.05
Nov	72.9	0.19	15.9	0.03
Dec	80.0	0.03	20.7	0.00

Figure 15.
Deenish Salmon Farm; Natura Impact Statement.
Deenish 50km² box model.
Estimated monthly oceanic nutrient fluxes vs. combined soluble nutrient discharges from Deenish farm site; Tpm.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Farm N discharge	0.00	0.00	0.70	1.11	1.62	2.62	3.92	5.07	6.03	7.75	9.19	8.28
Oceanic N flux	558.1	399.5	608.8	257.1	65.61	29.60	105.2	23.88	146.6	239.3	462.5	507.3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Farm N discharge	9.43	11.31	12.39	13.82	14.91	13.52	13.11	8.94	4.74	1.93	1.22	0.17
Oceanic N flux	558.1	399.5	608.8	257.1	65.61	29.60	105.2	23.88	146.6	239.3	462.5	507.3



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Farm P discharge	0.00	0.00	0.09	0.14	0.22	0.36	0.54	0.70	0.75	0.97	1.15	1.24
Oceanic P flux	148.1	138.8	129.7	62.92	46.75	28.40	34.73	38.89	69.69	72.09	100.7	131.0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Farm P discharge	1.41	1.69	1.85	2.07	2.23	2.02	1.96	1.34	0.71	0.29	0.18	0.03
Oceanic P flux	148.1	138.8	129.7	62.92	46.75	28.40	34.73	38.89	69.69	72.09	100.7	131.0

4.2.2. Oxygen requirements of salmon respiration and BOD[28].

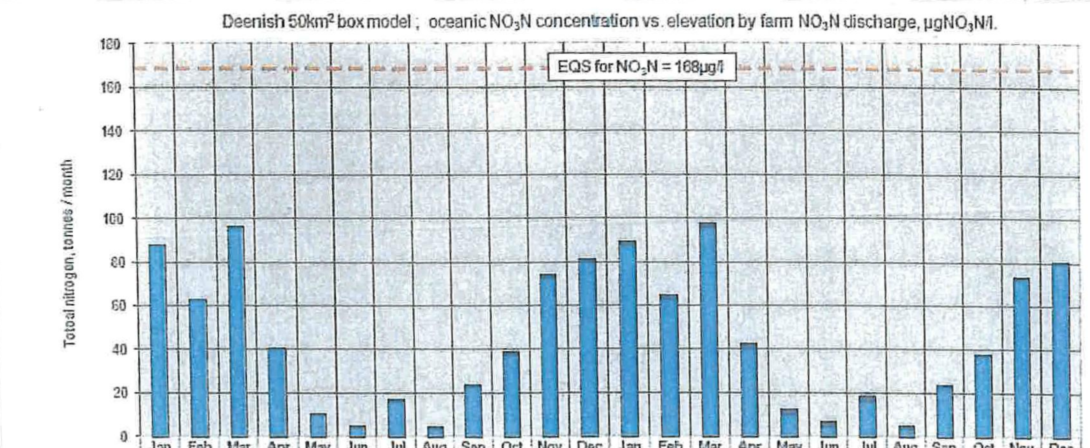
Table 7 tabulates the monthly growth in standing stock on the Deenish farm site. The oxygen consumption of salmon in respiration increases with total standing stock and also with temperature, although, expressed as mgO_2 consumed / kg body weight, it falls with increasing fish mean weight. Peak respiratory oxygen requirements coincide with total standing stock, when the oxygen consumption of the entire stock of 2,800 tonnes of fish will be approximately 420kg O_2/hour, or approximately 300 tonnes O_2/month.

[28] Biological Oxidation Demand (BOD) is the amount of oxygen required (mainly by bacteria) to assimilate organic waste to its most oxidised state. This is the point at which wastes no longer deplete the oxygen saturation of the surrounding environment.

Table 8.2 shows that the BOD of total discharges from the farm site peak during the summer months, to a maximum of 114 tonnes per month, when standing stock and feeding rate are at their highest (see Table 7).

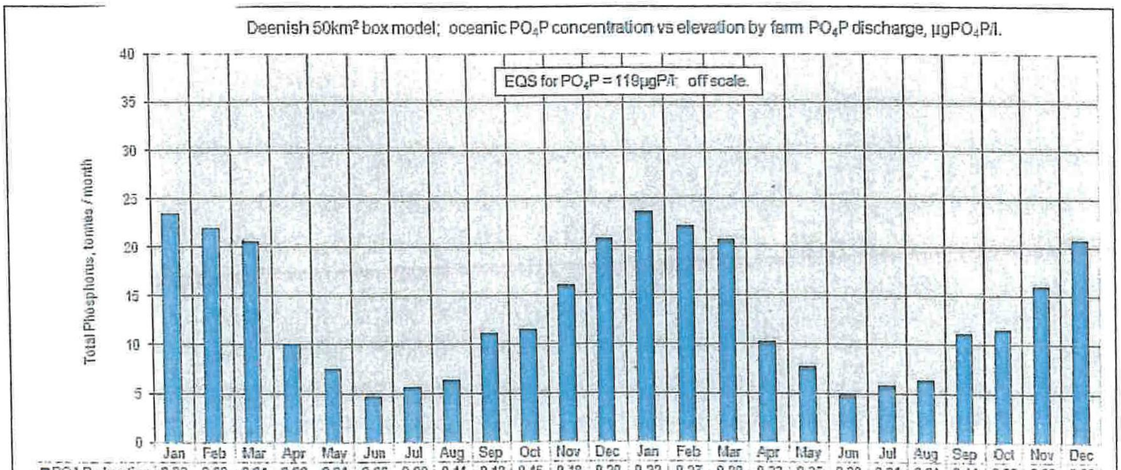
Table 9 shows that some 56,000 tonnes of oxygen per month is flushed through the selected 50km^2 box by tidal flow[29]. The combined peak oxygen uptake by the Deenish farm, in fish respiration and wastes BOD is estimated at 414 tonnes per month, or 0.74% of the oxygen available. This is an insignificant drawdown of oxygen resource that will be rapidly replenished by ongoing tidal flux and by reoxygenation at the air / water interface.

Figure 16.
Deenish Salmon Farm; Natura Impact Statement.
Deenish 50km^2 box model.
Predicted monthly ambient nutrient concentrations and nutrient elevation due to discharges from Deenish site; µg/l.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NO3 N elevation	0.00	0.00	0.11	0.17	0.26	0.41	0.62	0.80	0.95	1.22	1.45	1.31
Ambient NO3 N	88.0	63.0	96.0	40.5	10.3	4.7	16.6	3.8	23.1	37.7	72.9	80.0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NO3 N elevation	1.49	1.78	1.95	2.18	2.35	2.13	2.07	1.41	0.75	0.30	0.19	0.03
Ambient NO3 N	88.0	63.0	96.0	40.5	10.3	4.7	16.6	3.8	23.1	37.7	72.9	80.0



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PO4 P elevation	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.11	0.12	0.15	0.18	0.20
Ambient PO4 P	23.4	21.9	20.5	9.9	7.4	4.5	5.5	6.1	11.0	11.4	15.9	20.7

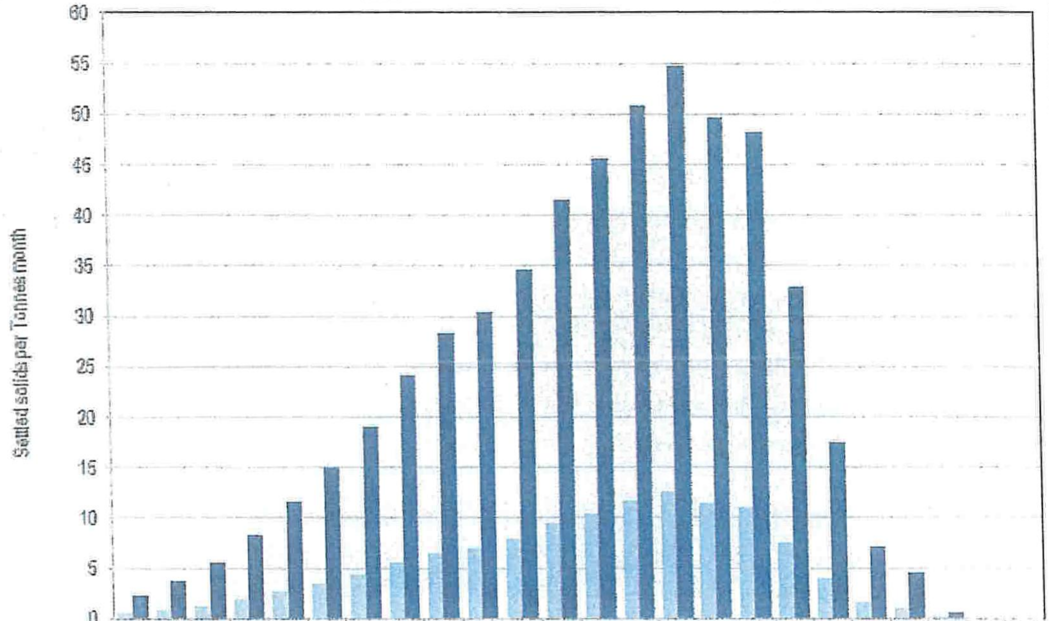
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PO4 P elevation	0.22	0.27	0.29	0.33	0.35	0.32	0.31	0.21	0.11	0.05	0.03	0.00
Ambient PO4 P	23.4	21.9	20.5	9.9	7.4	4.5	5.5	6.1	11.0	11.4	15.9	20.7

29 Oxygen flux is slightly lower in summer months than in winter months, as Figure 14 shows, because oxygen solubility decreases with increasing temperature

4.2.3. Solid wastes.

As well as soluble wastes, Figure 10 demonstrates the pathways for non-soluble wastes, comprising faeces (the indigestible remains of the ration), and waste feed (which comprises up to 3% of the total feed fed). Solid wastes sink to the seabed on a trajectory determined by the *forcing parameters* described in Section 2. Solids wastes are quantified in the discharge model in Table 8.2 and shown graphically in Figure 17.

Figure 17.
Deenish Salmon Farm; Natura Impact Statement.
Monthly farm settled solids; Tonnes per month.
Note. Site is fallow for months 23 and 24.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Feed T pm	0.53	0.84	1.27	1.89	2.66	3.44	4.35	5.52	6.48	6.97	7.93	9.52
Faeces T pm	2.32	3.65	5.53	8.24	11.6	15.0	19.0	24.1	28.2	30.4	34.6	41.5

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Feed T pm	10.4	11.6	12.5	11.3	11.0	7.52	3.99	1.62	1.02	0.14	0.00	0.00
Faeces T pm	45.5	50.7	54.7	49.6	48.1	32.8	17.4	7.09	4.47	0.63	0.00	0.00

Salmon feed comprises protein, oil, carbohydrate, vitamins, minerals and water. Carbon is the main constituent of protein, oil and carbohydrate and makes up about 44% of the entire salmon ration by weight. Much of this is digested by the fish and metabolised to support growth and body maintenance, along with other digested feed constituents. However a proportion of it goes to waste, in soluble form as inorganic carbonate salts, excreted in the urine, but mainly as solids. Settled carbon is a primary source of BOD (see Section 4.2.2). Biological oxidation is one of two main process steps in the Carbon Cycle, through which organic matter decomposes with the aid of aerobic bacteria, to be rebuilt by primary production of plants through the "opposite" process step of photosynthesis:-

$$\text{Waste matter (primarily C+H+O)} + O_2 \rightarrow CO_2 + H_2O + \text{energy}$$

Biological oxidation

Photosynthesis

$$CO_2 + H_2O + \text{energy (sunlight)} \rightarrow \text{plant matter (primarily C+H+O)} + O_2$$

This oxydation process proceeds in a healthy and environmentally sustainable manner unless the rate of buildup of organic material outstrips the availability of oxygen to support the required aerobic bacterial flora.

One aim of sustainable aquaculture is to limit the organic waste loading of the seabed to a level where impact is relatively low, quickly reversible with fallowing and confined to an area not much greater than the seabed area immediately beneath the farm itself. This is achievable at Deenish island through the choice of a suitable site, in combination with the use of highly digestible feeds, low fish stocking density and careful feed management.

Empirical data has been collected on seabed conditions under the Deenish site in statutory annual monitoring surveys[30]. Plates 3 to 8 indicate that the benthic impact of the Deenish operation is mild, with a patchy, thin layer of sedimentation (<10mm) limited to the area beneath the pens and just beyond it, even in the direction of the northerly current (Plates 3 to 6).

Whilst no depositional model has been executed for the Deenish operation, these empirical results bear similarities to the modelled scenario for a candidate farm site at Shot Head, in Bantry Bay, for a farm of the same size and projected production level, with broadly similar baseline seabed conditions, current regime and wave climate (mean current at Shot Head at the seabed is 5cmsec^{-1} relative to 6.3 cmsec^{-1} at Deenish) In fact the Deenish site has a more erosional hydrography than Shot Head in terms of frequency % of current <4.5cmsec^{-1}, below which deposition occurs and >.95cmsec^{-1}, above which resuspension and redistribution occurs; see Section 3.2 and Table 5. See also Table 6 for comparison of wave climates.

Figure 18 shows a hypothetical model to predict a conservative worst case at Shot Head, with peak monthly discharges every month for one year. Under these circumstances, a peak sediment depth of >13mm is predicted under each pen. In Figure 18.2 the model goes on to show organic Carbon sedimentation under the same conditions, from which ITI[31] can be predicted.

30 Monitoring Protocol No.1 for Offshore Finfish Farms Benthic Monitoring http://www.agriculture.gov.ie/fisheries/aquacultureforeshoremanagement/monitoringprotocols/

31 Codling ID and Ashley SJ. 1992. Development of a biotic index for the assessment of pollution status of marine benthic communities, Water Research Council Report No. SR 2995, Marlow, Bucks SL7 2HD, UK.

Plates 3 and 4

Deenish Salmon Farm. Natura Impact Statement

Benthic monitoring survey at Deenish site 27th July 2011

Plate 3. Under middle of end cage at Deenish site; scattered feed pellets, faecal casts, shallow ARPD, *Beggiatoa* , hermit crabs, commom starfish, brittlestars and anenomes, starfish (*Cerianthus lloydii*)

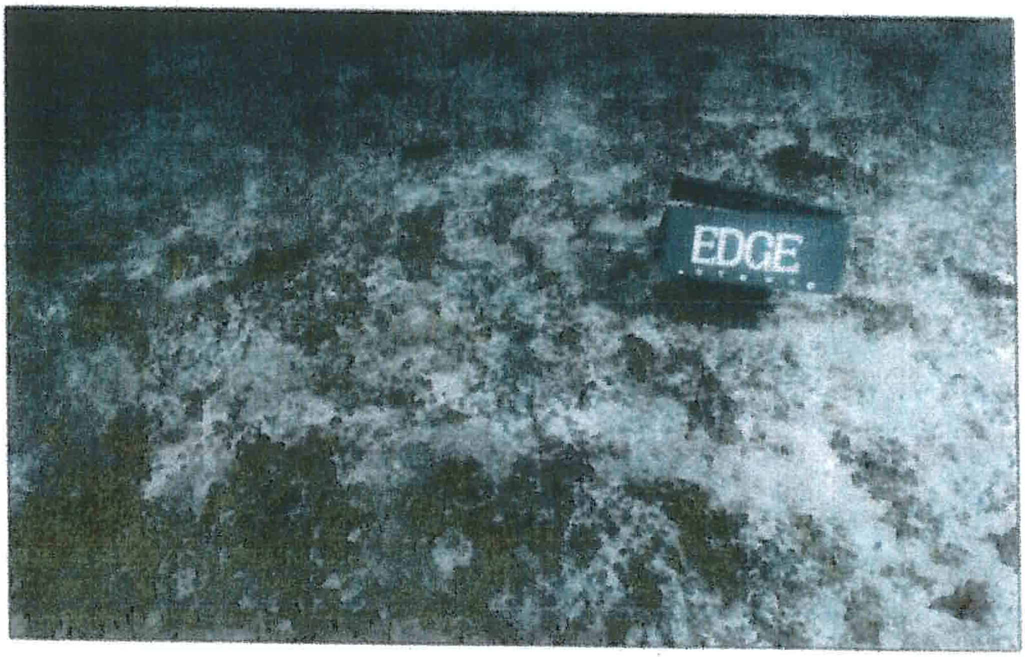


Plate 4 At edge of end cage, in current direction; scattered feed. faecal casts, relatively shallow ARPD depth, Beggiatoa; hermit crabs. common starfish. brittlestars, anenomes (*Cerianthus Lloydii*). seaslugs (Facilinidae. Aeoliniidae). hermit crabs.

Plates 5 and 6.
Deenish Salmon Farm: Natura Impact Statement.
Benthic monitoring survey at Deenish site 27th July 2011.

