Leonard, Brona

From: Francis X O Beirn [redacted]
Sent: Wednesday 20 September 2023 11:31
To: Alab, Info
Cc: [redacted]
Subject: ALAB Appeals AP34-48/2019 Composite response
Attachments: MI Response to ALAB Wexford SAC observations Sept 2023.pdf; MI Response to ALAB Wexford SPA observations Sept 2023.pdf

Dear Margaret,
In relation to the communications from ALAB to the Marine Institute (dated: 29, June, 2023 and 23 August, 2023) on licence deliberations in Wexford, I attached two responses. These composite responses are targeted as each communication, respectively.
Please do not hesitate to contact us if you have any other queries.
All the best
Francis

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To: **Margaret Carton, Secretary to the Board, Aquaculture License Appeals Board (ALAB)**

From: **Francis O'Beirn, Manager, Licensing and Policy Advice, Marine Environment and Food Safety Services Area**

CC: **Michael Gillooly, CEO - Marine Institute; Joe Silke - Director, Marine Environment Service Area, Marine Institute**

Date: **September 19, 2023**

Re: **Section 46 requests in relation to aquaculture appeals in Wexford Harbour – composite response.**

Further to the communications (dated August 23, 2023) from ALAB to Mr. Michael Gillooly (CEO Marine Institute), the Marine Institute (MI) has the following response. Please note the response is from the Marine Institute and is not intended to represent the views of any other body.

The Birds Case Roadmap document is a fluid report and forms part of the ongoing communication mechanism from the primary body responsible, NPWS, to the EU Commission. The progress addressing the issues relating to the case are formally communicated in these reports. These update reports are to be found on the NPWS website under the reference to Birds Case (C 418/04) Programme of Measures (https://www.npws.ie/publications).

In relation to the observation that ALAB is of the view that insufficient evidence was presented in the AA report to suggest that retention of some of the existing extent for bottom culture of aquaculture was not warranted, the Marine Institute reiterate the observations in the AA report below and have provided below some additional data (i.e., updated mussel input and TSAS status) as well as cited more recent peer reviewed material in support of the potential benefits that such bottom culture may provide to the system. In addition, the full profile of aquaculture (prepared by BIM) is provided (in the Appendix of this note) where the importance of bottom culture of mussels to the region is communicated. This importance relates to the social, cultural and economic aspects of the activity, among others.

Given the findings in the AA report[1], i.e., that the current and proposed (bottom mussel culture) activities appear to conflict with the conservation goals of the Slaney River Valley SAC, it was concluded that a reduction in licencing levels would be an appropriate management response. The MI broadly agrees with this approach, however it advised that prior to taking any such decisions that a number of important features in relation to the culture of this species that should be considered, especially if a large scale reduction of current cultivation area was proposed. More specifically, consideration should be given to aspects relating to the identification of likely disturbing activities and the establishment of the 15% threshold by NPWS in addition to historical, ecological and potential

[1] Marine Institute 2016. Appropriate Assessment Summary Report of Aquaculture in the; Slaney River Valley SAC (Site Code: 000781), Raven Point Nature Reserve SAC (Site Code: 000710), Wexford Harbour and Slobs SPA (site code 004076) and Raven SPA (site code 004019) Version: August 2016

eutrophication mitigation benefits that bottom mussel culture currently may provide to this system (i.e., ecosystem services).

1. **15% threshold:**

EU guidance acknowledges that development in Natura 2000 sites is not excluded. More specifically, the European Commission has published guidance documents on activities in Natura 2000 sites[2], within which is stated:

> *"There is no automatic exclusion of any economic activities in and around Natura 2000. Instead, human activities need to comply with the provisions outlined in Article 6 of the Habitats Directive to ensure that these activities are in line with the conservation objectives of Natura 2000 sites."*

To this end, and in order to facilitate decisions in relation to aquaculture licencing applications, assessments under Article 6(3) are carried out. The assessments for extensive aquaculture operations[3] are undertaken on a bay-wide basis and will consider all aquaculture activities and any other likely interactions with habitats and species for which sites are designated. More specifically, consideration is given to interactions between activities and the conservation objectives and targets for these features, as set out by the NPWS Conservation Objectives.

All activities may have some level of interaction with conservation features in a site. The significance of these interactions and the need for management intervention is identified on a case by case basis. In the absence of a scientific framework or guidance on what constitutes significance, in the practical sense as it applies to management of a site, pragmatic reference points are needed.

