An Bord Achomhairc Um Cheadúnais Dobharshaothraithe
Aquaculture Licences Appeals Board

Supplemental EIS submission

Save Bantry Bay

16 January 2019

Cúirt Choill Mhinsí, Bóthar Bhaile Átha Cliath, Port Laoise, Contae Laoise, R32 DTW5
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Brennan, Margaret

From:	Alab, Info
To:	OHara, Mary
Subject:	FW: Save Bantry Bay Response
Attachments:	SBB response supplementary EIS Dec 2018 (2).docx; Oceanographic modelling products as a decision support to the Irish aquaculture sector (1).pdf

From: Alec ODonovan [mailto:alecjodonovan@gmail.com]
Sent: 16 January 2019 21:58
To: Alab, Info
Subject: Save Bantry Bay Response

Dear Ms O'Hara,

Please find attached;

1. Save Bantry Bay response to supplementary EIS Ref; AP2-114/2015
2. Oceanographic modelling products as a decision support to the Irish aquaculture sector

Can you please acknowledge receipt of email.

Your sincerely

Alec O'Donovan
Secretary
Save Bantry Bay

Not to be cited without prior reference to the author **ICES CM 2010/A:05**

Oceanographic modelling products as a decision support to the Irish aquaculture sector

Glenn Nolan, Kieran Lyons, Neil Ruane, David Jackson, Joe Silke and Robin Raine

As high resolution physical circulation models in Irish waters have improved, there is a growing demand for operational outputs and products from these models. A regional physical model (ROMS) produces a 3 day forecast for Irish waters daily. Several nested models with a horizontal resolution of several hundred metres have been developed for coastal areas such as Connemara, Bantry and Killary Harbour. Several applications have been based on forecast and hindcast model output to date. Model flow fields that include the effects of river discharges, meteorological conditions and wider field oceanographic conditions have been used to accurately define epidemiological units around individual finfish aquaculture sites. In the event of a fish disease outbreak, this information supports decision making regarding movement of fish and fallowing of sites. In forecast mode, this tool will be used as a real-time decision support tool for the aquaculture industry. Similarly, models have been used in hindcast mode to examine the distribution and transport of sea lice between salmon farming sites. Varying resolution models have been compared to assess the accuracy of hindcasts and predictions under different forcing conditions. Finally, model currents are used to hindcast Harmful Algal Bloom events off southwest Ireland in 2009 to examine transit times of harmful algae from inoculation areas in the Celtic Sea to shellfish and finfish sites in Bantry Bay. This complements a short range model developed for Bantry based on shifts in wind direction that accurately predicts the onset of toxic algal events in several previous years.

Keywords: oceanographic products, forecasting, Ireland, HAB, sea lice, fish disease

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Introduction

Since 2004, significant improvements have been made in the development of operational physical circulation models in Irish waters. These improvements have enabled the use of such models to assist in applications where a predictive or hindcast product is required. In this paper we elaborate on recent work undertaken to make model outputs available as decision support tools to aquaculture researchers and the wider shellfish and finfish industries in Ireland. Critical to the success of these models is that they can reproduce the observed circulation patterns for this region. Features such as the Irish Coastal Current have been well elucidated by Raine and Mc Mahon (1998), Fernand et al. (2006) and Hill et al (2008) while a detailed examination of the circulation in Bantry Bay is presented in Edwards et al. (1996) and Raine et al. (2010). The western shelf region has been studied in detail by Nolan (2004) while Roden and Raine (1994) have focused on plankton dynamics and water column structure near the Connemara coast. The Northwest shelf region has been considered in detail by Gowen et al (1998). Our implementation of the Regional Ocean Modeling System (ROMS) reproduces the known circulation features of this region and is considered a robust tool for simulating conditions for applications related to the aquaculture industry. It is worth noting that most of the model data presented are based on physical circulation patterns (driven by wind, tide and density gradients) and do not account for biological or chemical distributions or indeed for the behaviour of individual organisms.

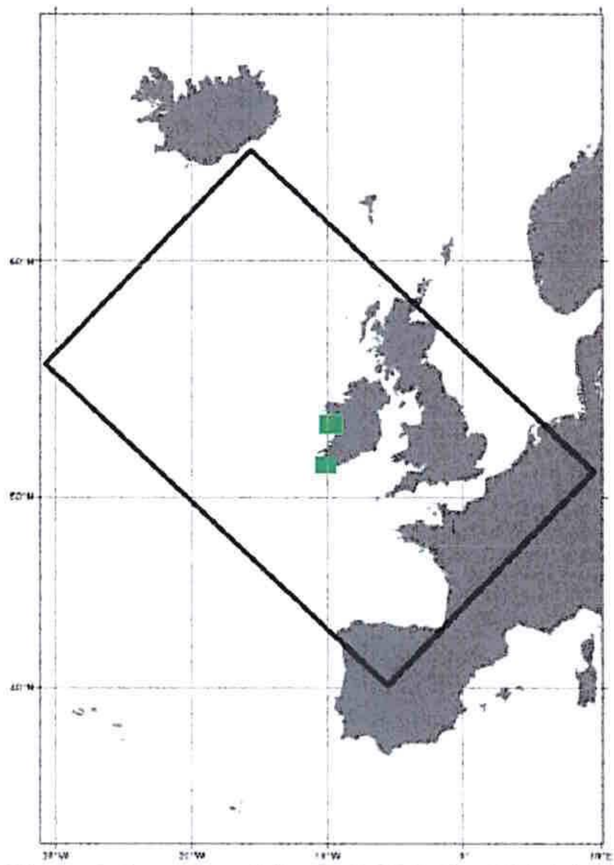


Figure 1 Domains of the ROMS 2.5km NE Atlantic domain with Bantry (SW Ireland) and Connemara (West of Ireland) 200m nested model domains also shown in green.

Methodology

The numerical model used is ROMS, the Regional Ocean Modelling System, which is a free-surface, hydrostatic, primitive equation ocean model described in Shchepetkin and McWilliams, 2005. ROMS is implemented for a domain in the northeast Atlantic (Figure 1). The resolution of the NE Atlantic model is approx. 2.5 km with 40 sigma levels (vertical layer thickness changes with water depth). Open boundaries and initial conditions are taken from the PSY2V3 operational model run by Mercator Ocean in France. We use atmospheric forcing from NOAA's GFS (Global Forecast System) model and tidal forcing at the boundary is obtained using OTIS, the Oregon State University Tidal Data Inversion Software. We introduce river flow data for 38 rivers including the major rivers of Ireland, west Britain and west France. The river flow rates are climatologies based on many year's of historical data for each river. The model is run operationally to produce a daily 3-day forecast.

ROMS is implemented for 2 nested domains in the NE Atlantic model (i.e. open boundaries taken from NE Atlantic model). The Connemara model covers an area on the west of Ireland encompassing Galway Bay and the Connemara coast and has a horizontal resolution of 200 metres and 20 sigma layers. The Bantry model focuses on the southwest of Ireland and it also has a horizontal resolution of 200 metres and 20 sigma layers. Both models use the same atmospheric forcing as the NE Atlantic model. The nested domains are shown in green in Figure 1.

A prototype disease transport model was incorporated into the Marine Institute's operational modelling system for the NE Atlantic region. The disease transport model was run for a period of 12 months throughout 2009. The model is run every week so 52 weeks of Lagrangian tracks were collected from 23 sites representing the main finfish aquaculture sites/bays and have been used to develop statistics about the overall transport of potential pathogenic organisms related to the season and the prevailing weather conditions. The aim is to provide information for the development of epidemiological units around marine fish farms.