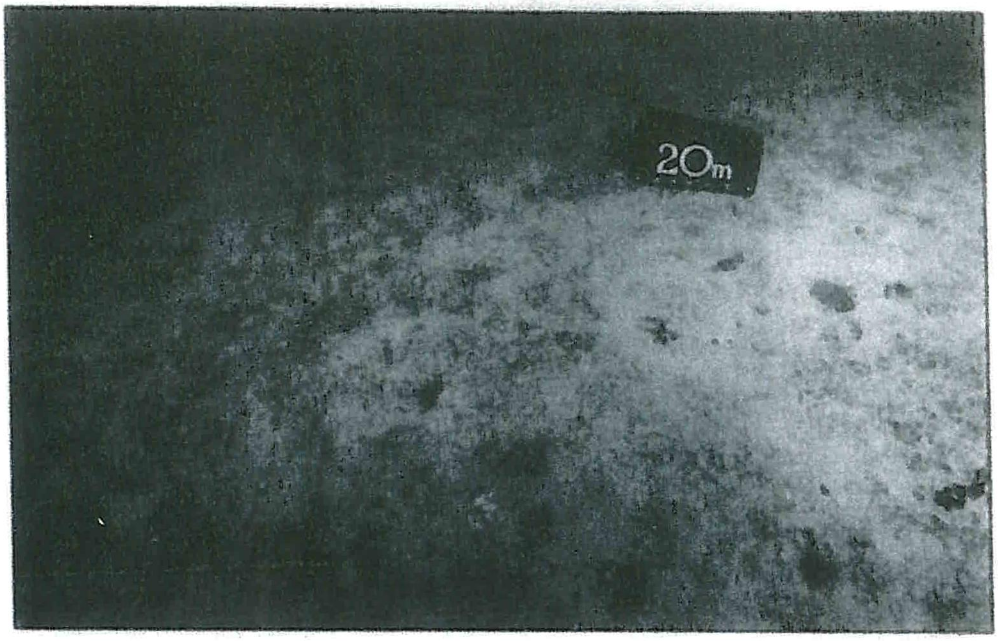


Plate 5. 20m from end cage edge in current direction. Light scattering faeces, scattered *Beggiatoa* , layer of benthic diatoms on seabed; 1 king scallop, sand mason (Lanice conchilega),brittlestars (*Ophiura sp*) , burrowing brittlestars (*Amphiura sp*).

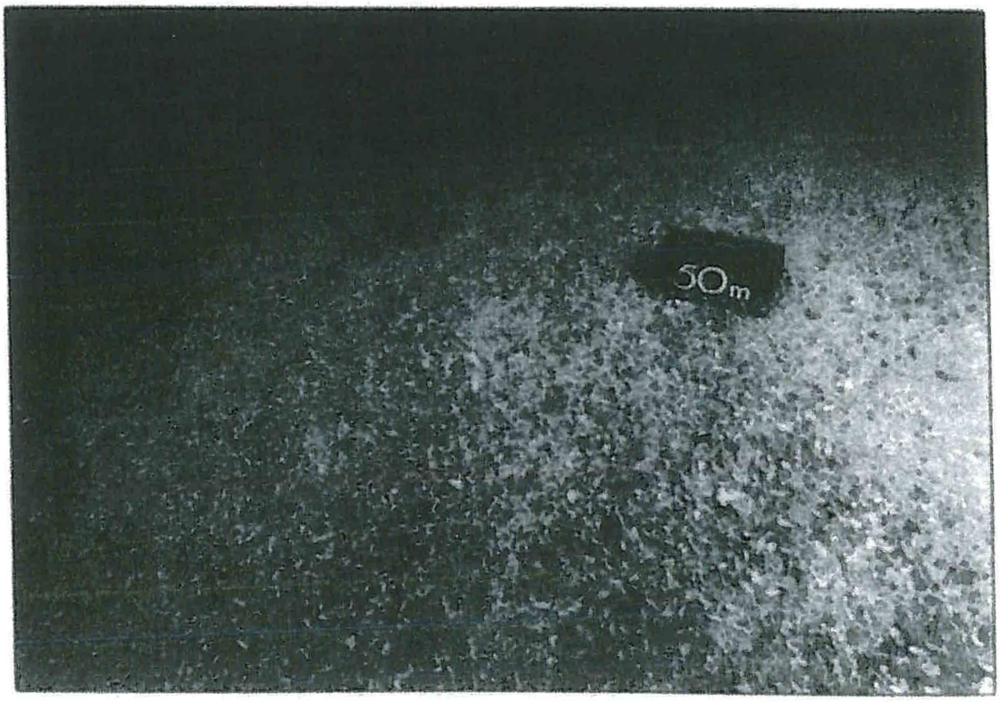


Plate 6. 50m from end cage edge in current direction. Variable ARPD, parchment worm (*Chaetopterus variopedatus*). red seaweed (*Phycodrys rubens*) attached to shell fragments.

Plates 7 and 8
Deenish Salmon Farm. Natura Impact Statement
Benthic monitoring survey at Deenish site 27th July 2011

Plate 7. 50m east cage edge Deenish site 27th July 2011. Clean shelly gravel. Gobie fish (*Pomatoschistus sp.*), red seaweed (*Phycodrys rubens*) attached to larger shell fragments, King scallop (*Pecten maximus*).

Plate 8. Reference station 200m from cage edge. Clean shelly sand with unimpacted flora: aenmomes (*Cerianthus lloydii*). 14 in shot, gobies (*Pomstoschistus sp.*) calcareous tube worms (*Pomatoceros sp.*) and 7-armed starfish (Luidia Ciliaris).

Figure 18.
Deenish Salmon Farm; Natura Impact Statement.
Hypothetical modelled example; projection of maximum sedimentation (mm on seabed) and Infaunal Trophic Index (ITI) to show impact on infauna; Shot Head site.
(From a dispersional study commissioned of RPS International by MHI in 2011).

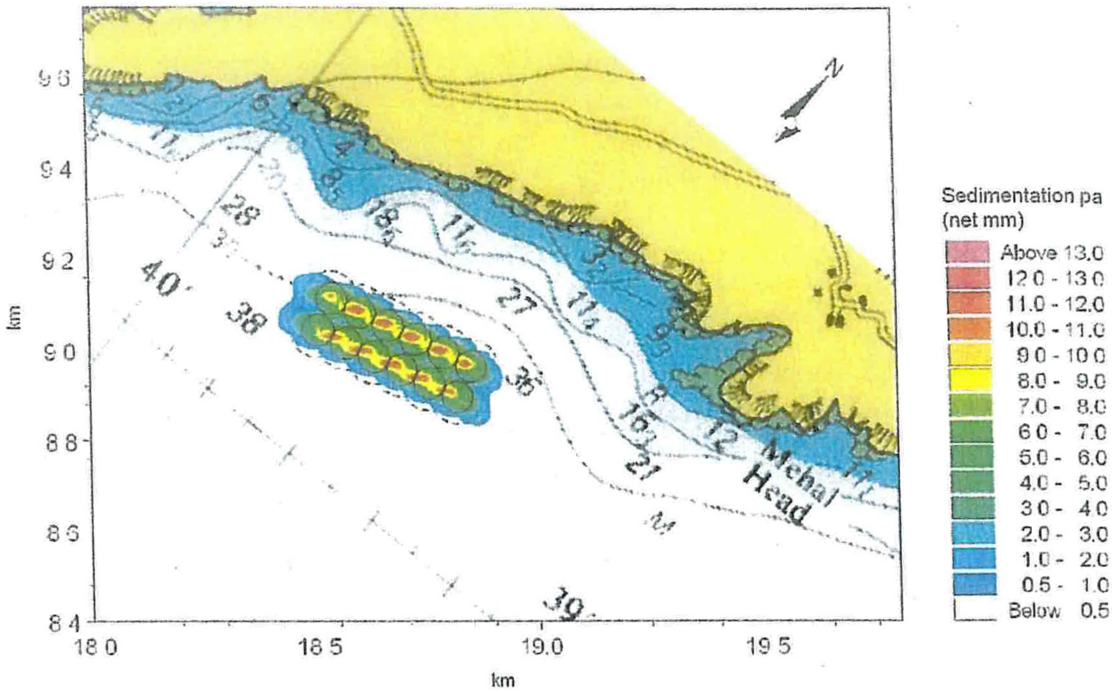


Figure 18.1 Net sedimentation (mm on seabed) following operation for one year at peak sedimentation rate (i.e. at constant maximum standing stock).

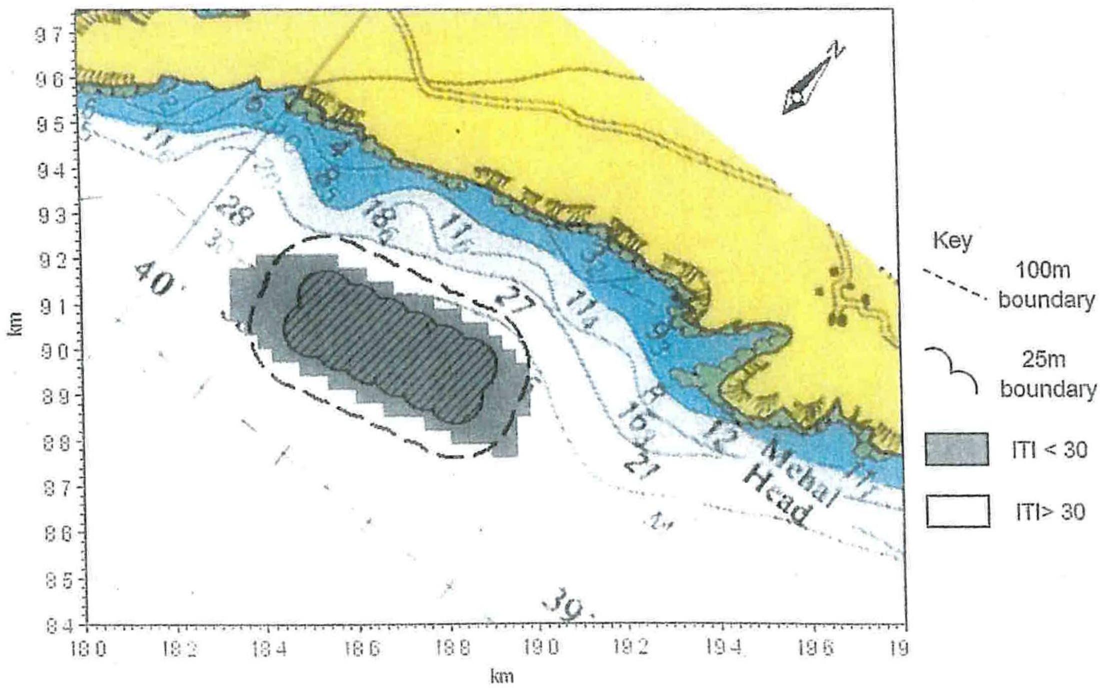


Figure 18.2 Area under site impacted by solids deposition as in Figure 18.1, showing extent of area with Infaunal Trophic Index (ITI) <30.

This shows that, even after an entire (albeit unrealistic) year of peak sedimentation, ITI only indicates a changed infaunal community, indicating some pollution present, under and extremely close to the pen footprint.

These observations suggest that no significant or lasting benthic impact arises as a result of the operation of the production model in use at the Deenish site. The impact is mild, limited to an area only slightly larger than the pen area footprint itself and will readily reversible with adequate fallowing of the site.

The full species list of surface observations of epifauna (at least 18 species) and the analysis of a total of 36 benthic grab samples, taken in triplicate from 12 sites, including the control site, involving the collection and identification of over 7,500 individuals of up to 100 taxa per site, revealed the presence of no species noted as being of special conservation interest in any SAC or SPA within a 20km radius of the site.

4.3. Medication and treatments; use and potential dispersal.

Fish health on MHI's fish farm sites is administered under a suite of Special Operating Procedures (SOP), including a Fish Health Plan drawn up and agreed with a specialised veterinary practice under contract to the company, a Medication of Fish SOP, individual SOP's to cover individual lice treatment strategies and an approved medicines list for certified organic farming.

4.3.1. Antibiotics.

In line with its organic certification, stocking density at the Deenish site is kept low throughout the cycle and never exceeds 10kg/m^3 of water. This is extremely low by salmon farming standards and reduces the occurrence of stress-related bacterial infections and therefore mitigates the need for antibiotic treatments. Use of medication is further mitigated by the prophylactic application of vaccines prior to fish transfer to seawater. In consequence, use of in-feed antibiotics on the site is negligible. The only antibiotic permitted for use in organic culture is Oxytetracycline Hydrochloride, which is administered in-feed. In the event of use, the route for any egested or waste residue is as for other in-feed treatments, see Slice®, below.

4.3.2. Sea lice treatments.

A range of treatments are employed against infestation by sea lice; these are used in strict rotation to reduce resistance build-up. Bath treatments against salmon lice are carried out using well boat tanks, which reduces the amount of treatment required and enables the control of its release into the environment, without impact.

The only lice treatment carried out in the pens, in which case a closed bag is used to enclose the net for the duration of the treatment, is Hydrogen Peroxide. In all events Hydrogen Peroxide is environmentally benign in that its breakdown products in seawater are water and oxygen. Lice dislodged in Hydrogen Peroxide treatment are collected on a specially designed lice filter and are destroyed and removed for onshore disposal.

A further lice treatment, Slice® is administered in-feed. This treatment is obtained on veterinary prescription (as are all veterinary medications and is mixed into feed off-site by a specialist company. Small quantities of Slice® residues can enter the water column through excretion via the gills or by leaching from waste feed or faeces, which fall to the seabed. However, due to the relative infrequency of Slice® treatment (see treatment rotation, above), low solids sedimentation rate and the low fish footprint per unit seabed area used in organic farming RPS project that presence of benthic medication residues per unit of seabed area, including Slice®, will be inconsequential[32].

The main target for criticism in respect of sea lice treatments has been their alleged effects, in particular on crustaceans and on the larval stages of both crustaceans and molluscs, a number of which are either human food species or a dietary component of such species. However, in its 2005 report[33], Scottish Environmental Protection Agency (SEPA) concluded that:-

"*the 2001 and 2002 surveys have shown that, at the majority of fish farm sites sampled, the concentrations of active ingredients from approved sea lice treatments in the adjacent sediments were likely to be below SEPA's environmental standards and therefore resultant environmental impacts would not have been significant at any of these sites*".

Similar sentiments were expressed in a report issued by the Scottish Association for Marine Science in 2005[34], with the statement:-

"*The broad objective of the project was to determine the ecological effects of sea lice treatments in Scottish sea lochs, and in those terms that objective as been met, with no gross effects of medicines on the receiving environment distinguished. The project has achieved much by helping to improve our understanding of natural variability in relatively unstudied systems and, most*

[32] RPS Group plc, Consulting Engineers, Elmwood House, Boucher Road, Belfast, County Antrim, BT12 6RZ. 0489 066 7914. www.rpsgroup.com. Full report available from Marine Harvest Ireland.

[33] Anon. 2005. The occurrence of the active ingredients of sea lice treatments in sediments adjacent to marine fish farms. Scottish environmental protection Agency (SEPA) www.sepa.org.

[34] Chromey C., Nickell T., Willis K. (Eds.) 2005. Ecological effects of Sea Lice medicines in Scottish sea lochs. Report; Scottish Association for Marine Science, Plymouth Marine Laboratory, Fisheries Research Services, SEAS Ltd. 60 pages.

especially, by demonstrating that wide-scale ecosystem-level effects from medicine use, if they exist at all, are likely to be of the same order of magnitude as natural variability and, therefore, inherently difficult to detect."

It is submitted that if this is situation in Scottish sea lochs, the same at least would be true in Irish coastal waters, since salmon farming is less intensive in Irish than in Scottish waters and Irish west coast bays are generally much better flushed than Scottish sea lochs and inshore waters.

4.3.3. Pen net antifouling treatments.

In compliance with organic standards, no net antifouling treatment are used at the Deenish site. Smolt nets, with a smaller mesh size than grower nets, are installed at the beginning of the cycle. These are changed after about six months and replaced with grower nets. Nets are cleaned in-situ on a regular basis throughout the growth cycle using a 7-head K-188-30 Idema net cleaner. This process avoids the dispersal; of organo-copper compounds from the site, which can be harmful to crustacean larvae in particular. Thus no impact whatever can arise from the use of net antifoulant treatments at the Deenish site. Net checking and repair, under a MHI Standard Operating Procedure, has significant role in fish escape prevention (see Section 4.5)

4.4. Sea Lice.

4.4.1. Background.

Sea lice are natural parasites of wild fish. Two sea lice species are major parasites of European salmonids. The marine louse, *Caligus elongatus* parasitises many marine fish, including salmon. *Lepeophtheirus salmonis* is the more problematic of the two species for both wild and farmed salmonids. Smolts of wild sea trout (*Salmo trutta*) appear particularly susceptible to it.