The methodology used was to divide the area around the farms into a grid of 500 x 500 m square cells and count the number of times a float track intersected each cell (the count for a cell is increased by one if an individual float track intersects the cell at least once). The float was considered "dead" after 5 days and so no statistics were collected after that period. This is slightly shorter than the 7 days chosen by Viljugrein et al (2009) in a modelling study of pancreatic disease in salmon farming and was imposed due to the constraints of the operational modelling system. The data collected over the year was aggregated to produce cumulative counts. These data illustrate the potential area of contamination around the site should it become the focal point of a disease outbreak.

In addition to this a calculation of the cross contamination of the particles released from all 23 sites was carried out. Each time a particle released from one site enters the area occupied by another site the cross contamination count is increased by one. These were then compiled over the 12 month period and provide an overview of the sites which can potentially influence each other and may have to be located within the same epidemiological units.

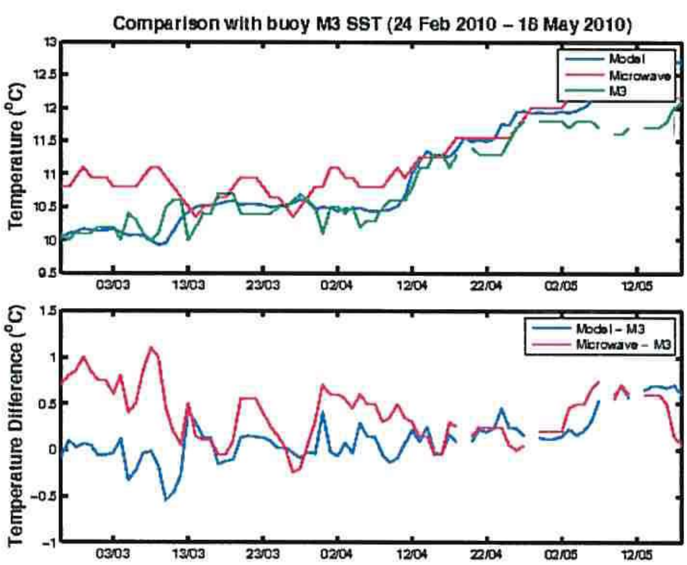
To simulate the transport of sea lice we ran Lagrangian particle tracking simulations in the Connemara model. We assumed that the sea lice were passive drifters with neutral buoyancy and that they did not respond to environmental factors such as salinity. We assumed that the sea lice had a lifespan of 14 days. The model particles were released near the surface at a number of locations every 6 hours for 75 days and the location of each particle was recorded every 20 minutes (particle time step).

The area around each release site was divided into 100 metre square cells and the number of particle time steps a given particle occupied each of those grid squares was calculated (after Murray A.G. and P.A. Gillibrand (2005)). This is a measure of length of exposure of the fish to risk of infection from sea lice. The data was aggregated for all particles released from each location and was then used to create risk maps around the release sites to highlight areas at risk of infection from those release sites.

To simulate the transport of harmful algae in the Bantry Bay model we ran Lagrangian particle tracking simulations whereby particles were released from various sites at various depths in the western Celtic Sea and at the mouth of Bantry Bay. We released particles every 3 hours for 65 days and used the results to build up a picture of the likely transport pathways of harmful algae under various weather and tidal conditions.

Results

The operational model undergoes routine validation using measured data from weather buoys, satellites radiometers, ARGO floats and tide gauges. Use is made of offshore buoy data and Microwave SST data to assess model performance in terms of sea surface temperatures at specific points in the domain (and over the whole domain in the case of Microwave SST). Figure 2 shows good agreement between buoy measured SST data and model output SST. The temperature difference between the satellite SST and the model output (and buoy data) can be significant due to factors such as the coarse spatial resolution of the microwave data (0.25 degrees) and the problem of comparing sub-skin seawater temperature with temperature at depth of a few metres.



Model minus M3

Bias: 0.13
RMS: 0.29
Skewness: 0.40
Correlation: 0.97

Microwave minus M3

Bias: 0.39
RMS: 0.49
Skewness: 0.13
Correlation: 0.89

Figure 2 Routine temperature validation of the ROMS 2.5km NE Atlantic domain model with Microwave SST data from satellite (red line) and offshore buoy data (green line).

In order to ensure that the model accurately represents the upper 1000-2000m of the water column use is made of available ARGO float data from within the model domain. The temperature and salinity fields from the floats are compared with model output fields. There is generally good agreement for temperature and salinity though there are examples where the float data exhibits more vertical structure than in the model output. This may be due to enhanced mixing in the model.

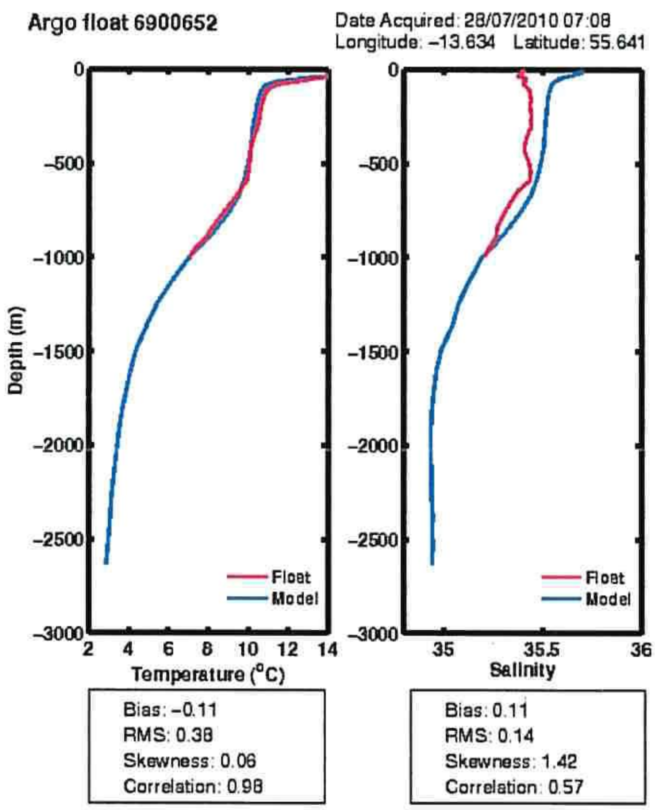


Figure 3 Validation of the ROMS 2.5km NE Atlantic model with ARGO float data for the deeper waters west of Ireland

Epidemiological units

The historical approach to defining epidemiological units around aquaculture sites typically consists of specifying a radius around each site based on estimated tidal currents in the vicinity. Following the protocol established in FRS, Aberdeen (now Marine Scotland) the maximum spring tide amplitude is equated with the tidal amplitude and the tidal excursion is calculated using the following equation:

$$\mathbf{X_T = UT / p}$$

Where:

X_T = tidal excursion distance (m)

U = tidal current amplitude (m/s)

T = tidal period (12.42 hours X 3,600 = 44,712 seconds)

p = constant (3.1416)

In the Scottish context a 40 km surveillance area was previously established to allow for water arriving from an infected farm by forces other than the tide over a ten day period.

In this work, the effects of wind driven circulation, currents established through density gradients and tidal currents are combined to produce more realistic epidemiological units that have previously been defined in Irish waters.