Salmon farming has long been held responsible, in some circles, for an allegedly "unnatural" increase in wild salmonid smolt infestation by *L. salmonis* during and immediately after their spring migration from freshwater to seawater. This view was first promulgated during the late 1980's and early 1990's following a major collapse of sea trout stocks in the West of Ireland. Such allegations spread to other salmon farming regions, including Kenmare Bay, where the Currane fishery, the nearest to the Deenish site, was said to have collapsed. Whilst opposed views were and indeed still are held on this topic, there is no doubt that it is incumbent upon salmon farmers to operate their businesses under the precautionary principle in the control of lice on their fish. By doing so, they minimise any suspicion of impact on wild salmonids and ensure that their own stocks do not fall prey to severe lice infestation, which originate from wild stock, and can be fatal, like many diseases of domesticated livestock, if not held in check.

4.4.2. Monitoring of sea lice infestation.

A mandatory lice monitoring and control protocol[35] was introduced in Ireland by the then Department of the Marine and Natural Resources (DCMNR) in March 1993. The protocol was strengthened following the Sea Trout Task Force (STTF) Report in 1994 and was last updated by the DCMNR in August 2001. The protocol is an invaluable tool in the management of sea lice on farmed salmonids. The Irish salmon farming industry was the first to monitor sea lice levels under statute, involving regular inspections by officers of the Marine Institute, on behalf of the regulator, as required by the protocol. Lice control is thought to be more rigorous and lice levels on farmed fish generally lower in Ireland than in other salmon farming nations.

A further protocol of the five issued by the regulator, *Monitoring Protocol No.5; fallowing at offshore finfish farms*[36] has a number of purposes, including the limitation of the spread of diseases and infestations, between farm sites and generations, by the use of fallowing.

The monitoring methodology set down in Protocol No. 3 comprises the inspection and sampling of fish on every salmonid farm site in each single bay area a minimum of fourteen times per annum. Inspections are to be carried out monthly, with the following exceptions:-

- During the "sensitive spring period" for migrating wild salmonid smolt especially sea trout smolt, during March to May, when there are two inspections per month.
- Over the two-month period of December to January, when lice growth is slow and therefore only one inspection is required.
- At each inspection two samples of thirty fish are taken. The first sample is taken from a standard pen, sampled on every inspection, whilst the second is taken from another pen, selected at random.

The primary objectives of the Irish sea lice monitoring protocol are:-

- To provide an objective measurement of farm infestation levels and in particular to monitor *chalimus*[37] settlement and to monitor ovigerous female lice, to a trigger point at which treatment ensues since it is hatches from the egg strings carried by ovigerous females and the development of infestive *copepodid* stages that causes infestation.

35 Monitoring Protocol No. 3. Protocol for Offshore Finfish Farms; Sea Lice Monitoring and Control, DCMNR / DAFF, 11th May 2000.

36 Monitoring Protocol No. 5 Protocol for Fallowing at Offshore Finfish Farms; DCMNR / DAFF, 11th May 2000.

37 The first larval stage *of Lepeophtheirus*, following metamorphosis form the infestive copepodid stage, which is free-living, in the plankton, until it finds a salmonid host (generally a salmon or sea trout smolt) to attach to.

- To investigate the nature of sea lice infestations.
- To provide management information to drive the implementation of management and control strategies.
- To facilitate further development and refinement of management and control strategies.

The control strategy set out in the protocol has six main components:-

- Separation of generations.
- A minimum of one month's fallowing of sites between cycles.
- Early harvest of two sea-winter fish[38].
- The use of trigger levels of lice numbers on fish at which point treatment is mandatory. The "year round" trigger level is 2 ovigerous lice[39] per fish, which drops to 0.3 to 0.5 ovigerous lice per fish during the smolt migration months of March to May.
- Targeted treatment regimes.
- Agreed husbandry practices.

The overall objectives of the monitoring and control strategy are:-

- Synchronised production and fallowing in single bay areas to ensure the breaking of disease and parasite life cycles.
- Zero ovigerous lice objective. This objective is most critical immediately prior to and during the wild smolt migration periods (February to June inclusive). This is best achieved through:-
    - Strategic timing of fallowing of sites.
    - Rigorous zone control of lice by best currently available treatment methods and synchrony of treatments between farms in the zone.

Two reports issued by the Department of Agriculture, Food and the Marine, have advanced the objectives of the original protocols to some degree

38 This now rarely needs to be applied since harvests of both S1 and S0 origin fish are generally completed before the second sea winter or, at the latest, very soon after it.

39 Adult female lice, bearing eggs.

(DAFF 2008[40], DAFF 2010[41]). The first of these reports outlined a comprehensive range of measures to provide for enhanced sea lice control whilst the second reported on the implementation of the measures proposed in the 2008 document. The 2010 document also set out the National Lice count data, collected between December 2008 and June 2010, by Marine Institute Officers, under the terms of the Monitoring Protocol No3. These data demonstrate that by and large, the implementation of proposed policies brought about a reduction in lice levels over the implementation period.

Marine Harvest Ireland has implemented all the recommendations arising from these two documents at al its sites, having served as an industry representative on the National Implementation Group. In particular:-

- MHI pioneered the use of well boats for lice bath treatments in Ireland, as a means of improving treatment efficacy whilst reducing medication use.
- MHI pioneered the strict rotation of treatments to reduce the risk of increase of lice resistance to specific treatments..
- MHI has pioneered the use of alternating sites, the current mode of operation of the Deenish and Inishfarnard sites in Kenmare Bay
- MHI pioneered the use of vaccines against pancreas disease as a means of ensuring better efficacy of lice treatment.

These efforts have greatly assisted in combating lice infestation on MHI southwest sites, including those in Kenmare Bay, as shown by the data given in Table 13 and Figures 19 and 20. Figure 19 shows that only on four inspection dates, in roughly 166 separate inspections since 1995, has the standard trigger level of 2.0 ovigerous lice per fish been breached and all four occasions were in the August September period, well clear of the smolt migration months. Figure 29 shows that, in the "sensitive" months of March to May, when wild smolt may be running, the 0.5 ovigerous lice per fish has only been breached five times and never since 1999, when three breaches occurred in that one year. In fact the Southwest has the best lice control record in the country.

The Kenmare Bay sites were left fallow between 2006 and 2008 but since being restocked under MHI's control, lice levels throughout the years have been very low, in particular during the March-May period.

40 A strategy for improved pest control on Irish salmon farms. May 2008. Department of Agriculture Fisheries and Food, Dublin. 56pp.

41 National Implementation Group Report on a strategy for improved pest control on Irish salmon farms. November 2010. Department of Agriculture Fisheries and Food, Dublin. 55pp.

Table 13.
Deenish Salmon Farm; Natura Impact Statement.
Kenmare mean ovigerous female lice counts 1995 to 2011.
Taken from the National Sealice Monitoring Program reports, 2000 to 2012.
Key NS = Not sampled; F = Site/s fallow.
Green = wild smolt migration months; Trigger level = 0.5, otherwise Trigger Level= 2.0.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Jan	0.01	0.33	0.02	0.32	0.85	0.11	0.57	0.38	0.04	0.03	0.63	F	F	F	0.00	F	0.00
Feb	NS	0.57	MW	0.03	1.88	0.07	0.29	0.07	0.02	0.08	0.90	F	F	F	0.02	F	0.00
Mar	0.02	0.57	0.24	0.09	0.60	0.07	0.39	0.00	0.05	0.18	0.07	F	F	F	0.01	F	0.00
Apr	0.10	0.24	0.31	0.13	0.79	0.08	0.16	0.04	0.15	0.46	0.11	F	F	F	0.00	F	0.00
May	0.18	0.32	0.94	0.14	0.57	0.11	0.35	0.06	0.24	0.15	0.03	F	F	F	0.00	F	0.00
Jun	0.20	0.30	0.59	0.04	1.62	0.33	0.32	0.06	0.97	0.04	0.00	F	F	F	0.00	F	0.05
Jul	0.28	0.30	0.30	0.07	0.91	0.36	0.13	0.09	NS	0.13	0.00	F	F	F	0.10	F	0.00
Aug	0.32	0.56	2.17	0.07	3.86	1.29	0.47	0.37	2.84	0.27	1.00	F	F	F	0.08	F	0.00
Sep	F	1.08	0.10	0.12	F	F	0.43	0.30	1.80	2.12	0.71	F	F	F	0.32	F	0.00
Oct	F	1.23	0.07	NS	F	F	0.52	0.13	F	0.21	0.93	F	F	F	0.45	F	0.03
Nov	F	0.32	0.20	0.13	F	F	1.55	F	F	0.50	F	F	F	F	1.29	F	0.00

Figure 19. Kenmare Bay mean ovigerous female lice counts 1995 to 2011.

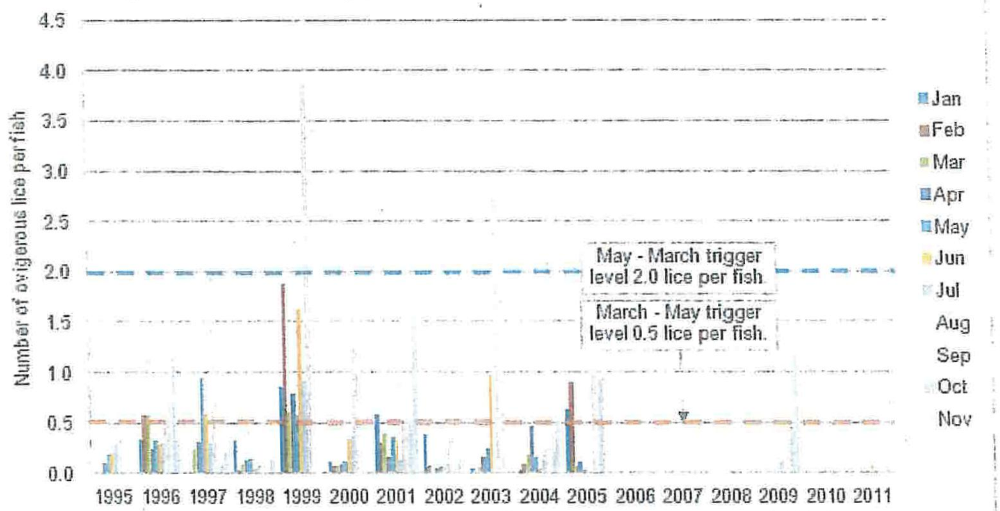
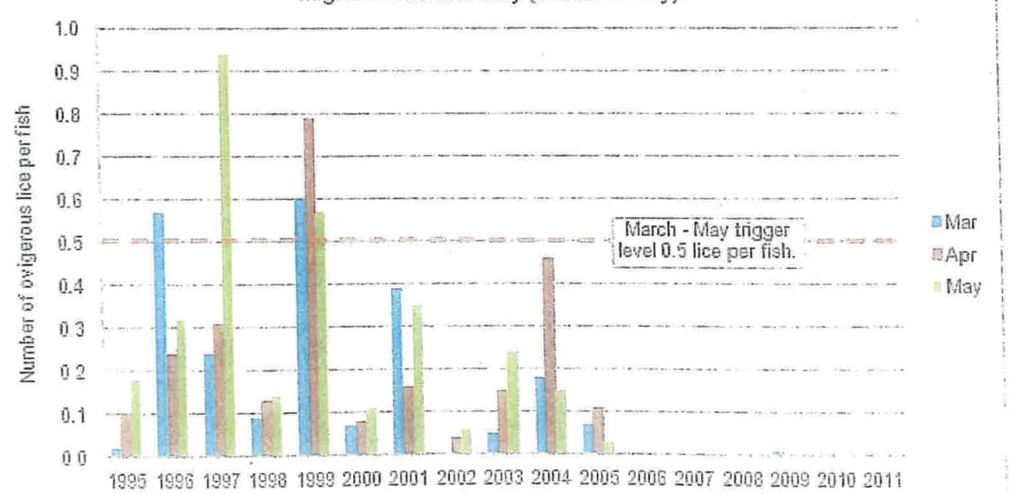


Figure 20. Kenmare mean ovigerous female lice counts for wild smolt migration months only (March to May).



4.4.3. Sea lice as a potential impactor in Kenmare Bay.

Background.

As has already been pointed out, at the outset of any new lice infestation cycle in a salmon farming area, the initiating step is the infestation of farmed fish by wild origin lice. Once infested, salmon farms have the capacity to generate large quantities of infestive lice stages, which re-infest the farm itself, if not controlled. The question remains; once infested, can salmon farms re-infest wild stocks? There is a widely held view that this is possible but, in Irish conditions and in all cases where the majority of salmon farming is well-removed from salmonid rivers (where the natural infestation cycle of wild fish occurs), the empirical and verifiable evidence is scant[48]. In these circumstances, it is relevant to ask what influence the distance between salmon farms and wild salmon rivers may have on the likelihood of such re-infestations.

Figure 21.
Deenish Salmon Farm; Natura Impact Statement.
Life cycle of the salmon louse, *Lepeophtheirus salmonis*.

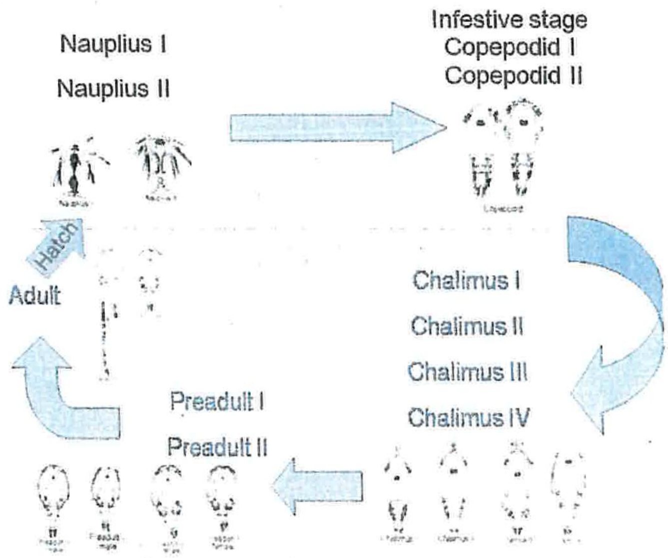


Figure 21 shows the life cycle of *Lepeophtheirus salmonis*. In nature, adult lice are carried into the estuarine reaches of salmonid rivers as parasites on mature wild salmonids, returning to their natal rivers to breed. En route, the ovigerous females lice release Nauplius larvae in or near the estuarine margins, where they form part of the plankton, drifting in the current. A single clutch of wild eggs can hatch to produce 400 or so Nauplii. Although lice can breed and mature at any time of year, it would seem that this activity peaks, in rising temperatures post-winter, in order to release the maximum numbers of larvae into such areas in the spring. After two metamorphoses through Nauplius I and Nauplius II, which takes about 4 days, the Copepodid I larva emerges. Copepodids are the infestive stage, at which the organism transforms from its planktonic phase, into its parasitic phase.

Copepodids are planktonic[42] and cannot control their position or direction of travel. This is of no consequence to the natural, wild infestation strategy, which is designed only to enable a critical mass of copepodid larvae to meet a critical mass of salmonid smolt, their potential hosts, as they migrate seawards in Spring. However, in the four decades, since the introduction of marine salmon farming, this ancient parasite has found a new population of hosts, on salmon farms, downstream of its ancestral source of hosts. As a rule, salmon farm sites lie downstream (seawards) from salmonid river estuaries. Farm pens offer large numbers of potential hosts to aimlessly drifting wild copepods that have failed to find wild hosts in or near their natal estuary. Even if a small number of wild copepodids find hosts amongst farmed fish, the resulting minor infestation has the potential to become an epidemic within a few generations of lice, amongst farmed fish, restricted within their pen nets. On the other hand, if small numbers of drifting, farm-origin copepodids have the unlikely good fortune to drift into a river estuary, they face a different outcome. To initiate a minor infestation amongst migrating smolts may be possible but the meeting of the critical masses hosted and parasites required for a successful, heavy infestation is unlikely to ensue and, with the migratory dispersal of the hosts, the chance to cause high levels of infestation by multiplication amongst a stationary host population (as on a farm site) is not in prospect.

That aside, in drifting between a river (wild origin copepodids) and a farm site or between a farm site (farmed origin copepodids) and a river, distance travelled cannot be measured as an uninterrupted line. It is, rather, a hydrographic distance, dictated by the speed and direction of successive ebb and flood currents. The period within which copepodids must find hosts before perishing is dictated by their yolk supply since they are not equipped to use an external food source. Copepodid longevity reduces with temperature but is generally taken to be about ten days in the spring period, when smolt are migrating (see Figure 22). Further, whether the direction of drift is towards a fish farm or towards a river, the greater the hydrographic distance or period of travel, the less dense and more dispersed the copepodid population becomes, relative to its highest density, at source, (be it in a river mouth or on a salmon farm). Thus the longer the Copepodid's travel time, the less likelihood there is of a successful infestation.