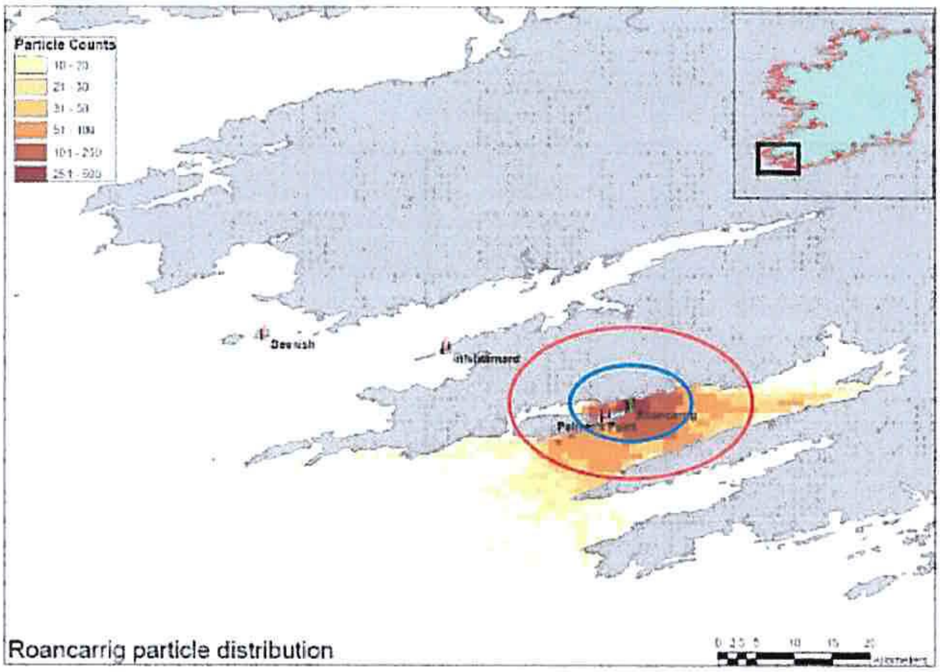


Figure 4 Particle counts for releases from Roancarrig fish farm during 2009. The 5km and 10km rings used for previous calculation of epidemiological units are shown in blue and red respectively.

In most cases around the Irish coast, using the combined circulation features of the model over a 1 year period meant a larger than previously defined epidemiological unit around any given site. An example of this is given in figure 4 where particles originating at Roancarrig are picked up in high numbers within the 5km and 10km radius zones but there is also extensive movement of particles eastward into Bantry Bay, south-westward into Dunmanus Bay and along the northern shore of Bantry Bay. When two sites in adjacent bays are considered the epidemiological units are extensive. Figure 5 shows that Roancarrig has the potential to infect almost all of Bantry Bay while the zone of potential influence from Deenish (Kenmare Bay) extends southwest of Bantry and northward to the Blasket Islands.

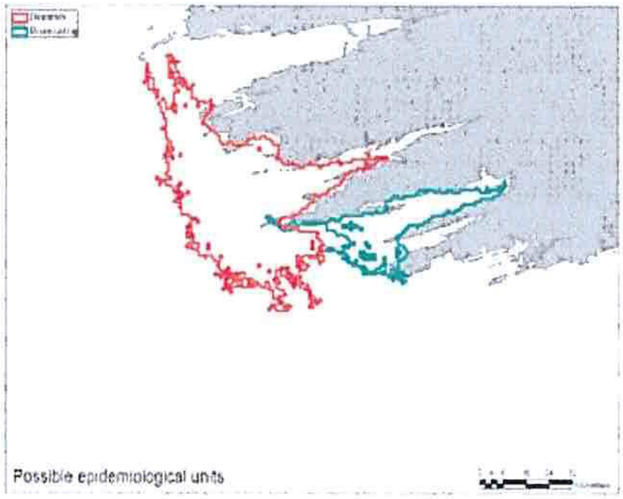


Figure 5 Likely epidemiological units for two aquaculture farms in Southwest Ireland based on 3d circulation features of the ROMS model run over a 1 year period.

The Connemara coast is another region of Ireland where extensive finfish aquaculture takes place. Some of the licensed aquaculture sites in this region are within 5km of each other. The potential scope for contamination between adjacent sites is high. Figure 6 depicts the particle counts for the Golam site in Connemara. While again the bulk of the particles remain within the 5km and 10km radii of the initiation site, there is evidence from the model that parts of Galway Bay and the Aran Islands could be affected by a disease outbreak at Golam, as could the region north-westward to Slyne Head. Up to 9 potential adjacent sites could be affected by a disease outbreak there according to the model results.

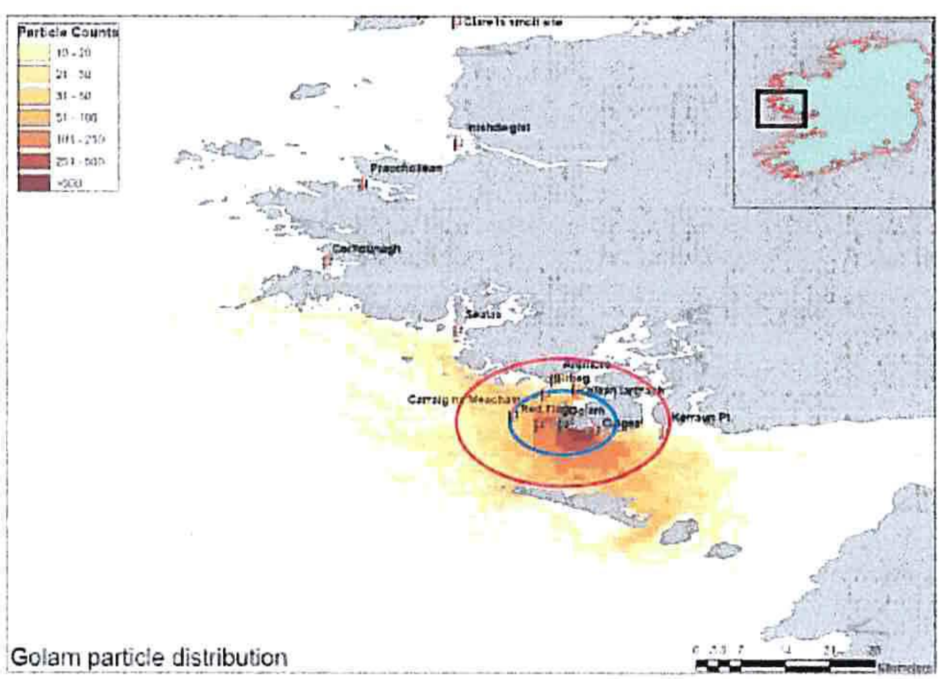


Figure 6 Particle counts for releases from Golam fish farm during 2009. The 5km and 10km rings used for previous calculation of epidemiological units are shown in blue and red respectively.

Sea lice transport

Using the count statistics from the particles released in the Connemara model we constructed risk maps for a number of salmon farms in the region. Figure 7 shows a risk map for the Daonish site, colour-coded to indicate zones of increasing risk. In this example Casheen is seen to be at considerable risk of infection from Daonish but Ardmore has a very small risk of infection.

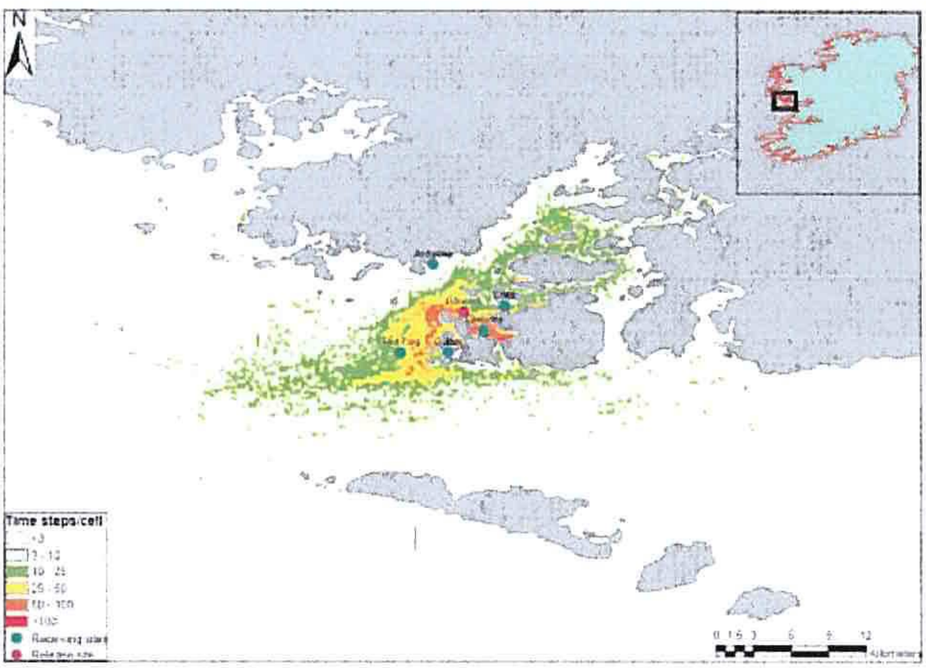


Figure 7 Aggregated cell counts for releases from Daonish fish farm during 2009

We also used the count statistics to create a cross contamination matrix for the release sites in an effort to highlight the risk of one site infecting another. For this exercise we considered each salmon farm as occupying a 500 metre square, centred on each release site. We then calculated the number of particle time steps when particles from the other release sites occupied this area and used those numbers to create the cross contamination matrix (Table 1). To put these numbers in context, if we divided our area of interest into 500 metre cells and if the particles occupied each cell for the same amount of time then would expect a value of 60 or so. Therefore a count of 60 represents a background value. Using these criteria it is evident that Ardmore is at negligible risk from Daonish and Golam and at very low risk from Cnoc. Casheen is at low risk from Cnoc and Golam but is at a significant risk from Daonish. Red Flag is at some risk from Golam but is at significant risk from Cnoc and Daonish.

Table 1 Risk matrix for various aquaculture sites in Connemara showing areas likely to represent a risk to adjacent sites (see text for detail). Low numbers represent a low overall risk of cross contamination

	Receiving Sites					
Release site	**Ardmore**	**Casheen**	**Cnoc**	**Daonish**	**Golam**	**Red Flag**
Cnoc	107	129		202	111	525
Daonish	43	1359	192		73	439
Golam	36	155	37	206		237

Risk matrices can be used as a management tool by those monitoring sea lice outbreaks at finfish aquaculture sites, allowing a response to such incidents in a timely manner.

Harmful Algal Bloom hindcasts

A significant harmful algal bloom event took place in August and September 2009. Results from the HAB sampling programme indicate a general rise in AZP values in the second half of August with values above the closure threshold at Gouladoo on 19th August and Castletownbere on 31st August. One hypothesis for appearance of harmful algae in Bantry is that they are transported there from the western Celtic Sea under certain forcing conditions. In an effort to test this hypothesis model particles were released every 3 hours at various locations and depths in the model domain for a 65 day period between July and early September of 2009.

Results showed that no surface particles released south of Clear Island were transported to Bantry Bay while it was common for mid-depth and deep particles to make it to Bantry. This was especially the case for particles released west of Clear Island. A further analysis of the data from a release point west of Clear Island for the month of August found that on two occasions (6th and 12th) particles released at 50m from this point arrived at the mouth of Bantry Bay in a cluster. The data indicates that the transport pathway described by Raine and Mc Mahon (1998) was closed off to particles except on these two occasions when the pathway was opened and particles could quickly move northwards (at depth) during this period. These particles occupy two broad distribution zones before and after the northwards movement. Zone 1 comprises an arc from west of Clear Head to Mizen Head. Zone 2 comprises the mouth of Bantry Bay (Figure 8). The red and orange zones in Bantry Bay indicate where the particles reside for a considerable period of time, thus allowing organisms like phytoplankton to remain in situ, vertically migrate towards the light and bloom if conditions permit.

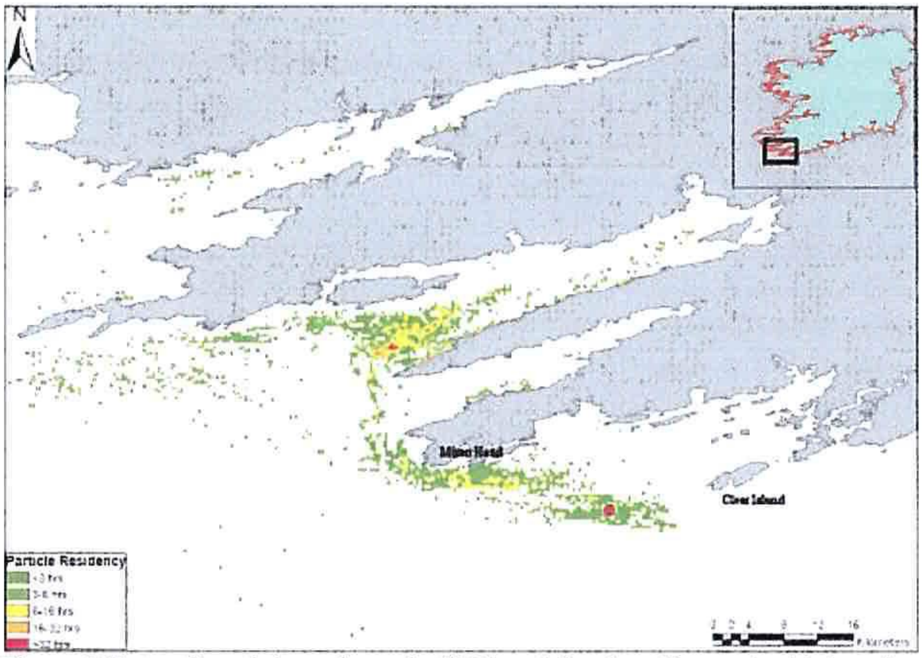


Figure 8 Fate of particles released off Clear Island at 50m and which arrived at Bantry Bay on 6/7 August 2009

The fate of particles released at the mouth of Bantry Bay between the 7th August and 19th August was also considered to examine whether they could be transported to the sampling sites in that time. The significance of this time window is that it starts when the model indicates a movement of particles into the area from the Celtic Sea and it ends on the date an elevated AZP value was measured at Gouladoo (resulting in closure of site to shellfish harvesting). Figure 9a visually summarizes the result of the analysis of surface particles released from a point NW of the Sheep's Head Peninsula. Figure 9b does the same for particles released at mid-depth from the same point. In figure 9a surface particles are carried to Go uladoo and Gearhies (southern shore of Bantry Bay) but not in significant numbers. No surface particles are transported to Castletownbere. The opposite is the case for the mid water particles. Interestingly, no particles from any depth made it past Whiddy Island in inner Bantry Bay.