The salmon louse did not evolve a planktonic Copepodid stage to target salmon farm sites downstream of rivers. The species evolved so that adult lice in or near river estuaries could reach peak fecundity as smolt migrate, such that optimal numbers of Copepodids could be concentrated in the waters through which the smolts move seawards. This undoubtedly depends on ovigerous female lice being located, by whatever means, close to the host source, in order to maximise the opportunities for parasite / host contact.

42 Carried in suspension in the water column with little or no ability to dictate its direction of travel although Copepodid larvae may have some ability to adjust their position in terms of water depth as an infestation strategy (Heuch 1995)

Unlike chance encounters of wild copepodids with farmed hosts, this is not a random event but an evolved, efficient and unchanging strategy, based around infestation by a planktonic Copepodid, that has ensured the survival of *Lepeophtheirus*, in the wild, through many millennia.

MHI commissioned RPS Consulting Engineers[43, 44], to conduct hydrographic modelling studies, to investigate the likely outcomes of farm-origin copepodid dispersals in Lough Swilly, County Donegal. This work was reported in a paper to the World Aquaculture Conference in 2007[45]. RPS concluded that, given the hydrography of Lough Swilly and the relative positions of proposed farm sites and its rivers, farm-origin lice copepodids could not reach river estuaries in sufficient numbers to make any significant difference to lice infestation levels on wild fish, even when the numbers of farm-origin copepodids released in the model were far greater than had ever been known to occur in reality. Indeed, even at the highest modelled release (more than $40x10^6$ copepodids released per tide, based on a theoretical infestation of 10 ovigerous female lice on every fish on the farm site), the density of copepodids capable of reaching estuaries never greatly exceeded 0.1 copepodid per m^3 of water. Clearly such concentrations are incapable of causing high infestation by large numbers of lice at the same development stage, a characteristic of wild infestations. In effect, this finding disproved a belief that lice infestations in Lough Swilly rivers, which reached an average of 50 lice or more per fish on samples collected in some rivers in some years, could be caused by farmed-origin lice. The only likelihood is therefore that such infestation levels were caused by high natural copepodid levels, arising from the presence of high numbers of ovigerous female lice in estuaries in some years, possibly assisted by favourable climate conditions.

Lice dispersal in Kenmare Bay

Whilst a full dispersion study has yet to be completed for Kenmare Bay, the following observations are made in an attempt to ascertain whether what appears to hold for Lough Swilly also holds for outer Kenmare Bay. There are three salmonid rivers within 20 linear km of the Deenish salmon farm site; the Currane / Cummeragh System and the Inny System on the Iveragh Peninsula, and the Kealincha River on the southern side of the bay. The Currane lies within the Killarney National Park, McGillicuddy Reeks and the Caragh River Catchment, SAC 000365 and the Inny lies within the Ballinskelligs Bay and Inny Estuary SAC 000335. The Kealincha River drains into the Kenmare River cSAC 002158; see Figure 4.

---

43 Shannon N. 2006. Modelling water quality at Dooanmore and Anny Point sites, Lough Swilly. RPS Consulting Engineers, Belfast. 133 pages.

44 Shannon N. 2007. Water quality modelling, Lough Swilly. Addendum report; lice dispersion. RPS Consulting Engineers, Belfast. 38 pages.

45 Bass N., Shannon N. 2007. Modelling the dispersal of salmon lice (*Lepeophtheirus salmonis*) from proposed salmon farm sites in Lough Swilly, County Donegal, Ireland. World Aquaculture Conference, 2007, Sea Lice Session, San Antonio, Texas, March, 2007.

Atlantic salmon in freshwater are cited as a conservation interest in the Killarney National Park SAC SAC000365, as listed Annex II in of the Habitats Directive[46] but are not mentioned in the case of the other two local SAC's.

At a distance of some 13 linear km, the Currane River is the nearest salmonid river to the Deenish farm site, although Lambs Head prevents straight line access by sea. Since salmon are protected by the SAC that includes the Currane system and also because Lough Currane is regarded by many being a globally important sea trout fishery, as well as a productive salmon fishery [47,48], the following remarks concentrate on this system.

---

46 Atlantic salmon are only protected under the Habitats Directive in freshwater, under Annex II, by which their conservation requires the designation of Special Areas of Conservation (SAC), and under Annex V, by which their taking in the wild or exploitation may be subject to management measures. (Guidance document on the strict protection of animal species of Community interest under the Habitats Directive 92/43/EEC, EU, February 2007).

47 Interestingly, although sea trout, *Salmo trutta*, is regarded by many as being a threatened species, it is absent from the Habitats Directive Annexes and is not therefore cited as being of conservation interest in any SAC area. Its status is therefore not a required topic of this report.

48 There is a historical perspective to the "relationship" between sea trout status on Lough Currane and the Deenish salmon farm, surrounding the Minister's Sea Trout Working Group (STWG), established to investigate the status of sea trout following the collapse of the western fisheries around 1990. The 1991 STWG report did not link salmon farming to sea trout problems, except, perhaps by implication, in respect of the Western Collapse, in its conclusion that "*61% of fish farm production of salmon is from within the Galway / Mayo area*" (as it was at that time).

In 1992 STWG reported observations on lice infestation of sea trout on 14 rivers ranking the Inny and the Currane as the 7th and 11th most infested in terms of median infestation level . Angling in the Currane was described as "poor" that year following three excellent seasons. The report concluded that whilst "*a relationship is postulated between production of juvenile sea lice from fish farms and the mean intensity of sea lice found on prematurely returning sea trout during May......data examined by the Working Group in 1992 again failed to show a causal link....*"

The 1993 STWG report examined 36 rivers nationally and again ranked Kenmare Bay rivers high in terms of sea lice median infestation including the Inny (5th) and the Currane (9th). The 1993 Currane sea trout rod catch was described as down further to 345 fish, whilst fishing on the Inny was described as "poor". The STWG report concluded that "*the scale of the sea trout collapse in the western region was not reflected in any other region*", but, on the basis of the limited fishery data and no recent stock data for Waterville, concluded further that; ..."*despite the possible association of poor catch of sea trout in Lough Currane with a substantially reduced rod effort, it is reasonable to assume that the sea trout stock suffered a serious decline.*"

The findings of the 1993 STWG report were heavily influenced by a "statistical model", submitted by some STWG members, albeit contested by others. The model purported to show a statistical relationship between sea lice counts on returning sea trout post smolts and linear distance to salmon farms. This did much to damage the reputation of salmon farming in Ireland and was probably the original catalyst for a level public condemnation of the industry which has persisted for far longer than the veracity of the model. The model held sway for some time but was discredited in due course by international experts on the quality of its sampling program. However, it is submitted that its major fault would now be seen to be its failure to recognise that, although *Lepeophtheirus* infestive stages (copepodid larvae) can drift quite large distances down-current to reach a source of captive hosts on salmon farms, they completely lack any means to travel up-current to reach a river from a salmon farm site (clearly an impossibility).

A fish counter was installed at the Waterville weir by the Fisheries Research Centre for the 1994 season; in addition, farm lice monitoring and control increased radically as a result of the conclusions of 1993 report. In the 1994 STWG report, 53 rivers were sampled nationally. Again, the Currane and the Inny were ranked high in terms of median infestation. The 1994 report addressed the case of the Currane at length. The angling catch for the 1994 season increased to 1,655 fish. The newly installed counter counted over 25,000 validated sea trout (upstream count) returning to the system. This substantial number included fish from one sea winter to five sea-winters in age.

In the absence of a full dispersion model, of the type generated by RPS for MHI in Lough Swilly, the following arithmetic ranging exercise is carried out to attempt some estimate of the likely population density of lice larvae that could result from hatches of larvae from ovigerous female lice infesting the Deenish farm site (see Figure 21). Their dispersal, under the forcing parameters in Kenmare Bay, described in Section 3, is then considered.

Table 14 tabulates numerical fish data for the Deenish site, taken from Table 7, and uses these data to calculate hypothetical figures for monthly releases of Nauplius larvae at the site, from three selected mean populations of ovigerous female lice. The ovigerous female populations calculated relate to the two seasonal trigger levels of 0.5 and 2.0 ovigerous lice per fish, whilst the third level is derived from the empirical data in Table 13 and Figures 19 and 20, which show that mean ovigerous lice levels for the bay have exceed 2.0 lice per fish four times but have never exceed 4.0 lice per fish, between 1995 and 2011. On this basis, 5.0 lice per fish is selected as a hypothetical maximum infestation level, for examination. The maximum hatch of Nauplii from farmed fish is widely held to be 250 per clutch (less than for wild lice) and, for the sake of this exercise, as for the Lough Swilly model, it is assumed that, in spring, the generation time for *Lepeophtheirus* is 1 month and that Nauplii are released on every high tide, at slack water.

Table 14 shows that this yields a maximum total Nauplius hatch of:-

- Say 1,700,000 Nauplii per tide or 100,000,000 Nauplii per month at 0.5 ovigerous females per fish.
- Say 6,800,000 Nauplii per tide or 400,000,000 Nauplii per month at 2.0 ovigerous females per fish.
- Say 17,000,000 Nauplii per tide or 1 billion Nauplii per month at 5.0 ovigerous females per fish.

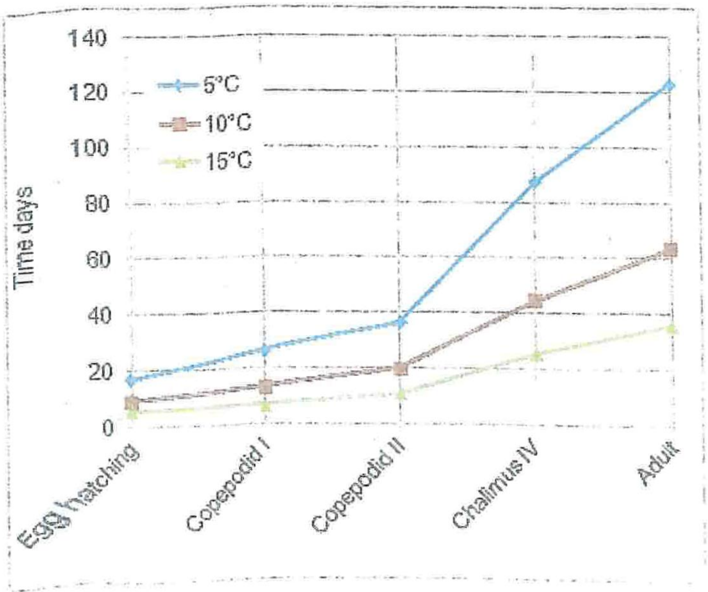
The relative proportions of the year classes indicated the reality of the good health and performance of the breeding stock over the past five seasons, when reported rod catch data had brought the status of Currane stocks into question and made the Deenish salmon farm the culprit. Taking the 25,000 returned fish as the standing stock for the 1994 season and assuming a normal rod exploitation rate of 15-29%, the group concluded that the Waterville rod catch should have been of the order of 4,350-5,800 fish, rather than 1,655. This new information led to the following conclusions in the 1994 report that *"The scale of the sea trout collapse in the west of Ireland has not been reflected in ....any other region"* and that *"New data for the Waterville fishery, available for the first time this year, support a revised opinion that the sea trout stock in Lough Currane was not in serious decline, as concluded by the 1993 STWG".* The 1994 report also noted that, possibly due to reduced fishing effort, the rod catch was not representative of the stock and again questioned the use of rod data alone as an indicator of stock status.

The STWG met to consider the 1995 data but the report remains unpublished. Importantly, the group again concluded that conclusive proof of a causal link between salmon lice infestations of farmed salmon and wild sea trout remained elusive. Although data is only currently available until 2001, there was strong evidence, according to the Sea Trout Review Group Report (2002) to that date of the ongoing health and stability of the Currane sea trout stocks. It will be noted that counter returns reached 60,000 in some years to 2001 and that rod catch, approaching 7,000 in some years, was probably then meeting the anticipated level of exploitation.

Table 14.
Deenish Salmon Farm. Natura Impact Statement.
Hypothetical sea lice larval production data for the Deenish site.

Month	Fish number		Ovigerous lice @ 0.5/fish	Nauplius larvae released @ 250 larvae / clutch		Ovigerous lice @ 2.0/fish	Nauplius larvae released @ 250 larvae / clutch		Ovigerous lice @ 5.0/fish	Nauplius larvae released @ 250 larvae / clutch	
	begin month	end month		Per month	Per tide		Per month	Per tide		Per month	Per tide
Mar	835,884	814,987	412,718	103,179,431	1,697,030	1,650,871	412,717,725	6,788,120	4,127,177	1,031,794,313	16,970,301
Apr	814,987	802,762	404,437	101,109,312	1,662,982	1,617,749	404,437,249	6,651,928	4,044,372	1,011,093,123	16,629,821
May	802,762	796,340	399,776	99,943,881	1,643,814	1,599,102	399,775,524	6,575,255	3,997,755	999,438,810	16,438,138
Jun	796,340	792,358	397,175	99,293,644	1,633,119	1,588,698	397,174,575	6,532,477	3,971,746	992,936,437	16,331,191
Jul	792,358	788,397	395,189	98,797,175	1,624,954	1,580,755	395,188,702	6,499,814	3,951,887	987,971,755	16,249,535
Aug	788,397	784,455	393,213	98,303,190	1,616,829	1,572,851	393,212,758	6,467,315	3,932,128	983,031,896	16,168,288
Sep	784,455	777,394	390,462	97,615,560	1,605,519	1,561,849	390,462,240	6,422,076	3,904,622	976,155,600	16,055,191
Oct	777,394	768,066	386,365	96,591,259	1,588,672	1,545,460	386,365,034	6,354,688	3,863,650	965,912,585	15,886,720
Nov	768,066	756,545	381,153	95,288,151	1,567,239	1,524,610	381,152,604	6,268,957	3,811,526	952,881,511	15,672,393
Dec	756,545	739,144	373,922	93,480,556	1,537,509	1,495,689	373,922,226	6,150,037	3,739,222	934,805,565	15,375,092
Jan	739,144	725,840	366,246	91,561,486	1,505,945	1,464,984	366,245,945	6,023,782	3,662,459	915,614,863	15,059,455
Feb	725,840	721,485	361,831	90,457,759	1,487,792	1,447,324	361,831,037	5,951,168	3,618,310	904,577,592	14,877,921
Mar	721,485	712,827	358,578	89,644,456	1,474,415	1,434,311	358,577,824	5,897,662	3,585,778	896,444,559	14,744,154
Apr	712,827	707,124	354,988	88,746,929	1,459,653	1,419,951	354,987,717	5,838,614	3,549,877	887,469,291	14,596,534
May	707,124	702,174	352,325	88,081,149	1,448,703	1,409,298	352,324,596	5,794,812	3,523,246	880,811,490	14,487,031
Jun	702,174	693,748	348,981	87,245,151	1,434,953	1,395,922	348,980,606	5,739,813	3,489,806	872,451,515	14,349,531
Jul	693,748	600,423	323,543	80,885,710	1,330,357	1,294,171	323,542,839	5,321,428	3,235,428	808,857,097	13,303,571
Aug	600,423	475,620	269,011	67,252,687	1,106,130	1,076,043	269,010,748	4,424,519	2,690,107	672,526,869	11,061,297
Sep	475,620	336,815	203,109	50,777,165	835,151	812,435	203,108,662	3,340,603	2,031,087	507,771,654	8,351,507
Oct	336,815	229,794	141,652	35,413,050	582,451	566,609	141,652,200	2,329,806	1,416,522	354,130,500	5,824,515
Nov	229,794	118,645	87,110	21,777,434	358,181	348,439	87,109,735	1,432,726	871,097	217,774,338	3,581,815
Dec	118,645	0	29,661	7,415,337	121,963	118,645	29,661,348	487,851	296,613	74,153,369	1,219,628
Jan	Deenish site fallow										
Feb											

Figure 22.
Deenish Salmon Farm; Natura Impact Statement.
L. salmonis; development time vs. ambient temperature.
Source Bjorn Midttun, Inverness 2005, Pharmaq Limited.



Further assumptions, referenced to the literature, are made, that the Nauplius stage lasts for four days, that there is a 30% mortality of Nauplius II larvae on metamorphosis to Copepodid I larvae and that, following this, Copepodid larvae can survive for ten days before a host must be found; see Figure 22. For the sake of this model, it is assumed that 10% of the Copepodids metamorphosed from Nauplii still remain viable at the 10-day Copepodid extinction point.