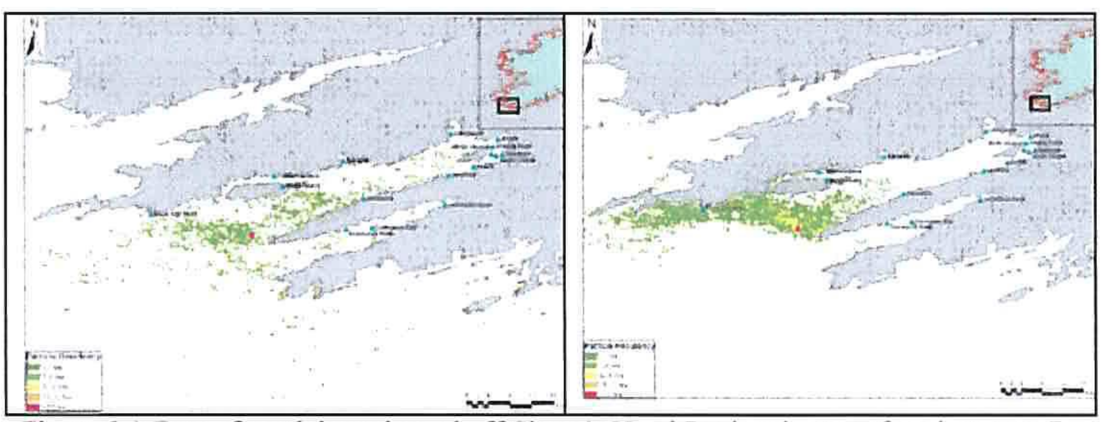


Figure 9a) Fate of particles released off Sheep's Head Peninsula at surface between 7 and 20 August 2009 and b) from same release point at 25m between 7 and 20 August 2009.

The model indicates that particles in the mouth of Bantry Bay can move to Castletownbere (mid-depth) and Gouladoo/Gearhies (surface) in the period between 7th Aug and 19th Aug.

Azaspiracid (AZP) toxin values for the farms inside Whiddy Island only become elevated towards the end of August and in early September. Figure 10 shows that the model predicts a stream of particles moving along the southern boundary of the bay in late August (under the influence on some strong westerly and south-westerly winds).

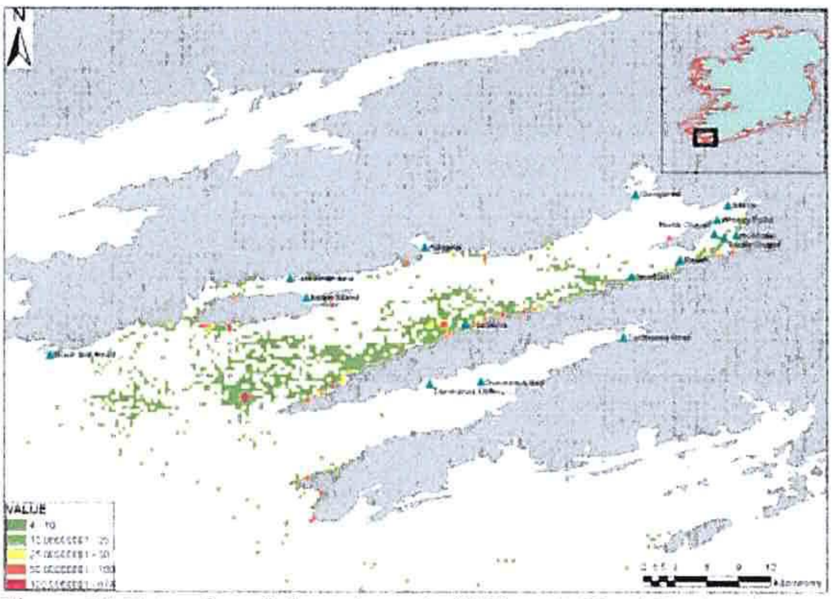


Figure 10 Fate of particles released off Sheep's Head Peninsula at surface between 20 and 31 August 2009

Some consideration was also given to the background oceanographic conditions that may explain the sustained high AZP values from late September until November 2009. Particle tracks were not available for this period so bottom salinity was used as a proxy indicator of the transport pathway being open or closed. During late September and October there were some sustained periods where the wind had a large northerly and or easterly component. This seems to have promoted the movement of fresher water around the southwest corner of Ireland, possibly opening the transport pathway to Bantry Bay and beyond. Figure 11 shows two images of the bottom salinity which highlights the dramatic differences that can be seen in that parameter. If the encroachment of low salinity water around the corner is indicative of the transport pathway opening up then the model shows a sustained period of movement during late September and October which would continually “top up” particles in Bantry Bay.

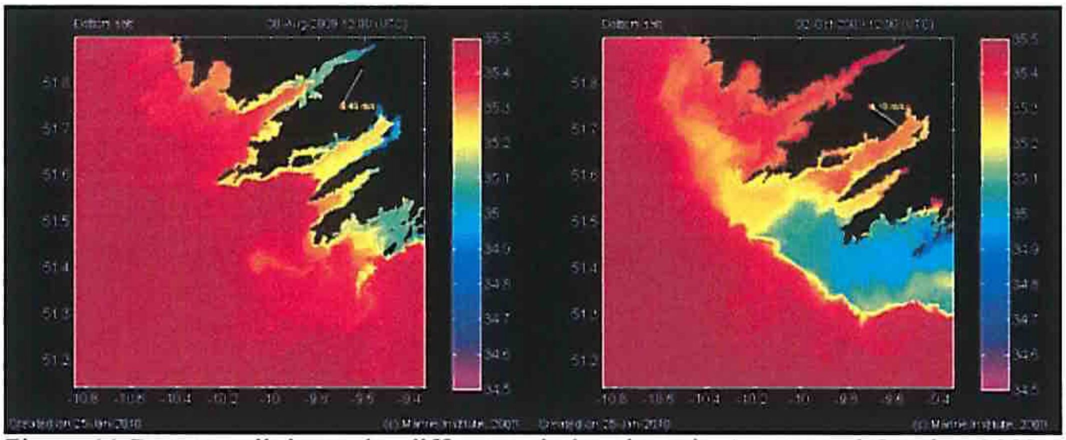


Figure 11 Bottom salinity under different wind regimes in August and October 2009

HAB short range model

Given the important control that the prevailing winds have on coastal current activity off south-west Ireland, Raine et al. (2010) have developed a wind index for Bantry Bay that hindcasts HAB events in the bay over the past decade. As an example of this method, exchange events in 2005 are predicted for 16th and 30th June and 30th July when values of the wind index of over 10 m s-1 were forecast (Figure 12). On each occasion water exchange as indicated by sharp increases in the bottom temperature record(upper panel) were observed as indicated with the filled arrows. The temperature data suggest a fourth exchange may have taken place on 16th July, although here the forecast wind index did not achieve a value of 10 m s^{1}.

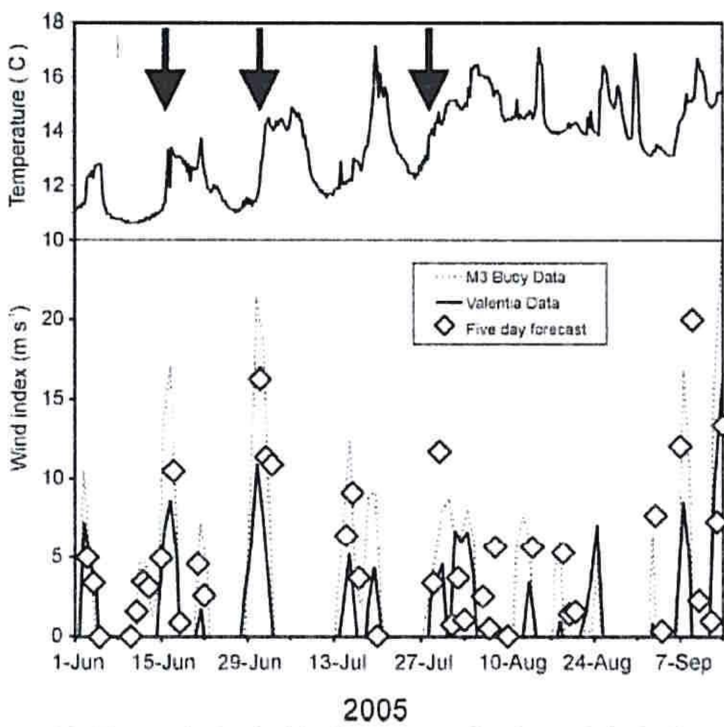


Figure 12 The use of wind indices to predict harmful algal events in Bantry Bay. The wind index obtained from the 5-day weather forecast is plotted against actual values calculated from measurements at both Valentia and the M3 Weather Buoy (from Raine et al. 2010)

Conclusions

This paper has demonstrated how operational model outputs and indices of wind speed and direction can be used to provide decision support tools for the aquaculture industry. Models clearly have a role to play in the definition of epidemiological units for fish disease and for defining likely transport pathways of sea lice and harmful algae. The resolution of the model is important to the assessment of the risk of disease spread between two adjacent aquaculture sites. Taking Golam as an example (data not shown), the coarser (2.5km) resolution model output suggests a significantly higher likelihood of contamination between Golam and adjacent sites. The likelihood is significantly reduced in the higher resolution model. Thorough validation of both models is now required.

While some validation of the models with ARGO and buoy data has taken place to date there is a need for thorough validation of the model drift patterns using surface drifters in the vicinity of the aquaculture sites discussed above. This validation will take place in late 2010. There is also a considerable array of equipment deployed in Bantry Bay to validate the physics within that model. Validation data will become available from this exercise in the near future.

While it is useful to define epidemiological units based on the physical oceanographic outputs from a circulation model it is important to note that knowledge of the behaviour of pathogens that cause disease in fish is very limited. As more becomes known about the behaviour and persistence of pathogens this can in principle be incorporated in a future model eg. Individual Based Modelling.

Similarly for harmful algae, there are many unknowns regarding behaviour of these organisms and their preferences in terms of light availability, nutrient distribution and distinct layers within the water column among other factors. An ecosystem model is currently being developed for Bantry Bay which may improve our understanding of conditions that promote phytoplankton blooms and whether the population is self-sustaining. Such an understanding will enhance the predictive capability of such models in the future.

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SAVE
BANTRY BAY

Aquaculture Licence Appeals Board
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16 January 2019

To whom it may concern,

RE: AP2/1-14/2015: Response to Supplementary EIS from Marine Harvest Ireland in relation to the foreshore licence application at Shot Head, Bantry Bay, Co.Cork.

Further to your email regarding the supplementary EIS submitted by Marine Harvest Ireland in relation to the foreshore licence application at Shot Head in Bantry Bay Co. Cork, we should like to register the submission and observations.

Issue 1. The risk (i.e. posed by the proposed salmon farm installation) of sea-lice infestation of wild salmonids migrating from/to the Dromogowlane and Trafrask rivers and any implications for local freshwater pearl mussel (FPM) populations.

The supplementary EIS states, based on their modelling and desk research, "*wild salmonid stocks of Bantry Bay will suffer no additional impacts....*".

This conclusion states the exact opposite to the international research consensus which states sea lice emanating from salmon farms cause local wild salmon populations to be reduced by 29% to 50%, with the proximity of the salmon farm to the salmon river being critical - see Appendix 1. Given the Dromogowlane and Trafrask rivers are a mere 2.5km from the Shot Head site, this raises the question of how the modelling produced results which directly contradict scientific understanding.

This could be explained by a number of factors not being taken into account within the model:

- Historical data for sea lice numbers on salmon farms in Bantry Bay is used. This fails to take consider ever increasing treatment resistance being witnessed within salmon farming today. [1-6]

- Increasing prevalence of other salmon disease (amoebic gill disease, pancreatic disease,) has affected fish appetite in recent years resulting in decreased ingestion of in-feed medication to control sea lice which results in sea lice prevention methods being less effective.[7]

- Greater cross contamination of sea lice between salmon farms as farm density increases within Bantry Bay (though while not accounting for this in the model, the report does note a risk and that "*this should be avoided*").[6]

- Increasing water temperatures which encourages sea lice reproduction.[8,9]

Research globally has noted sea lice are becoming an increasing problem due to these particular issues.

The supplementary EIS goes on to show maximum plumes of dispersing copepodid density from both the currently operational Marine Harvest salmon farm at Roancarrig, and the proposed one at Shot Head. What is interesting is the distances of copepodid dispersion suggested by the RPS model in the supplementary EIS are considerably smaller than those found in a similar but more detailed study by the Marine Institute and Martin Ryan Institute (copy attached).[10] Here sea lice from the Roancarrig salmon farm are mapped as disseminating distances many many times greater than the distances suggested by the RPS model.[10] This study states "*In most cases around the Irish coast, using the combined circulation features of the model over a 1 year period meant a larger than previously defined epidemiological unit around any given site. An example of this is given in figure 4 where particles originating at Roancarrig are picked up in high numbers within the 5km and 10km radius zones but there is also extensive movement of particles eastward into Bantry Bay, south-westward into Dunmanus Bay and along the northern shore of Bantry Bay. When two sites in adjacent bays are considered the epidemiological units are extensive. Figure 5 shows that Roancarrig has the potential to infect almost all of Bantry Bay while the zone of potential influence from Deenish (Kenmare Bay) extends southwest of Bantry and northward to the Blasket Islands'.*

This offers clear evidence of sea lice dispersing far more widely than the supplementary EIS states, and raises serious questions of the validity of the RPS model.

The supplementary EIS goes on to note that highest risk of Copepodids from the salmon farm attaching to Salmonids were if they were to pass close to the site, and make the assumption this is will not occur when it's concluded there will be zero impact. This fails to acknowledge Salmonids are attracted to the ready food source salmon farms provide, and provides significant risk of cross contamination from sea lice.

What is more, no data has been gathered on local wild salmonids migration patterns. Local expertise (see evidence from Ger O'Sullivan, former NPWS, ALAB Oral Hearing) state wild salmon population in the Trafrask Harbour are known to leave the river and circulate in the harbour regularly during the 'riverine' phase, which would increase the risk of sea lice contamination further. Once cross contamination has occurred, and wild salmon return to their rivers, they will infect further wild salmon and sea trout. These knock on effects are not considered within the conclusions either.