Calculations of larval density are made at two points in the dispersion:-

- It is assumed that Nauplii are hatched in a pulse at high tide, on slack water. These would be released into the immediate "box" of water surrounding the net pens, say into the grid area, of 300m x 225m, within 4m of the water surface[49, 50, 51]. Thus the farm box volume would be 27,000m^3 . Using the Nauplius production data in Table 14, it is then possible to calculate a number and concentration of such larvae in this water volume at slack water, that would then commence dispersion with the ebbing of the tide.

- With reference to the 50km^2 box model employed in Section 4.2.1 to calculate nutrient dispersal and dilution, (see Table 9), the tidal prism calculation showed that a mean volume of 6,342,275,269m^3 (6.34×10^9) of water flushes the 50km^2 box each month. Using the Nauplius production data in Table 14 and the assumptions set out above, it is possible to estimate the number and concentration of Nauplii that would hatch and the resulting number of Copepodids that would be dispersed within the box volume over one month in the following calculation steps:-

  Copepodid density = Number of Nauplii released per month, less 30% Nauplius mortality on metamorphosis to Copepodids, less 90% mortality of Copepodids to age 10 days, divided by the box flushing volume.

These calculations are shown numerically in Table 15.

---

49 Costelloe M, Costelloe J and Roche, N., 1995. Variation in sea lice infestation on Atlantic salmon smolts in Killary Harbour, West coast of Ireland. *Aquaculture International* 3, 379-393.

50 Costelloe M. et al. 1996. Planktonic dispersion of larval salmon lice, *Lepeophtheirus salmonis* associated with cultured salmon, *Salmo salar*, on the West coast of Ireland, *JMBAUK*, 76, 141-149.in a number of selected bays on the West coast of Ireland,. ICES Journal of Marine Science.

51 Costelloe M. et al. 1997. Distribution of larval stages of *Lepeophtheirus salmonis* in a number of selected bays on the West coast of Ireland,. *ICES Journal of Marine Science*.

Table 15.
Deenish Salmon Farm. Natura Impact Statement.
Hypothetical *L. salmonis* larval dispersal calculations for the Deenish site.

15.1. Hatch of Nauplii into 270,000m^3 "farm box".

Trigger level	Mean ovigerous lice per Deenish fish	Nauplius hatch per tide			Farm Box volume 300 x 225 x 4 m3		Post hatch Nauplius density in box
0.5	400,000	1,644,737			270,000		6.09
2.0	1,600,000	6,578,947			270,000		24.37
5.0	4,000,000	16,447,368			270,000		60.92

15.2. Dispersal of Copepodid larvae into a 50km^2 box model.

Trigger level	Ovigerous lice on Deenish farm	Nauplius hatch per month	Larval populaiton post Nauplius	Copepodid popuation post 10 days	Box volume 50km2 x 45m m3	Flushing volume per month m3	Copepodid density in 50km^2 box
0.5	400,000	100,000,000	30,000,000	27,000,000	2,250,000,000	6,342,275,269	0.004
2.0	1,600,000	400,000,000	120,000,000	108,000,000	2,250,000,000	6,342,275,269	0.017
5.0	4,000,000	1,000,000,000	300,000,000	270,000,000	2,250,000,000	6,342,275,269	0.043

This arithmetic model in Figure 15.1 indicates that, for the range of trigger levels tested, the concentration of Nauplius larvae in the immediate farm area, following a single hatch pulse at high water would be of the order of 6 to 60 larvae per m^3 water. These figures are within the same order of magnitude as empirical data for Nauplius I concentrations, collected within salmon farm pens in Killary Harbour, using plankton nets, of an average of 70 nauplii/m^3, in 1995-1996[50]. Almost none could be found within 200m of the pens.

The arithmetic model in Figure 15.2 indicates that, using the same box model employed to predict nutrient elevation in outer Kenmare Bay as a result of the operation of Deenish salmon farm, along with a range of established assumptions regarding sea lice survival, metamorphosis and longevity, and using the same trigger level range of 0.5 to 5.0 ovigerous lice per farmed salmon, the concentration of copepodid larvae at the limits of the 50km^2 box will be in the range of 0.004 to 0.04 copepodids per m^3 water. These figures are in the same range of larval density as predicted to occur in river estuaries in Lough Swilly in the RPS computer-generated dispersional model, commissioned by MHI in 2006-2007[52].

The nominal horizontal dimensions of a 50km^2 box are 7km x 7km. It is noted from Section 3.2 that the residual current at the Deenish farm site in some 2.5cmsec^{-1}, or about 7km per month, travelling between WNW to NW, or roughly towards the ocean, between Puffin Island and the Skelligs (see

[52] Shannon N. 2007. Water quality modelling, Lough Swilly. Addendum report; lice dispersion. RPS Consulting Engineers, Belfast. 38 pages.

Figure 4). It might therefore be more likely that the 50m^2 box that was originally defined as spreading more or less symmetrically around the Deenish site, would in fact move away from the Deenish farm, in the residual current, to a position about 7km further down its residual current path. However it cannot be assumed that either the residual current speed or direction as measured at the farm would necessarily be maintained as the water body moves away from the point of data measurement. That said, it would be expected that residual current would not increase, because bathymetric depth increases with distance away from the Deenish site until inshore shallows are reached and then other forcing parameters such as frictional losses come into play. Nonetheless, it may be that the net residual current could disperse the lice from the site on a more northerly course, towards the outfall of the Currane River. What is certain is that the Copepodids would disperse, and dilute, and be inexorably subject to the extinction curve dictated by their limited feed reserves. And, even if they were to disperse 7km per month in the direction of the Currane River estuary, they would still only be about half-way there at their point of extinction.

The purpose of this exercise is for use as no more than a ranging test, to determine a likely order of magnitude of Copepodid density that could arise, if the larvae were indeed able to travel all the way to the outfall of the Currane River, 13km from the Deenish site, as some have alleged. This question seems to have been answered by a simple calculation that indicates that, in the case of the Deenish farm site, the Copepodid population would dilute by at least three orders of magnitude to densities of, perhaps, a single, 0.8mm long Copepodid in every 25m^3 to 250m^3 of water (0.04 to 0.004/m^3; see Table 15.2) and they would still not be much closer than half-way towards an opportunity to infest emerging wild smolt. Much as the summation of the findings of the STWG indicated[48], this observation leans heavily towards a balance of probability that, on the basis of empirical data collected on ovigerous lice populations at the Deenish farm site in the last 15 years or so, there is no significant risk that lice originating from the farm site could augment the natural infestation of salmonid smolt as they emerge from the estuarine reaches or inshore margins around the Currane River.

There remains one further possibility to consider and that is that salmonids of any age could venture into ambient densities of farm-origin Copepodids in Kenmare Bay as they migrate. The Lough Swilly model and the current exercise as well as extensive survey work in Killary Harbour in the mid-90's[50] all indicate that farm-origin larval densities fall extremely rapidly with distance from the farmed source. What must also be borne in mind is that the first four days or so of dispersion and dilution from the hatching source is of non-infestive Nauplii, before their metamorphosis into infestive Copepodids. Nauplii would have been exposed to at least eight tidal flushes and would already be well dispersed before they would metamorphose into infestive

Copepodid larvae that could be encountered by potential hosts. In all events, evidence suggests that wild salmonids do not linger close to salmon farm sites and that salmon migrate directly to their feeding grounds, taking the most direct route to the ocean. Again it is submitted that, in the case of the Deenish farm site, there is no significant risk that salmon could suffer any consequential infestation of farm-origin *Lepeophtheirus* within the marine environment in Kenmare Bay.

4.5. Farmed salmon escapes.

The following concerns are voiced over the risk of escapes of fish farm escapes:-

- Over-running wild salmon redds by escaped farmed fish and displacement of wild salmon eggs by mature farmed fish, with the potential to impede natural spawnings.
- Genetic dilution and weakening of wild stocks by interbreeding between farmed and wild fish.
- Transfer of disease into wild stocks, by vertical transfer or infection spread from farmed fish.

No farmed escapes have been reported from MHI's Kenmare Bay sites since MHI acquired them. Impact risks associated with escaped fish depend on the maturity of escapees since onset of maturation triggers the instinct of salmonids to seek rivers in which to breed (and their choice of river is wide because their natal rivers would be far from Kenmare Bay). However, farmed fish are harvested before onset of maturity. As sheltered, domesticated stock, dependant on a readily available food source, escapees are more likely to die or be preyed upon than to enter river systems, especially if immature at time of escape, which is the most likely prospect. Overrunning of redds or interbreeding with wild fish is only a risk if escapees are mature. Overrunning and displacement of wild salmon eggs could be regarded as a potential impact risk because farmed fish tend to mature later than wild stock[53]. However later maturation would limit interbreeding risks.

Fears of genetic interactions between farmed and wild salmon stocks were expressed by McGinnity et al (2003)[54]. However, as they have acknowledged, the scenario that the authors depict could only result from significant, persistent or annual escapes of fish and their survival to regularly enter the same rivers.

53 Anon. 2009. Fish farming policy statement, Marine Conservation Society. www.mcsuk.org

54 McGinnity et al. 2003. Fitness reduction and potential extinction of wild populations of Atlantic salmon, *Salmo salar*, as a result of interactions with escaped farmed salmon. Proc. R. Soc. B. 2003, **270**, 2443-2450.

Prior to the banning of the drift net fishery in 2006, annual net returns for the nearby port of Castletownbere, where much of the Kenmare Bay drift net catch was landed, indicated very low levels of farmed fish in drift net catches in SW Regionall Fisheries area, in the range of zero to single figures per annum. It is submitted that escapes of such numbers and regularity as to cause noticeable impact is not in prospect and completely counter to the profit objectives of commercial salmon farming.

MHI has implemented fish escape mitigation policies and procedures for the installation and operation of all its fish farms in addition to comprehensive inspection and monitoring procedures, set out in a series of Special Operating Procedures (SOP's). In addition, all Irish salmon farms are subject to independent audit by Engineers from the Department of Agriculture Food and the Marine under Monitoring Protocol No. 4 for Offshore Finfish Farms – audit of Operations.

Amongst the MHI SOP's relevant to fish escape prevention an mitigation are:-

- Net Inspection by diver and on net-changing; SOP 28941 and SOP 26166.
- Maintenance of nets and other cage components; SOP 28646; SOP 28940.
- Emergency Plan for fish escapes SOP 2556.

All nets are number-coded, net stock is rotated and usage recorded. Nets are cleaned and dried prior to storage and are stored off the ground in vermin-free conditions. Nets are inspected before use and regularly renewed. Spare nets are always available. Members of staff are trained in net inspection and maintenance.

MHI also follows the guidelines on containment of farmed salmonids, drawn up between the North Atlantic Salmon Organisation (NASCO) and the International Salmon Farmers Association (ISFA). These guidelines set out preventative measures, which are observed by the company, in respect of:-

- Site selection.
- Equipment and structural specification.
- Preventative strategies, inspection and maintenance.
- Staff training.

The location, equipping and operation of the Deenish site complies with these guidelines, with an eye to fish escape risk, which increases, for example, in areas exposed to excessively heavy seas or heavy boat traffic. All floating cage equipment, nets and associated structures are now specified to withstand local current and wave climate conditions. Mooring systems are specified to withstand predicted 50-year local wave climate conditions ensuring the integrity of the cages. Preventative strategies include guidelines for the use of vessels around cages and the provision of adequate navigational lighting and radar reflectors to prevent damage arising due to navigational errors by non-company vessels.

The Department of Agriculture Food and the Marine and its aquaculture management agency, AFMD, have become proactive in the matter of certification of standards for aquaculture installations, following the introduction of a legally enforced standard for aquaculture installations in Norway[55] and the recent drafting of a similar standard in Scotland[56]. It is expected that the specifications for all containment equipment on all Irish salmon farm sites will have to undergo independent certification of their adequacy for their selected site, prior to the granting of permission to equip the site, from now on.

All farm activities that may increase the risk of fish escape are carried out by staff aware of the risks and trained for the task in hand. The majority are also covered by further Standard Operating Procedures, These include:-

- Fish sampling.
- Fish movements for smolt transfer, grading, relocation and harvesting.
- Net changing.
- Use of vessels in the vicinity of cages.

The practice of moving fish by cage towing is not now used under current best practice, the preference being to use well boats, in the interests of both fish health and safety.

The historical record, MHI's own operational and mitigation procedures and recent moves towards independent certification of specifications for Irish fish farm containment systems all suggest that the escape of sufficiently large number of fish to cause indirect impacts in areas protected under the Habitats and Birds Directives around outer Kenmare Bay is not a significant risk.

4.6. Risks of increase of impacts in combination with other developments.

The Deenish salmon farm operation is located in outer Kenmare Bay, a considerable distance from all other developments, both existing and in prospect. Even the nearest salmon farm site, MHI Inishfarnard in 13 km to the ESE, off the Beara Peninsula (about equidistant with the nearest town, of Waterville and the Currane River, to the NNW of the site).

The mean ambient nutrient data for outer Kenmare Bay, set out in Table 10 represents monthly "background" nutrient levels plus their elevation by all assimilated inputs entering Kenmare Bay, from all the nutrient sources (agriculture, livestock, fertilisers, human population, aquaculture, industry etc.) within the catchment areas, for which Kenmare Bay is the receiving water. Thus the current measured total ambient levels of nutrients are in a sense a "snapshot" of the nutrient status of the catchment and the capacity of the bay to sustain the resulting nutrient load. It is observed that, since the ambient nutrient levels and the ECE projected to

55 Technical requirements for fish farming installations. Nytek NS9415 2009.

56 A Report Presenting Proposals for a Scottish Technical Standard for Containment at Marine and Freshwater Finfish Farms SARF073. 2012.

arise from the Deenish operation show absolutely no sign of approaching the EQS for Nitrogen and Phosphorus, Outer Kenmare Bay is operation and will continue to operate well within its carrying capacity in terms of nutrient loadings. This has much to do with the flushing of the bay by tidal currents.

As to future prospects of likely combined impacts, it is predicted that nutrient inputs from the Kenmare Bay catchment may well be ameliorated by improvements to effluent waste water treatment plants and septic tank efficiency, driven by the Water Framework Directive, the Nitrates Directive and National legislation. On the other hand, new initiatives in both agriculture and aquaculture may counteract this. However the evidence is that the carrying capacity of the outer bay area is more than adequate to deal with these eventualities.

There is insufficient shelter for the development of further finfish farm sites in the outer bay area so significant increase in levels of risk of the direct and indirect impacts discussed in this report on local protected areas is a highly unlikely prospect.

Section 5.
Conclusions.

The completion of this Natura Impact Statement (NIS) has been requested by the Aquaculture Licence Appeals Board (ALAB) to consider the production strategy employed at Deenish Salmon Farm in Kenmare Bay by its owners, Marine Harvest Ireland (MHI). It should be further noted that legislation and guidelines require that only protected areas created (SAC's and SPA's) are considered in an NIS. Therefore this document only makes passing reference to other designations, created under national legislation or other EU directives.

As for many embayments along the Irish coast, the Natura process is as yet incomplete in Kenmare Bay, which is still designated as a Candidate SAC (cSAC). This is a critical issue for the progress of sustainable aquaculture development in Ireland, and indeed for the compiling of this NIS, because much of the information required for the assessment of the impacts of existing and proposed enterprises within the bay will not be available until the Natura process is complete and the licensing of enterprises within the bay can properly proceed.

A salmon farm has been operating at Deenish Island over the last 23 years. The farm was first licensed and deployed in 1989.

In 2011, in line with current best practice, an improved mooring and containment system was installed at the site, using a submerged grid with a total of 26 mooring ropes and anchors, to support the net pens. Twelve, 40m diameter, Aquiline-type pens were installed into the grid, in the existing site area. A feed barge, nominal length 25m, is now also moored west of the pens.

This is a large salmon farming unit by current standards and it is relevant to ask what risks there are of significant impacts on the environment, in both the near-field and the far-field. An NIS addresses these issues by considering the risk of impacts on protected areas around the site, created under the Habitats Directive (92/43/EC) and the Birds Directive (79/409/EEC).

The NIS considers risks of direct impacts on the two protected sites within which the salmon farm site is located, the Kenmare River cSAC 002158 and Deenish and Scariff Islands SPA 004175. The document also considers the possibility of indirect risks on all other protected sites within a 20km radius of the site.

Risk of direct impacts are considered on the habitats and species cited as being of special conservation interest in the two protected sites within which the farm is located. Of the rare and notable species that occur on the seabed within the cSAC, none mentioned in the site synopsis are known to occur close to the Deenish site. This has been indicated in benthic surveys conducted for two EIS's and a number of annual monitoring surveys.
In respect of mammals, Otter (*Lutra lutra*), the Common / Harbour Seal (*Phoca vitulina*) and the Lesser Horseshoe Bat (*Rhinolophus hipposideros*), all Annexe II species, occur within the SAC. However none are recorded as inhabitants of the vicinity of Deenish or Scariff Islands.

Regarding marine mammals, local haul-outs of Common and Grey seal are regarded as being too far away for the farm site for risks of direct impact to be significant

Although cetaceans will come within close range of the farm operation on an intermittent basis, these visits are not expected to be subject any significant or regular risk of impact.

The boundary of SPA 004175 is drawn 500m seawards around Deenish and Scariff islands. The boundary therefore encompasses the bulk of the licensed Deenish farm site area. The SPA also lies within the Kenmare River SAC. The SPA site is of special conservation interest for the following sea bird species: Fulmar (*Fulmarus glacialis*), Manx Shearwater (*Puffinus puffinus*), Storm Petrel , Lesser Black-backed Gull (*Larus fuscus*) and Arctic Tern (*Stema paradisaea*). Shag (*Phalacrocorax aristotelis*), Herring Gull (*Larus argentatus*), Great Black-Backed Gull (*Larus marinus*) and Black Guillemot (*Cepphus grylle*) also breed there. Of terrestrial bird species, Chough (*Pyrrhocorax pyrrhocorax*), are recorded as breeding in small numbers on Scariff Island. All these species and some other seabird species mainly nest along or at the base of the sea cliffs of both islands.

The NIS finds that, although the farm site is located within the area of the SPA, it occupies no more than 3% of the marine area designated (and none of the island area designated) The nesting areas for projected species are on sea cliffs on the opposite sides of Deenish and Scariff Islands from the farm location. It is therefore concluded that there is no significant risk of impact on seabirds as a result of spatial obstruction, noise and activity, smell, waste discharges or any other cause, arising from the Deenish salmon farm.

It is further observed that the Deenish salmon farm has been in operation in the same location since 1989. The synopsis for the SPA, which was written in 2007, lists the historical threats to the breeding populations of protected bird species in the site as being sheep, feral goats and rabbits. The Deenish farm site is not mentioned as a historical, current or potential threat in the SPA synopsis.

In respect of risk of indirect impact, the five protected sites beyond the salmon farm boundaries but within a 20km radius of it, are considered. The forcing parameters that have a potential to carry particulate and soluble wastes, as well as sea lice and other potential contagions are considered. It is observed that, as the result of the active hydrography of the outer Kenmare Bay area, the potential for dispersal and dilution of all such agents is very significant indeed. In this sense, it is submitted that the Deenish farm site is far removed hydrographically from protected sites within a 20km (linear) radius of it.

The NIS develops growth, feeding and discharge models, based on company, in-house empirical data, for the Deenish farm operation, in order to project the likely soluble and solid waste inputs into outer Kenmare Bay and the uptake of oxygen by the fish and by discharges. Waste streams from the site are classified as waste feed and faecal solids, nutrients, carbon and medicines, the latter used in-feed, in in-pen bath treatments and in-well boat bath treatments. The report goes on to investigate the potential dispersal and dilution of soluble inputs by the use of a box model and the settlement of solid wastes on the seabed from empirical data and by reference to previous studies.

In respect of soluble nutrient wastes, the report concludes that, due to the high values for forcing parameters (based on empirical evidence) and consequent rates of dispersion and dilution, ambient Nitrogen and Phosphorus will only show marginal elevation as a result of the operation of the farm. Kenmare Bay is operating well within its carrying capacity as defined by established EQS levels, both before and after nutrient inputs from the Deenish farm operation. The potential impact of such small elevations on local protected areas is regarded as wholly insignificant, both in the near field and the far field. The nutrient dispersion model is regarded as conservative in that it takes no account of the reality of nutrient assimilation, through primary production and bacterial action in the water column.

In respect of Oxygen uptake through fish respiration and the BOD requirements for the assimilation of discharges, the model projects a total monthly Oxygen requirement of 0.74% of the oxygen available in the waters that flush the modelled 50km^2 box model on every tide. No significant impact will result from this level of uptake. The oxygen model is regarded as conservative, because it makes no allowance for natural oxygen dissolution into the water column, either through primary production or through oxygen diffusion at the air water interface.

In respect of settled solids and their impact on the benthic infauna, empirical data is provided in the form of photographic plates, taken during a routine statutory benthic survey in July 2011. The plates show the seabed immediately under a net pen at the site, at its downstream edge and at other locations further downstream and away from the immediate under-pen area. Even the worst case (under the pen) indicates only a very sparse layer of solids on the seabed. Infaunal data collected at the same time indicates that the benthic infaunal community is only "changed" in the immediate under-pen area.

A dispersional model has yet to be completed for solutes and solids dispersion at the Deenish farm site but empirical observations at Deenish are compared with modelled data from another, broadly similar site. The model predicts that, even after one year of deposition at the maximum monthly deposition rate every month, (at maximum standing stock, based on an identical growth forecast to that applied to the Deenish site), maximum under-cage sediment depth would be no more than 13mm and the infaunal community would only be "changed" (ITI = 30) within this zone. The report concludes that, bearing in mind that bottom currents run at above the sediment resuspension speed of 9.5cmsec^{-1} for 17% of the production cycle, sediment loading will remain low and benthic communities will rapidly return to normal during the minimum 2 months fallowing period, every second year. The benthic survey infaunal lists provided as part of the 2011 benthic survey reveal no species indicated for special protection in the Kenmare River SAC or neighbouring SAC's. Generally, these are all found further to the east in the SAC area, in more sheltered conditions. The benthic data provided is regarded as conservative because no account is taken of the reduction of benthic loading as a result of grazing down of sediments by opportunist epifauna and infauna, or of the scouring effects of wave climate on exogenous benthic sediments. In conclusion the report finds no significant likelihood of impact on protected habitats or species as the result of the sedimentation or subsequent further dispersal of settled solids emanating from the Deenish farm site.

In respect of medication, the report concludes that such is the low deposition rate of solids per unit seabed area (aided by low stocking densities in the farm pens under organic certification, the use of highly digestible feeds, good feed management and a significant proportion of seabed currents over the required resuspension speed), that residues from in-feed treatments are unlikely to impact on the seabed or its infauna or epifauna. The only in-pen bath treatment now practiced by MHI is Hydrogen Peroxide treatment, against sea lice. The breakdown products of this treatment are environmentally neutral (water and oxygen) and lice dislodged by the treatment are collected, destroyed and removed from the site for onshore disposal. All other bath medication treatments are carried out in well boat tanks; this economises on treatment quantities and increases treatment efficacy. Once used, treatments can be discarded from the well boat tanks, well clear of sensitive areas. The report therefore concludes that no significant impact will arise on Natura-protected habitats or species as a result of medicine treatments at the Deenish farm site. This finding is in line with the findings of the Scottish Environmental Protection Agency (SEPA) and other Scottish authorities in the case of Scottish salmon farming.

Regarding sea lice, the historical record of statutory sea lice monitoring, conducted by Irish government officials over the last 15 years or so, indicates that ovigerous lice (*L. salmonis*) levels on fish sampled at the Deenish farm site have remained extremely low and have never breached the trigger level of 0.5 lice per fish, which applies during the sensitive spring period. Levels have only exceed the outside-spring period trigger level of 2.0 lice per fish on four occasions in 166 separate inspections. The data also indicate that new infestations of lice-free fish at the Deenish site have always tended to be low. Thus suggests that the hydrographic distance from sources of wild lice and local hydrography do not favour the infestation of farmed salmon at the site from natural sources.

The NIS proposes a simple arithmetic model to establish the order of magnitude of dilution of farm-origin infestive Copepodid lice larvae, if dispersing from the site. A tidal prism model is used to calculate the volume of water that will flush through a given box area at the site each month and this is used to dilute the concentration of Copepodids calculated to disperse from the site during the same period. The model is tested at three different trigger levels for on-farm ovigerous lice, at 0.5, 2.0 and 5.0 lice per fish, as the basis for the numbers of Copepodids hatched and dispersed. The model calculates that the density of surviving Copepodids at the limits of a 50km^2 box would be 0.04 to 0.004 Copepodids/m^3 water, or one Copepodid per 25 m^3 to 250m^3 water. This up to three orders of magnitude lower than the density of larvae at the point of hatch. The report concludes that, wherever potential host fish (Atlantic salmon, a protected species in freshwater in SAC 000365 for the Currane river system, 13km from the Deenish farm site, or sea trout, which is not protected) encounter such a density of lice, be it in a river estuary or on the high seas, such a density has no significant prospect of augmenting natural infestation levels, by wild-origin lice. This model is regarded as conservative because the numbers of lice dispersed include all Nauplii from the first four days of the larval dispersal, which is 28.5% of the total dispersion period used in the model.

Note that these observations apply to lice infestation dynamics at the Deenish site only and cannot necessarily be expected to apply to other farm sites in other locations, in particular where there is a more proximate relationship between the farm site and wild fishery rivers.

The NIS then investigates the potential for significant risks of impacts arising for Natura-protected habitats and species from escapes of stock from the Deenish farm site. The report concludes that, as a result of historical evidence, operational and mitigation measures taken by MHI, as well as the impending implementation of a certification protocol for fish farm containment structures in Ireland, the risk of such impacts is not a significant one.

Finally the NIS assesses the prospects of combination impacts, with other developments in the Kenmare River area and concludes that, as a result of the geographical remoteness of the Deenish farm site and the hydrography of outer Kenmare Bay, the significance of both direct and indirect impacts on Natura-protected habitats and species is unlikely to increase as the result of any combination of impacts between the Deenish farm site and any other developments.

In final conclusion, this NIS finds no grounds to believe that any significant impact, either direct or indirect, on Natura-protected habitats or species, will arise from any activity, or discharge, or infestation, infection or escape from the MHI Deenish salmon farm site. This conclusion is reached primarily as a result of the synergistic benefits of certified organic operation of the site, its remoteness from many protected areas in the outer Kenmare Bay area, including protected salmon rivers, the operational methodologies employed by MHI, the current best practice specifications of the containment system deployed at the site and the site location, in particular in respect of local hydrography and exposure to oceanic conditions.

Appendix 1
SAC and SPA site Synopses
In their order of appearance in the main text.

Kenmare River SAC 002158.
Deenish Island and Scariff Island SPA 004175.
Killarney National Park, McGillicuddy Reeks and the Caragh River Catchment, SAC 00365.
Ballinskelligs Bay and Inny Estuary SAC 000335.
The Iveragh Peninsula SPA 004154.
Puffin Island SPA 004003.
The Skellig Islands SPA 004007.
Bull and Cow Rocks SPA 004066.
The Beara Peninsula SPA 004155.

SITE SYNOPSIS

SITE NAME: KENMARE RIVER

SITE CODE: 002158

Kenmare River, Co. Kerry, is a long and narrow, south-west facing bay. It is a deep, drowned glacial valley and the bedrock is mainly Old Red Sandstone which forms reefs along the middle of the bay throughout its length. Exposure to prevailing winds and swells at the mouth diminishes towards the head of the bay. Numerous islands and inlets along the length of the bay provide further areas of additional shelter in which a variety of habitats and unusual communities occur.

Kenmare River has a very wide range of marine communities from exposed coast to ultra-sheltered areas. The site contains three marine habitats listed on Annex I of the EU Habitats Directive, namely reefs, large shallow bay and caves. There is also an extremely high number of rare and notable marine species present (24) and some uncommon communities. Kenmare River is the only known site in Ireland for the northern sea-fan, *Swiftia pallida* and is the only known area where this species and the southern sea-fan *Eunicella verrucosa* co-occur. Midway along the south coast of Kenmare River, a series of sea caves stretch back into the cliff. They typically support encrusting sponges, ascidians and bryozoans.

In the more exposed areas within Kenmare River the sublittoral sediment is composed mainly of coarse shelly sand and gravel forming small dunes frequently with sparse bivalves including *Lutraria*. In sheltered areas the muddy sand has communities characterised by burrowing megafauna. Some areas have the Norwegian Prawn *Nephrops norvegicus* and others the burrowing sea cucumber *Neopentadactlya mixta*. Kenmare River is one of only four known locations in Ireland for the burrowing anemone *Pachycerianthus multiplicatus*. Communities characterised by burrowing brittlestars including the uncommon *Ophiopsila annulosa* also occur. Red calcareous free living algae generally termed 'maerl' (also known as 'coral') occur in the sheltered bays and at one site the rare burrowing brittlestar *Amphiura securigera* occurs.

The Annex I habitat 'perennial vegetation of stony banks' is well represented at two locations within Kenmare River – Pallas Harbour and Rossdohan Island. Characteristic species recorded here include Thrift (*Armeria maritima*), Common Scurvygrass (*Cochlearia officinalis*), Rock Samphire (*Crithmum maritimum*) and Sea Campion (*Silene vulgaris* subsp. *maritima*). Beaches in outer Kenmare River are composed of coarse, mobile sand and have sand hoppers in the high shore and polychaete worms in the low shore. More sheltered covés, sometimes backed by sand dunes, have sandhoppers in the upper shore, lugworm (*Arenicola marina*) in the mid-shore and the razor shell *Ensis arcuatus* and the burrowing sea-urchin *Echinocardium cordatum* in the lower shore.

Within the Derrynane Bay area on the south side of the Iveragh Peninsula there are good examples of a number of habitats listed on Annex I of the EU Habitats Directive including dry heath, fixed dunes, marram dunes, sea cliffs and salt meadows (both Atlantic and Mediterranean types). Of particular note within the dry heath habitat here is the occurrence of the rare Kerry Lily (*Simethis planifolia*) which, except for one recently discovered site in Co. Cork, is unknown in Ireland outside of the Derrynane area. Kerry Lily is protected under the Flora (Protection) Order 1999. Several other locally uncommon plant species add to the importance of this area: Chaffweed (*Anagallis minima*), Crowberry (*Empetrum nigrum*), Madder (*Rubia peregrina*) and Roseroot (*Rhodiola rosea*).

Fixed dunes, a priority habitat on the Habitats Directive, occur at Derrynane. In damp slacks amongst the sand dunes, the rare snail *Vertigo angustior* has been found. This species is listed on Annex II of the EU Habitats Directive. The nationally endangered and protected Red Data Book species, Natterjack Toad, has also been recorded from this area and, following a re-introduction programme, has re-established itself at the site.

Kenmare River holds an important population of Common Seal (maximum annual count of 121, including pups, since 1989). Some 40 of these frequent the Greenane Islands and Brennel Island groups. Otters are also known to occur within the site. Both the Common Seal and the Otter are listed on Annex II of the EU Habitats Directive. Two internationally important roosts of the Lesser Horseshoe Bat, another species listed on Annex II of the EU Habitats Directive, are included in the site: approximately 100 bats were recorded hibernating in a souterrain near Dunkerron in 2001, while over 100 bats have been counted in recent summers in a two-storey cottage near Killaha.

An Common/Arctic Tern (20+ pairs) have been recorded breeding on rocky islands in Derrynane Bay and on other islands within the site including Eyeries Island, Spanish Island and Brennel Island. In 1995 two pairs of the scarce Little Tern bred.

Recreational activities pose the greatest potential threat to many parts of Kenmare River. Within this large coastal site there are several resorts for water sports and a number of popular beaches. Bait digging is also a potential threat in some areas. Housing developments within the areas of dry heath present another possible threat to the integrity of the site. The seals and bats may be vulnerable to disturbance. Grazing at Derrynane is managed for the conservation of the dune habitats and the rare species they contain.

Kenmare River contains an exceptional complement of marine and terrestrial habitats, many of which are listed on Annex I of the EU Habitats Directive. The presence of a number of rare species, including two species listed on Annex II of the Directive and a protected plant, together with the ornithological interest of the area, adds further to the importance of the site.

20.8.2004

SITE SYNOPSIS

SITE NAME: DEENISH ISLAND AND SCARIFF ISLAND SPA

SITE CODE: 004175

Deenish Island and Scariff Island are small- to medium-sized islands situated between 5 and 7 km west of Lamb's Head off the Co. Kerry coast; they are thus very exposed to the force of the Atlantic Ocean. Scariff is the larger of the two. It is steep-sided all the way around and rises to a peak of 252 m. The highest cliffs are on the south side. The island vegetation is a mix of maritime grassland, areas dominated by Bracken (*Pteridium aquilinum*) and heathy areas with Ling Heather (*Calluna vulgaris*). There are the ruins of a monastic settlement and a cottage in the north-east sector of the island. Deenish is less rugged than Scariff, and rises to 144 m in its southern half; the northern half is lower and flatter. The vegetation is mostly grassland, with some heath occurring on the higher ground. Old fields are now overgrown with Bracken and brambles (*Rubus* spp.). The sea areas to 500 m around the islands are included to provide a 'rafting' area for the shearwaters.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Fulmar, Manx Shearwater, Storm Petrel, Lesser Black-backed Gull and Arctic Tern.