Interestingly, the supplementary EIS acknowledges they have little information on salmonids in the Trafrask / Dromogoulane River stating "*little is known about stock status of these, including Trafrask...*".

It goes on to also acknowledge limited understanding of salmon population in the Adrigole River, another river in close proximity to the Shot Head site, but also close to Marine Harvest's current salmon farm at Roancarriag. Salmon migrating from the Adrigole River must pass the Roancarriag farm. The EIS notes this river is not recovering from the drift net ban as well as others in Bantry Bay, and suggests "*riverine habitat conditions may be impacting on juvenile fish recruitment*" with no evidence to back this claim. The only conclusions that can be drawn is wild salmon populations in the Adrigole River are not currently clear, and why this particular salmon river in Bantry Bay is failing to recover is not known. While water quality may or may not be an issue, there is plenty of research evidence on the impact of salmon farms on wild salmon (see Appendix 1); the Marine Institute and Martin Ryan Institute suggest high concentrations of sea lice in the vicinity; and the EIS itself shows plumes of sea lice in the path out to sea which salmon would follow when migrating to and from the Adrigole river.

The fact is, the EIS confirms limited understanding of the salmon population in the Adrigole River, salmon are not recovering as well as in other rivers in Bantry Bay, and Marine Harvest's other salmon farm is in close proximity, suggests an opportunity for understanding has been missed. While correlation and causation shouldn't be confused, neither should empirical data be ignored.

It is concluded in the supplementary EIS that *"...there is effectively no lice risk projected from the proposed Shot Head site, to wild salmonids at any location."* This extraordinary claim is based on a hydro-dynamic model which uses historical sea lice data only, fails to take account of current sea lice trends on salmon farms, overlooks other research models on sea lice dispersal in the area, and ignores the vast cohort of international research on the impacts of sea lice emanating from salmon farms.

Nor has local understanding or recent data on salmonids population and behavioural patterns in the Trafrask or Adrigole Rivers been gathered and considered, instead old and incomplete data has been relied upon.

Thus the model is inadequate and incomplete, and thereby fails to offer a true projection of potential outcomes for wild salmonids.

The impact of a salmon farm at Shot Head on Freshwater Pearl Mussels (FPM) will be affected by the impact on wild salmonids. The supplementary EIS states *"It is further submitted that there is zero risk that anadromous salmonids will be reduced in numbers in their freshwater phase, as a result lice larva dispersal from the proposed Shot Head site, to impact on the availability of vector hosts for FPM Glochidia larval development and dispersal".* This cannot be claimed with a number of missing elements in the model offered, as noted above.

Any monitoring of future impacts if the farm goes ahead will also be impossible, as little baseline data on FPM populations is available. The supplementary EIS notes *"monitoring has been sparse or non-existent and their precise stock status has not been ascertained".* The only data available is 10 years old, part of a survey completed by Ross in 2008. It concluded the populations of FPM in the Trafrask and Adrigole rivers were two of the four most significant populations identified out of 14 rivers in Cork and Kerry; and may be of national significance. Yet no further surveys have been completed to determine whether or not this is the case, and to establish what current status of the FPM in the Trafrask / Dromogoulane Rivers.

The supplementary EIS goes on to state current FPM populations in the Trafrask River are *"under huge risk of extinction"* stating this is largely due to neglect of their freshwater habitat, which is categorised as having 'high' water quality. It is also acknowledged there's a lack of understanding of these FPM populations *"even to an extent overlooking legal requirements".* This suggests there may have been legal failings to designate the area as an SAC under the Habitats Directive, which had this been the case may well have prevented a salmon farm license at Shot Head ever being granted.

Next, it's concluded recovery of a local FPM population *"may be a forlorn hope"* and *"this is the true background against which the risk exposure of FPM in the Trafrask River, must be judged".* This suggests a gun-ho attitude of 'they're extinct anyway and it's not our fault' - hardly an approach which should be taken towards protected species, where it's been acknowledged legal obligations may have been missed. The Precautionary Principle must prevail, and if it continues to be unclear whether or not this protected species is at risk, a salmon farm at Shot Head should not go ahead.

Indeed, it clearly remains beyond reasonable scientific doubt a salmon farm at Shot Head will impact on this protected species nearby. The sea lice model is inadequate and incomplete as it doesn't address a number of sea lice concerns being witnessed today. Resulting implications for wild salmonids populations, and in turn for FPM populations, are therefore not fully understood, and it cannot be claimed neither species will be affected.

Issue 2. The impact of salmon farm waste on water quality in Bantry Bay, having regard to the maintenance of 'good water status' as required under the Water Framework Directive.

Both the EIS and supplementary EIS offer a model of dispersion from the proposed salmon farm at Shot Head. Based on the model, it is concluded *'benthric infaunal composition is only impacted within the Acceptable Zones of Effects established for salmon farming operation. Beyond these limits, benthic infaunal composition is projected to be normal throughout the Outer Bantry Bay Water Body, if the Shot Head site is licenced for full operation'.*

The Shot Head site lies near the boundary of Inner Bantry Bay, where water quality impacts have not been considered. This is a clear omission.

Further difficulty lies in the modelling approach taken. Empirical data suggests such simplistic modelling approaches cannot fully represent the reality of the situation. Following the oil tanker Betelgeuse explosion on 8 January 1979 pollutants may dispersed far more widely than the model in the supplementary EIS suggests would be possible. [11]

This is further supported by the research completed by the Marine Institute and Martin Ryan Institute, which examines dispersion of sea lice and harmful algal blooms in Bantry Bay which show far greater dispersal of pollutants in Bantry Bay than the model in the EIS claims. [11]

Yours sincerely,

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APPENDIX 1: IMPACT OF SEA LICE EMANATING FROM SALMON FARMS ON WILD SALMONIDS

Threat from sea lice

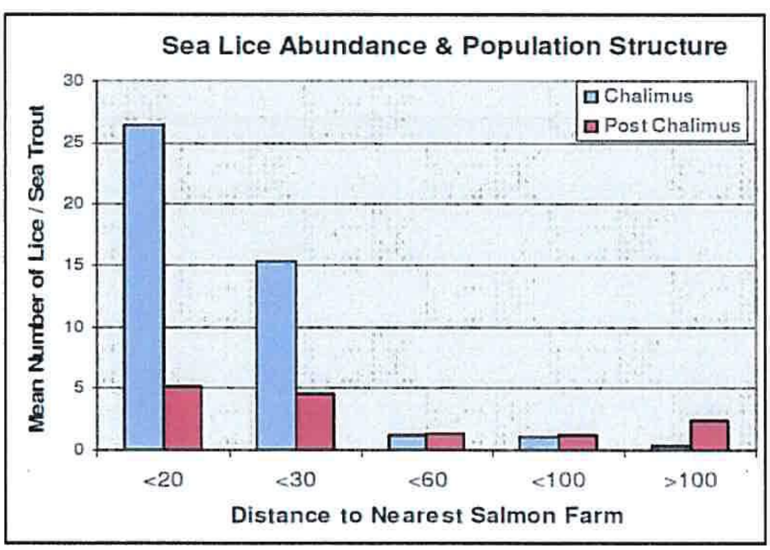
In the wild, salmon are perfectly adapted to cope with sea lice concentrations found in natural open ocean environments. However, in salmon farms sea lice build up to such an extent that the fish have to be treated with pesticides to stop them suffering such severe damage that they develop infections and die. In the west of Ireland, where salmon farms are near ubiquitous, young wild salmon (smolts) must migrate unprotected through dense clouds of sea lice and sea lice larvae. It is universally accepted that these lice are having a negative impact on wild salmon and sea trout populations.