The islands support important populations of breeding seabirds. The Seabird 2000 survey recorded 1,960 pairs of Manx Shearwater on Scariff Island and 351 pairs on Deenish in 2000, giving a total of 2,311 pairs which is equivalent to *c.* 5% of the national total. On Scariff, the shearwaters breed in burrows on the cliff tops on the south and west of the island. Birds also breed within the ruins, including the souterrain below the oratory. On Deenish, birds breed in burrows on steep grassy slopes with rock outcrops in a limited area on the south-east side of the island. Scariff Island has long been known as a breeding site for Storm Petrel. Whilst there are no recent survey data for this nocturnal species, an estimate of between 1,000 and 10,000 pairs is given, with several hundreds also estimated for Deenish Island. Scariff also supports nationally important populations of Fulmar (385 pairs in 2000) and Lesser Black-backed Gull (97 pairs in 2000). Deenish Island is a traditional site for nesting terns, with 54 pairs of Arctic Tern present in 1995 - a population of national importance. Other seabirds which breed on the islands are Shag (5 pairs in 2000), Herring Gull (28+ pairs in 2000), Great Black-backed Gull (7 pairs in 2000) and Black Guillemot (several pairs).

Chough is a resident species on Scariff, with 2 pairs recorded in 1992. Other species which breed on the islands include Oystercatcher, Skylark, Wheatear, Stonechat, Rock Pipit and Raven.

There are no apparent threats to the breeding birds of these islands due partly to their inaccessibility. However, the islands have been grazed by sheep in the past and a herd of feral goats existed on Scariff in the 1980s; Deenish Island was grazed by rabbits at the same time - excessive grazing could lead to soil erosion.

Deenish Island and Scariff Island SPA is a site of high ornithological importance on account of the nationally important populations of Manx Shearwater, Storm Petrel, Fulmar, Lesser Black-backed Gull and Arctic Tern. Future surveys may show the Storm Petrel population to be of international importance. Also of note is that Storm Petrel and Arctic Tern, as well as Chough, are listed on Annex I of the E.U. Birds Directive.

4.9.2007

SITE SYNOPSIS

SITE NAME: BALLINSKELLIGS BAY AND INNY ESTUARY

SITE CODE: 000335

This site is located at the western end of the Iveragh Peninsula, County Kerry, close to the town of Waterville. It comprises the marine waters of Ballinskelligs Bay as far out as the 5 fathom line, some adjoining terrestrial areas and the estuary of the River Inny upstream to Breahig townland. The site extends from Horse Island at the western end of the bay round to Rineen Point at its south-eastern side.

Much of the site comprises shallow marine water, Ballinskelligs Bay, but it also supports a wide variety of other habitats, including intertidal mud/sand flats, sandy beaches, shingle, tidal river channels, sea cliffs, wet and dry grassland, freshwater marshes, swamps, cutaway bog, scrub, Bracken and salt marsh. Two types of salt marsh occur on the site, Atlantic salt meadows and Mediterranean salt meadows - both of these are listed on Annex I of the E.U. Habitats Directive. Mediterranean salt meadows are characterised by the presence of Sea Rush (*Juncus maritimus*), while species such as Thrift (*Armeria maritima*) and Common Saltmarsh-grass (*Puccinellia maritima*) are typical of Atlantic salt meadows.

A small area of sand dunes near to the mouth of the estuary supports a population of the rare liverwort species, Petalwort (*Petalophyllum ralfsii*). This species is protected under the Flora (Protection) Order, 1999 and is also listed on Annex II of the E.U. Habitats Directive.

The site is used in the winter by nationally important numbers of Common Scoter (953 individuals, recorded 1994/95-96/97) and Ringed Plover (147 individuals, 1994/95-96/97). The site is also commonly used by waders such as Oystercatcher (130 individuals, 1994/95-96/97) and Curlew (140 individuals, 1994/95-96/97). A colony of Grey Seal, a protected species, occurs within the bay.

Human useage of the site includes fishing and tourist activities.

The site is of considerable conservation significance, particularly for the presence of two types of salt marsh that are listed on Annex I of the E.U. Habitats Directive and of a population of *Petalophyllum ralfsii*, a species that is listed on Annex II of this directive. Additionally, the site is of significance for the nationally important populations of Common Scoter and Ringed Plover that use it.

04.09.2001

SITE SYNOPSIS

SITE NAME: KILLARNEY NATIONAL PARK, MACGILLYCUDDY'S REEKS AND CARAGH RIVER CATCHMENT

SITE CODE: 000365

This very large site encompasses the mountains, rivers and lakes of the Iveragh peninsula, and the Paps Mountains which stretch eastward from Killarney towards Millstreet. It is the most mountainous region in Ireland and includes Carrauntoohil (1039m), the highest peak in the country. The underlying geology is almost entirely Old Red Sandstone, although Carboniferous Limestone occurs on the eastern shores of Lough Leane and rhyolitic lavas occur above Lough Guitane. The dramatic sandstone ridges and valleys have been shaped by glacial processes and many of the lakes are impounded by glacial moraines. Located close to the Atlantic in the south-west of Ireland, the site is subject to strong oceanic influences. Generally, the Lusitanian flora and fauna is well represented, while the high peaks and cliffs support arctic-alpine relicts.

The site is of great ecological interest, with at least ten habitats which are listed on Annex I of the EU Habitats Directive. The site is a candidate SAC selected for blanket bog, Yew wood and alluvial woodlands, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate SAC for lowland oligotrophic lakes, upland oligotrophic lakes, floating river vegetation, alpine heath, dry heath, wet heath, *Molinia* meadows, old Oak woodlands, Rhynchosporion, Calaminarian grassland and Juniper scrub, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Killarney Fern, Slender Naiad, Freshwater Pearl Mussel, Kerry Slug, Marsh Fritillary, Killarney Shad, Atlantic Salmon, Brook Lamprey, River Lamprey, Sea Lamprey, Lesser Horseshoe Bat and Otter.

The Oak woodlands, occurring mostly around the Killarney lakes, are the habitat for which the area is perhaps best known. They form the most extensive area of native woodland remaining in Ireland and include Derrycunihy Wood, described as perhaps the most natural Sessile Oak wood in the country. The woods are typically dominated by Sessile Oak (*Quercus petraea*) with an understorey of Holly (*Ilex aquifolium*). The Strawberry Tree (*Arbutus unedo*) is a notable component of the woods and there are scattered Yew (*Taxus baccata*). The herb layer is not particularly species-rich, but the woods support perhaps the best developed Atlantic bryophyte community in Europe. Several rare species are present including *Lejeunea flava*, *Cyclodictyon laetivirens*, *Daltonia splachnoides*, *Sematophyllum demissum* and *Radula carringtonii*.

Yew, which favours the limestone of Muckross peninsula, forms the only sizeable Yew woodland in Ireland and some of the trees are up to 200 years old. The dense shade beneath the tree results in few herbs in the ground flora, but the bryophyte layer is almost continuous.

Wet woodland or carr, occurring on the low-lying limestone areas within the flood plain of Lough Leane, forms one of the most extensive areas of this woodland type in Ireland. The dominant canopy species are Alder (*Alnus glutinosa*), willows (*Salix* spp.), Ash (*Fraxinus excelsior*) and Downy Birch (*Betula pubescens*), while the field layer is dominated by Remote Sedge (*Carex remota*) and Creeping Bent (*Agrostis stolonifera*).

Adding to the diversity of the woodland component of the site are a number of mixed woodlands, including those of Ross Island which support one of the richest herb layers of the Killarney woods.

The dominant habitat types within the overall site are blanket bog, heath and upland grassland. The heath and grassland generally occur on areas with shallow peat and on the mineral soils of the steep mountain sides, while the blanket bog occurs on the more gentle slopes, plateaux and other level ground. Often the habitats occur in a mosaic, with exposed rock frequently occurring.

A variety of blanket bog types are represented from lowland valley to mountain blanket bog. Some of the best include: Cummeragh River Bog Nature Reserve, a domed bog which is perhaps the most southerly intact blanket bog in the country; Ballygisheen, which contains one of the most extensive areas of intact lowland blanket bog in Co. Kerry; Coomacheo/Caherbarnagh, which combine to form the largest mountain blanket bog in the south-west; Eirk Bog Nature Reserve, a classic example of a bog intermediate between a raised and blanket bog; Mangerton Bog, an upland bog which grades into an unusual lichen heath seen at no other site; and Oolagh East, a quaking basin mire. Generally, the bogs have a characteristic flora. The Lusitanian species, Large-flowered Butterwort (*Pinguicula grandiflora*) is common. The bogs also support a number of unusual species, including mosses (*Sphagnum pulchrum, S. fuscum, S. platyphyllum, S. strictum, S. contortum* and *Calliergon stramineum*), liverworts (*Cladopodiella francisci* and *Calypogeia azurea*) and lichens (*Cladonia mediterranea, C. macilenta, C. rangiferina, C. arbuscula* and *Cetraria islandica*).

Rhynchosporion vegetation is confined to wet areas within the lowland blanket bogs, with one of the best areas for the habitat being to the north-east of the Ballygisheen Pass. On a portion of this bog there is an extensive area of quaking flats and pools dominated by *Sphagnum cuspidatum* and *Sphagnum auriculatum*. These areas have a typically species-poor flora which includes Bogbean (*Menyanthes trifoliata*), White Beak-sedge (*Rhynchospora alba*), Bog Asphodel (*Narthecium ossifragum*), Bog Cotton (*Eriophorum angustifolium*) and Great Sundew (*Drosera anglica*). Brown Beak-sedge (*Rhynchospora fusca*), a locally rare plant of wet bog pools, is occasional within the site. Although the habitat is best developed in very wet areas of intact bog it may also occur in wet areas of regenerating cutover blanket bog.

Wet heath often occurs in association with blanket bog and features Cross-leaved Heath (*Erica tetralix*). Dry heath is more frequent and is dominated by Heather (*Calluna vulgaris*), Bell Heather (*Erica cinerea*) and Western Gorse (*Ulex gallii*), with occasional Bilberry (*Vaccinium myrtillus*). This habitat is well developed on the Paps. Elsewhere it is often overgrazed, with upland grassland becoming more frequent. Some of the highest ridges support alpine heath (referable to the Lycopodium alpinum - Racomitrium lanuginosum association). Widespread plant species of the alpine heath include Bog Myrtle (*Vaccinium myrtillus*), Crowberry (*Empetrum nigrum*) and Fir Clubmoss (*Huperzia selago*), while species such as Juniper (*Juniperus communis* subsp. *nana*) and Dwarf Willow (*Salix herbacea*) have a much more restricted distribution.

The site contains many lakes, but these can be broadly divided into two types: small upland corrie lakes and larger lowland lakes. Examples of the first type are Lough Murtagh and Lough Gortavehy in the Paps. They are oligotrophic and typically species-poor, with Quillwort (*Isoetes lacustris*), Water Lobelia (*Lobelia dortmanna*) and Shoreweed (*Littorella uniflora*) occurring most commonly. The lowland lakes are mostly oligotrophic, although Lough Leane, the largest fresh water body in the region, has become somewhat mesotrophic as a result of pollution from Killarney town. These lowland lakes tend to be more species-rich than those at higher altitudes, with additional species such as Awlwort (*Subularia aquatica*), Six-stamened Waterwort (*Elatine hexandra*) and Alternate Water-milfoil (*Myriophyllum alterniflorum*). Good examples include Lough Caragh, Upper Lake and Muckross Lake.

The rivers associated with these lakes are also of importance. The Caragh is relatively unpolluted from headwater to estuary, a rare phenomenon in Europe. The Flesk runs over Old Red Sandstone in its upper reaches and limestone as it nears Lough Leane. Both rivers support floating and submerged vegetation and rare invertebrates. Rocks around the smaller mountain streams often support a lush vegetation of ferns and bryophytes, most notably at Torc Waterfall.

Other habitats of note include: Juniper (*Juniperus communis*) scrub found on islands in the Upper Lake and on dry ridges in nearby Newfoundland Bog; damp meadows, with Purple Moor-grass (*Molinia caerulea*), supporting scarce species such as Whorled Caraway (*Carum verticillatum*) and Ivy-leaved Bellflower (*Wahlenbergia hederacea*); and Calaminarian grasslands, associated with the old copper mines on Ross Island, with species such as Sea Campion (*Silene vulgaris* subsp. *maritima*) and Thrift (*Armeria maritima*).

A large number of plant and animal species of interest occur within the site:

There are two plant species listed on Annex II of the EU Habitats Directive: Slender Naiad (*Najas flexilis*) which is found in some of the lakes; and, most famous of all, the Killarney Fern (*Trichomanes speciosum*). An additional twenty-two Red Data Book plant species have been recorded, but only twelve of these have been seen recently. These are Pillwort (*Pilularia globulifera*), Kerry Lily (*Simethis planifolia*), Irish Lady's Tresses (*Spiranthes romanzoffiana*), Slender Cottongrass (*Eriophorum gracile*), Slender Cudweed (*Logfia minima*), Betony (*Stachys officinalis*), Heath Cudweed (*Omalotheca sylvatica*), Alder Buckthorn (*Frangula alnus*), Alpine Saw-wort (*Saussurea alpina*), Hoary Whitlowgrass (*Draba incana*), Smooth Brome (*Bromus racemosus*) and Holly Fern (*Polystichum lonchitis*). The first seven of these species are legally protected (Flora Protection Order, 1999).

The site is very important for oceanic bryophytes, particularly the woodland species. It also contains good representative examples of the Northern Atlantic Hepatic Mat community and other oceanic montane communities. Killarney Oak woods and mountains have been nominated as a site of international importance for bryophytes.

Additional plant species of interest include a fern (*Dryopteris affinis* subsp. *stilluppensis*) and a Whitebeam (*Sorbus anglica*), both at their only Irish locations.

The Killarney Woods are notable for the number of rare species of Myxomycete fungus that have been recorded, namely *Collaria arcyrionema*, *Craterium muscorum*, *Cribraria microcarpa* (only known Irish site), *C. rufa*, *C. violacea*, *Diderma chondrioderma*, *D. lucidum*, *D. ochraceum*, *Fuligo muscorum*, *Licea marginata*.

The site has six bird species which are listed on Annex I of the EU Birds Directive. A small flock of Greenland White-fronted Geese, which winters on the boglands within the National Park, is now the only regular flock in the south-west. The site has one of the highest concentrations of breeding Peregrines in the country, as well as some breeding Merlin. Chough is found both in the coastal areas and inland areas of the site, with possibly up to 30 pairs breeding. Kingfisher is a species associated with the lakes and rivers, especially in the National Park and probably breeds. Finally, a few pairs of Common Tern breed within the site.

The woodlands provide habitat for a variety of breeding birds, most notably Garden Warbler, Blackcap, and probably a few pairs each of the rare Redstart and Wood Warbler.

Lough Leane is a site for wintering wildfowl with the following the average counts for the two winters 1995/96 and 1996/97: Teal (208), Mallard (350), Pochard (81), Tufted Duck (323) and Coot (169).

The site supports most of the Irish mammal species. Of particular note is the occurrence of two EU Habitats Directive Annex II species: Lesser Horseshoe Bat, with a total population of about 300 individuals distributed at several locations, including both nursery and hibernation sites, and Otter. Perhaps the best known mammals of the Killarney National Park are the Red Deer, which form the only remaining native herd in Ireland, comprised of around 600 animals. Sika Deer also occur. Pine Marten is another notable species.

The site is valuable for its rare fish species, five of which are listed on Annex II of the EU Habitats Directive: Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*), Sea Lamprey (*Petromyzon marinus*), Atlantic Salmon (*Salmo salar*) and Killarney Shad (*Alosa fallax killarnensis*). The Killarney Shad is a unique land-locked subspecies confined to the Killarney lakes. Also of note is the glacial relict, Arctic Charr (*Salvelinus alpinus*), a Red Data Book species, a unique form of which is found in Lough Coomasaharn.

There are numerous rare invertebrates within the site. These include three EU Habitats Directive Annex II species: Kerry Slug (*Geomalacus maculosus*), the Freshwater Pearl-mussel (*Margaritifera margaritifera*) and the Marsh Fritillary (*Euphydryas aurinia*). The Kerry Slug and Pearl-mussel populations are of particular importance in a national context. Other species of note include: three chironomids of international importance found in the River Flesk; a wood ant (*Formica lugubris*) at one of only four Irish sites; a snail (*Limnaea involuta*), in Lough Crincaum, at its only known location; two dragonflies (*Cordulea aenea* and *Somatochlora arctica*), the former at one of only two known sites in Ireland and the latter at its only known Irish location; and several other aquatic and woodland species at their only known Irish locations.

The main landuse within the site is grazing by sheep. In and around the National Park deer grazing is also common. The extensive grazing has caused damage to many of the terrestrial habitats, resulting in degradation of heath and blanket bogs and prevention of woodland regeneration. In the upland habitats the erosion caused by grazing is exacerbated by the exposed nature of the terrain.

Apart from grazing, the woodlands are particularly threatened by Rhododendron (*Rhododendron ponticum*) invasion: approximately two thirds of the Oak woodlands are affected, although a Rhododendron removal programme is underway in the National Park. The Yew wood has been adversely affected by heavy grazing for many years, but it is intended to control this in the near future by erection of a deer fence. The bogs are sensitive to grazing and are also threatened by turbary, burning and afforestation. Most of the lakes are very acid sensitive and therefore vulnerable to afforestation within the catchment areas. Lough Leane has been subject to some eutrophication, although water quality appears to have improved since phosphates were removed from the sewage in 1985.

A management plan was drawn up for the Killarney National Park in 1991. The park is managed primarily for conservation purposes although recreation is also provided for.

Overall, the site is of high ecological value because of the diversity, quality and extensiveness of many of the habitats and impressive list of rare species of flora and fauna. In recognition of its importance the Killarney National Park has been designated a World Biosphere Reserve.

6.10.2006

SITE SYNOPSIS

SITE NAME: IVERAGH PENINSULA SPA

SITE CODE: 004154

The Iveragh Peninsula SPA is a large site situated on the west coast of Co. Kerry. The site encompasses the high coast and sea cliff sections of the peninsula from just west of Rossbehy in the north, around to the end of the peninsula at Valencia Island and Bolus Head, and as far east as Lamb's Head in the south. The site includes the sea cliffs, the land adjacent to the cliff edge (inland for 300 m) and also areas of sand dunes at Derrynane and Beginish. The high water mark forms the seaward boundary except at Doulus Head/Killelan Mountain where the adjacent sea area to a distance of 500 m from the cliff base is included to provide areas for foraging and socialising activities for breeding seabirds. The site is underlain by Devonian sandstones, siltstones and mudstones. A small area of igneous rocks (dolerite and gabbro) occurs at Beginish and on the adjacent shore.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Chough, Peregrine, Guillemot, Fulmar, and Kittiwake.

Vegetated sea cliffs dominate the site; these occur along the length of the site and support a good variety of plant species typical of the habitat, including Thrift (*Armeria maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Sea Spleenwort (*Asplenium marinum*) and Rock Sea-spurry (*Spergularia rupicola*). The cliff-tops support heath or coastal grassland. Apart from the sea cliffs themselves, the site includes areas of dry heath, wet heath, upland acid grassland, dense Bracken (*Pteridium aquilinum*), semi-improved and improved pasture grassland, dune grassland, streams, bedrock shores and islets.

The site supports an important population of breeding Chough, a Red Data Book species that is listed on Annex I of the E.U. Birds Directive; 109 breeding pairs were recorded from the site in the 1992 survey and 88 in the 2002/03 survey. The birds are found around the coast from Lamb's head in the south-west to Rossbehy in the north. A small number of pairs are found inland, mainly around the Macgillycuddy's Reeks.

The topography of the Iveragh Peninsula, with its mosaic of grazed semi-improved and improved pastures, extensive inland upland areas of coastal heath and grassland, and sand dune systems in close proximity to breeding cliffs, favours Chough. Particularly high densities of Chough occur at Valencia Island where livestock grazing presents the species with widespread feeding opportunities. Valencia Island held the largest autumn flock, (42 birds), observed in the period 2002 to 2004. Choughs also benefit from the close proximity of the dune systems at Rossbehy in the north and at Inch, where flocks of up to 81 birds have been observed in the autumn. The smaller area of dune habitat at Derrynane is also used, with flocks of up to 33 birds present in October 2003. Communal roosts exist on Lamb's Head near Derrynane and at the western tip of Valencia Island. Pairs and small flocks of Chough can be found around the coast and in the mountainous uplands of the Iveragh Peninsula throughout the year. Studies have shown that Chough forage mainly within 300 m of the cliff tops used for breeding and these areas have been included in the site.

Landuse is predominantly extensive grazing of sheep, and to a lesser degree, cattle. This grazing regime, which results in a tight vegetation sward, is beneficial to Chough. The habitats present are quite robust and there are few noticeable activities negatively impacting on the Chough population. However, the reduction in cattle numbers and increase in sheep numbers in the recent past, is less beneficial to Chough, as sheep grazing results in a more uniform vegetation sward. One other potential threat is the residue left in livestock dung due to the application of broad-spectrum anti-parasitic drugs.

The site supports an important Peregrine population (6 pairs in 2002); this species is listed on Annex I of the E.U. Birds Directive. The site also holds nationally important populations of Guillemot (2,860 pairs in 1999-2000), Fulmar (766 pairs in 1999-2000), Kittiwake (1,150 pairs in 2000), Great Black-backed Gull (63 pairs in 1999-2000) and Black Guillemot (118 individuals in 1999), as well as smaller populations of other breeding seabirds: Razorbill (90 pairs in 1999-2000), Herring Gull (30 pairs in 1999-2000), Cormorant (33 pairs in 1999-2000) and Shag (11 pairs in 1999-2000).

The Iveragh Peninsula SPA is the second most important site in the country for Chough and is of high importance for Peregrine. It also supports a range of breeding seabirds, including populations of Guillemot, Fulmar, Kittiwake, Great Black-backed Gull and Black Guillemot of national importance. The presence of Chough and Peregrine, both species that are listed on Annex I of the E.U. Birds Directive, is of particular significance.

13.11.2006

SITE SYNOPSIS

SITE NAME: PUFFIN ISLAND SPA

SITE CODE: 004003

Puffin Island lies approximately 0.5 km off the northern side of St Finan's bay in south-west Co. Kerry. It is a long, narrow island of Old Red Sandstone. The island is almost divided into two halves – the southern half is a long narrow, rocky ridge, rising to 130 m, while the northern half broadens into a grassy plateau though has a high point of 159 m. The island is surrounded by mostly steep cliffs and slopes. The vegetation of the main part of the island is a typical maritime grassy sward, though nine different plant communities have been distinguished, including a small area of Ling Heather (*Calluna vulgaris*) heath. A Thrift (*Armeria maritima*) community dominates the slopes. In the past Puffin Island was grazed quite heavily by sheep, and today rabbits are common.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Fulmar, Manx Shearwater, Storm Petrel, Lesser Black-backed Gull, Razorbill and Puffin. The site is also of special conservation interest for holding an assemblage of over 20,000 breeding seabirds.

Puffin Island is one of the most important seabird sites in Ireland. In the recent Seabird 2000 survey, it was rated as of international importance for its breeding populations of Storm Petrel (5,177 pairs), Manx Shearwater (6,329 pairs) and Puffin (5,125 individuals). The colony of Puffins was the largest recorded in Ireland during the survey, while that of Manx Shearwater is the second largest colony after the Blaskets. The island also supports nationally important populations of Fulmar (447 pairs in 2000), Lesser Black-backed Gull (139 pairs in 2000), Great Black-backed Gull (72 pairs in 2000) and Razorbill (800 pairs in 1982 - incomplete survey in 2000). Other seabirds which breed are Shag (5+ pairs in 2000), Kittiwake (250 pairs in 1982), and Guillemot (250 pairs in 1982).

A further bird species of conservation importance which breeds on Puffin Island is Chough, with up to 3 pairs recorded in 1992 and at least one pair in 2000. During winter the resident population may be joined by other birds that breed on the mainland. The presence of Chough and Storm Petrel is of particular note as these species are listed on Annex I of the E.U. Birds Directive.

Puffin Island is owned by BirdWatch Ireland and is managed for conservation. The island is also a Statutory Nature Reserve. Unauthorised grazing, which has occurred in the past, is the main threat to the island as this could lead to erosion of the fragile soil cover.

8.9.2006

SITE SYNOPSIS

SITE NAME: SKELLIGS SPA

SITE CODE: 004007

The site comprises Great Skellig and Little Skellig islands. These highly exposed and isolated islands, which are separated by a distance of 3 km, are located in the Atlantic some 14 km and 11 km (respectively) off the County Kerry mainland. The geology of the islands is of Old Red Sandstone, with a little slate and veins of white quartzite. Both islands are precipitous rocky sea stacks, Great Skellig rising to 218 m and Little Skellig to 134 m.

Great Skellig supports a sparse maritime flora on shallow soils. Common plant species include Thrift (*Armeria maritima*), Sea Campion (*Silene maritima*) and Rock Sea-spurrey (*Spergularia rupicola*), with patches of Red Fescue (*Festuca rubra*), Dock (*Rumex* sp.) and Sea Mayweed (*Matricaria maritima*) occurring frequently. Little Skellig is largely unvegetated, due both to the low soil cover and to the effect that the nesting birds have on the vegetation. However, Sea Mayweed occurs on ledges that are too small for Gannets, and Tree Mallow (*Lavatera arborea*), a local species in Ireland, has been recorded.

The Skelligs comprise one of the most important seabird colonies in the country for populations and species diversity. Great Skellig has an internationally important population of Storm Petrel (4,000-6,000 pairs in 2002), with birds nesting both in the stonework associated with the monastic settlement and in natural crevices amongst the scree and rock. Little Skellig is best known for the long established colony of Gannets, with 26,436 pairs in the last full census in 1994. This is by far the largest colony in Ireland and one of the largest in the world. Great Skellig also has one of the largest colonies of Puffins in the country, with 4,000 individuals estimated in 1999. Other seabird species which occur on the islands in nationally important numbers are as follows (counts made between 1999 and 2002): Fulmar (806 pairs), Manx Shearwater (2,370 pairs), Kittiwake (944 pairs), Guillemot (2,551 individuals) and Razorbill (454 individuals).

Great Skellig is a traditional site for Chough, though the relatively small size of the island supports only one nesting pair. Peregrine has also nested in some years.

The breeding seabirds on the Skelligs have been fairly well documented over the years, with references to the Gannets dating back to the 1700s. Owing to the high importance of the islands for birds, each has been designated a Statutory Nature Reserve. In addition, the non-governmental organisation, BirdWatch Ireland, holds a long-term lease on Little Skellig. There are no known direct threats to the breeding seabird populations, though high numbers of day trippers to Great Skellig could cause disturbance to the fragile soil cover and lead to soil erosion, particularly if visitors do not keep to the stone paths. Little Skellig is largely inaccessible.

In addition to the bird interests, Great Skellig is well known for its early Christian monastic settlement. An automated lighthouse also exists on Great Skellig.

This site is one of the top five seabird sites in the country and is of international importance on account of the Storm Petrel and Gannet populations. Storm Petrel is listed on Annex I of the E.U. Birds Directive, as is Chough and Peregrine.

6.10.2004

SITE SYNOPSIS

SITE NAME: THE BULL AND THE COW ROCKS SPA

SITE CODE: 004066

The site comprises two very small rocky islands, the Cow and the Bull, situated 2.5 km and 4 km respectively from Dursey Head in the extreme south-west of Ireland. The islands, which are composed of vertically stratified sandstone, rise to over 60 m and are generally precipitous. Vegetation is sparse and is a typical maritime flora, mostly comprising a sward of Thrift (*Armeria maritima*) and Sea Campion (*Silene maritima*). A few rocky islets occur off the main islands. The surrounding water, between and to a distance of 500 m around each island, is included within the site for the benefit of the breeding seabirds. The Commissioners of Irish Lights maintain a lighthouse on the Bull.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Storm Petrel, Gannet and Puffin.

The site holds one of the most important seabird colonies in the country, with populations of Storm Petrel and Gannet of at least national importance. The petrels breed on both the Cow and the Bull but have not been censused in recent times. A pre-1987 estimate of between 2,000 and 5,000 pairs is given. The Gannet colony on the Bull is long established and had 1,815 pairs in 1994 – this is the third largest colony in Ireland.

The site also supports a good diversity of other seabird species though these have not been surveyed since at least the early 1990s. The populations of Puffin (200 individuals) and Great Black-backed Gull (280 pairs) are still probably of national importance. Other species which breed are Cormorant (40 pairs), Kittiwake (350 pairs), Guillemot (1,400 individuals), Fulmar (40 pairs), Herring Gull (<20 pairs) and Razorbill (132 individuals).

Both islands are extremely inaccessible and difficult to land on and hence are seldom visited. There are no known threats to the breeding seabirds.

This site is of high importance for Storm Petrel and Gannet, and supports nationally or regionally important populations of at least a further five species. Storm Petrel is listed on Annex I of the E.U. Birds Directive. Owing to their importance, both islands have been designated as Refuges for Fauna. The Cow is State-owned.

7.9.2006

SITE SYNOPSIS

SITE NAME: BEARA PENINSULA SPA

SITE CODE: 004155

The Beara Peninsula SPA is a coastal site situated on the west coast of Co. Cork, south-west of the town of Kenmare. It encompasses the high coast and sea cliff sections of the western end of the peninsula from Reenmore Point/Cod's Head in the north, around to the end of Dursey Island in the west, and as far east as Bear Island in the south. The site includes the sea cliffs, the land adjacent to the cliff edge (inland for 300 m) and several upland areas further inland of the coast about Eagle Hill, Knockgour, Allihies and Firkeel. The high water mark forms the seaward boundary. Most of the site is underlain by Devonian sandstones and siltstones, though Carboniferous rocks are found about Black Ball Head and on Bear Island; small areas of igneous rocks occur at Cod's Head, Dursey Island, Black Ball Head and Bear Island.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Chough and Fulmar.

Vegetated sea cliffs dominate the site; these occur along the length of the site and support a good variety of plant species typical of the habitat, including Thrift (*Armeria maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Sea Spleenwort (*Asplenium marinum*) and Rock Sea-spurry (*Spergularia rupicola*). The cliff-tops support heath or coastal grassland. Apart from the sea cliffs themselves, the site includes areas of dry heath, wet heath, blanket bog, freshwater marsh, upland acid grassland, dense Bracken (*Pteridium aquilinum*), scrub, semi-improved and improved pasture grassland, dune grassland, exposed rock, streams, shingle, bedrock shores and islets.

The site supports an important population of breeding Chough, a Red Data Book species that is listed on Annex I of the E.U. Birds Directive; 62 breeding pairs were recorded from the site in the 1992 survey and 54 in the 2002/03 survey. The birds are found along the coast from Bear Island in the south to Reenmore Point/Cod's Head in the north, including Dursey Island. Studies have shown that Chough forage mainly within 300 m inland of the cliff tops used for breeding and these areas have been included in the site. Inland breeding pairs occur in the Slieve Miskish and Caha Mountains, with additional pairs likely to be breeding on other inland cliffs. The area around the old copper mines at Allihies is regularly used by both breeding birds and a wintering flock. Large flocks of Chough occur on Dursey Island, especially in the summer months, as well as in the uplands, in both summer and winter. The largest flocks recorded are on Dursey Island (42 birds in September 2003), Knockgur (30 birds in July 2004) and Eagle Hill (34 birds in September 2003). Choughs roost in small numbers on the Beara Peninsula; two regularly used roosting sites (identified during a study from September 2003 to August 2004) are Dursey Sound (maximum of 17 roosting birds) and Allihies copper mines (maximum of 37 roosting birds).

The habitats and topography present on the Beara Peninsula favour Chough. It is characterised by marginal agricultural land with large tracts of semi-natural vegetation, all in close proximity to cliffs used for breeding. Small improved fields, along with heath, sometimes dominated by Gorse (*Ulex gallii* and *U. europaeus*), and coarse grassland form an intimate mosaic. Many earth and stone banks and walls, remnants of formerly more intricate enclosed field systems, remain throughout the peninsula. The interior of the Beara Peninsula is mountainous, in places rising to over 650 m, with steep-sided valleys and exposed rock.

Landuse is predominantly extensive grazing of sheep, and to a lesser degree, cattle. This grazing and the resultant tight vegetation sward is beneficial to Chough. The habitats present are quite robust and there are few noticeable activities negatively impacting on the Chough population. However, there is a level of agricultural abandonment. The resultant rank vegetation renders some of these areas unavailable to feeding Chough. Also, the reduction in cattle numbers and increase in sheep numbers in the recent past, is less beneficial to Chough, as sheep grazing results in a more uniform vegetation sward. One other potential threat is the residue left in livestock dung due to the application of broad-spectrum anti-parasitic drugs.

The site also holds a nationally important population of Fulmar (575 pairs) and Black Guillemot (87 individuals in 1999), as well as smaller populations of other breeding seabirds: Shag (12 pairs), Herring Gull (20 pairs), Lesser Black-backed Gull (4 pairs) and Razorbill (5 pairs) – all seabird data from 2000. The site is also used by Peregrine (4 pairs in 2002).

The Beara Peninsula SPA is one of the most important sites in the country for Chough. It also supports a range of breeding seabirds, including populations of Fulmar and Black Guillemot of national importance, as well as a significant population of Peregrine. The presence of Chough and Peregrine, both species that are listed on Annex I of the E.U. Birds Directive, is of particular significance.

13.11.2006