Various scientific studies have examined the scale of this impact. What is clear is the sea lice emanating from salmon farms are significantly increasing mortality rates in juvenile salmon migrating out to sea. The young salmon, smolts, are most vulnerable because of their size. Indeed, it only takes a couple of sea lice significantly impacting their potential survival. In turn, the numbers of adult salmon returning to spawn has dropped so drastically they're increasingly limited in their ability to sustain future generations.

Three recent scientific papers, including three meta-analysis, show that sea lice emanating from salmon farms cause anything from a 39%, 44% or even 50% reduction in wild salmon populations.[1,2,3,4] The most recent Irish study in 2017, focussing on the Eriff River showed a reduction of more than 50%;[5] whilst a 2018 comprehensive review of research put the population-level effects of salmon lice in Ireland and Norway showed that lice-induced mortality in farm-intensive areas can lead to an average of 29% fewer adult salmon.[6]

So, it can be seen it is only the size of the negative impact that is in dispute today.

Research conducted in Ireland revealed the highest level of sea lice were recorded at sites less than 20km from salmon farms, with total lice infestation lower at sites less than 30km from farms.[7,8]



This research highlights the need to separate salmon farms from wild salmon rivers to ensure wild salmon populations are not at risk of collapsing. It is for these reasons, that in 1994 a Report commissioned by the Minister of the Marine from the Sea Trout Working Group stated that until the precise nature of the relationship between sea lice and sea trout is understood '*a precautionary approach dictates that it would be prudent to avoid siting new fish farms or increased salmon farm production...within 20km of a sea trout river mouth*'.[9] Meanwhile, in Scotland the 'rule of thumb' is salmon farms should be located at least 18km from salmon river mouths.[10]

More recently, as part of the Strategic Environmental Assessment [SEA] of the Irish Seafood National Program 2007 – 2013 published under the National Development Plan in July 2010 it was determined that '*The targets for increased productive capacity for salmon will now have to be deferred until after 2013 at the earliest as a result of the amendments made to this Programme... during the SEA process*'.[9] The concerns again related to the negative impact of sea lice, and were submitted by the former Central and Regional Fisheries Boards and supported by the Department of Communication, Energy and Natural Resources (DCENR).[11]

Today, the situation is far from resolved. Salmon farms continue to be located much too close to wild salmon rivers with the result that local salmon and sea trout populations have been devastated.

While some progress has been made in the control of sea lice on some farms, these are often thwarted. Increasing disease incidence, recently seen with the widespread outbreaks of amoebic gill disease, has affected fish appetite resulting in decreased ingestion of in-feed medication to control sea lice. Furthermore, increased resistance to treatment and warming seas are also favouring lice breeding. The result is persistent breaches of the Treatment Trigger Level (TTL), the accepted level of lice per fish, beyond which immediate treatment is required. The number of salmon farms exceeding the TTL in 2010, 2011, and 2012 show that the sea lice levels have not been controlled and in some cases are worse than at the time of the publication of the "Irish Seafood National Program 2007 – 2013" in July 2010.[12, 13, 14] One winter salmon farm exceeded the limit in 25% of salmon farms over the last three years. The number of sites with lice levels above the TTL in two-winter salmon farms has risen continually over the last three years from 24% to 40% to 50% in 2011.

Recently published large scale Norwegian research study noted that '*increased intervention efforts have been unsuccessful in controlling elevated infection levels*'.[15] In particular the paper notes that where there is an increased number of farmed salmon, either through a greater number of farms or greater farm size in an area, sea lice control becomes more difficult. It is suggested this is due to sea lice gaining resistance to available treatments.

It is this experience that has led government bodies in other countries to take action to protect their valuable wild salmon populations. The recent Cohen Report published in Canada has recommended banned all expansion of salmon farming, with a view to possibly closing existing salmon farms should the issue not be resolved.[16] Meanwhile, in Norway 29 fjords and 52 rivers have been designated as salmon protection areas in which the development of salmon farming in banned.

A note on Dr Jackson's (Marine Institute's) sea lice research claims provided as evidence in the supplementary EIS:

Despite the bulk of research determining a negative impact of sea lice from salmon farms on wild salmon, there remain some 'doubters'. Just as there have been in the smoking causes cancer or climate change debates. Ironically, in Ireland the key 'doubter' is the Marine Institute. The government agency responsible for monitoring lice on salmon farms and charged with advising Ministers on salmon farm licence applications.

To date, the most conclusive research studies examining the impact of sea lice emanating from salmon farms on wild salmon populations have been based on the same model. A research team will release pesticide treated smolts, alongside ordinary smolts, and monitor differing return rates.

A team from the Marine Institute, led by Dr Jackson, undertook such a research study. They published three papers using their data which concluded '*that infestation of outwardly migrating salmon smolts with the salmon louse was a minor component of the overall marine mortality in the stocks studied*'.[17,18,19]

The Marine Institute's conclusion was quickly picked up and quoted by Simon Coveney, Minister for Agriculture, Food and the Marine; Bord Iascaigh Mhara; and the Irish Farmers Association and government bodies when promoting the current salmon farming agenda.[20,21,22] They claimed the study was definitive and unequivocal.

Meanwhile, there was outcry amongst the international research community. One key player, Prof Costello, wrote directly to Minister Simon Coveney, to inform him he was being misled.[23] Inland Fisheries Ireland wrote a public statement, as did the internationally renowned Prof Ken Wheelan on behalf of the Association of Salmon Fishery Boards in Scotland.[24,25]

Not long after, in August 2013, a devastating critique of the Marine Institutes work was published in The Journal of Fish Diseases. The international team of experts from Scotland, Norway and Canada re-analysed the Marine Institute's data. It noted that the Marine Institute's team '*incorrectly lead the reader to a conclusion that sea lice play a minor, perhaps even negligible, role in salmon survival*' and that '*such conclusions can be supported only if one is prepared to accept at least three methodological errors*'.[26]

Having re-analysed the data using the standard statistical methods the international team highlight that rather than sea lice emanating from salmon farms causing a 1% mortality of salmon smolts, as David Jackson of the Marine Institute concluded, they in fact cause a one third reduction in adult salmon returns. The research team concluded that this '*has implications for management and conservation of wild salmon stocks*'.

The results of the reanalysis concur with other international studies, as well as Irish studies [1,2,3,26] which indicate that sea lice emanating from salmon farms have a devastating impact on wild Atlantic salmon populations. Inland Fisheries Ireland, national and international angling and environment groups, as well as international research teams have all welcomed the clarification. Inland Fisheries Ireland stated '*In this context, the location of salmon farms in relation to salmon rivers and the control of sea lice prior to and during juvenile salmon migration to their high seas feeding ground is critical if wild salmon stocks are not to be impacted. The development of resistance to chemical treatment of sea lice and other fish husbandry problems, such as pancreas disease and amoebic gill disease, are likely to make effective sea lice control even more difficult in future years.*'[27]

More recently in September 2014, a definitive review of over 300 scientific publications, was published by a team of international scientists from Norway, Scotland and Ireland. It concluded sea lice have negatively impacted wild salmon and sea trout stocks in salmon farming areas in Ireland, Scotland and Norway.[4]

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