In order to identify situations that would trigger management intervention resulting from the findings of Article 6.3 assessments, the NPWS identified a level of 15% spatial overlap of likely disturbing activities on marine biological communities as a threshold for such management intervention. The 15% threshold value is presented as part of the conservation objectives (CO) for the site (NPWS 2011: https://www.npws.ie/protected-sites/sac/000781). This threshold is applied at both Annex I habitat level and also at the finer spatial scale of the marine community types (MCT) within these large-scale physiographic habitats. This guidance, as presented in the CO, was prepared in the absence of specific guidance from the EU and has been applied since the initiation of AA reporting for aquaculture licencing in 2011. The 15% threshold is considered a guide to trigger management actions when likely disturbing activities may spatially overlap Annex I habitats (QIs). NPWS propose as a management response that an increasingly cautious approach is advocated. Prior to any further licensing of this category of activities considered disturbing and above the 15% threshold, an inter-Departmental management review (considering *inter alia* the robustness of available scientific knowledge, future site requirements, etc) of the site is recommended. It is unclear if such a review was ever conducted. However, it is the view of the MI that such an avenue would be open to ALAB.

Disturbance of habitats is defined as activities that cause change to community structure and function. Structure relates to the characterising species of a community, or the collection of animals that make

[2] EU (2018). Guidance on Aquaculture and Natura 2000 Sustainable aquaculture activities in the context of the Natura 2000 Network. PDF ISBN 978-92-79-99668-9 doi:10.2779/34131

[3] Extensive aquaculture operations are those defined as production methods relying on ambient food (i.e., plankton or nutrients) as defined in S.I. No. 240 of 2018.

up that community. Function is considered the process whereby the animals living on and in the seafloor, by virtue of their activities, influence benthic dynamics which is reflective of system health (Bolam et al 2002; Solam et al 2004). Such activities or traits are considered in relation to, among others, the organisms feeding type (e.g., scavenger, predator, filter or deposit feeders), mobility, body size, and ability to bioturbate (i.e. introduce oxygen into the sediment). All such traits can result in the removal or conversion of organic matter to biomass (i.e. secondary production). It should be noted that while the structure of a community can be dynamic (i.e. subject to change), it may still retain similar levels of function (Tsikopoulou et al 2021). This demonstrates a resilience in the ecosystem which will continue to provide goods and services (Shojaei et al., 2021). The disturbance is considered persistent when the pressure is generally present. In the case of aquaculture, the persistence of pressures varies over time depending on the type of activity but typically, these pressures do not lead to permanent habitat loss and are, for the most part, considered no more disturbing that many natural disturbance events in such shallow environments, e.g. storms. Given the resilience of many habitats in the absence of the pressure it is likely the communities will revert to baseline state within a defined period. This period is a function of the nature of the habitat and species therein. Data on habitat and species resilience are derived from primary literature, review documents and sensitivity assessment frameworks specific to marine systems (e.g. MarLIN, MarESA[4])

The application of the 15% threshold to the AA process for aquaculture licencing is guided by a number of principles:

- All new applications are subject to full assessment which considers the pressures cumulatively with licenced aquaculture practices. This has led to the revision of AA reports (screening and full assessment) for many of the aquaculture areas in Ireland as new licence applications area considered.
- This is not a 15% threshold for aquaculture activities alone - all other likely disturbing activities (e.g. fishing, dredging) acting on habitats are considered in-combination with aquaculture activities.
- The process is applied to Annex 1 - habitats (qualifying Interests) and within these habitats, to the marine community types – which represent finer resolution habitat designation.
- For highly sensitive marine communities such as eel grass, mearl and biogenic reefs no spatial overlap is tolerated and buffer zones are advised and factored in, if necessary, to ensure complete separation of effects.
- Likely disturbance effect resulting from aquaculture practices are derived primarily from peer reviewed literature and established risk frameworks (e.g., MarLIN and MarESA). The outputs of these frameworks are specifically derived, in many instances, from empirical studies examining pressures resulting from specific activities.
- The process is considered precautionary in its application as the entire licence area is considered when in reality, any effects are likely to be more restricted and confined to the footprint of the structures.
- In the majority of sites/AA reports where aquaculture activities were under consideration, this threshold is never closely approached – those that do approach or exceed the value will result in mitigation or, perhaps, licence refusal.

[4] https://www.marlin.ac.uk/

- The thresholds apply to habitats only and do not apply to other conservation features, e.g. Annex 2 species and birds, which are considered separately in the reports.
- Other pressures such as risk of establishment or introduction of alien species are also considered on a case-by-case basis.

The following information box summarises the interpretation of the application of the 15% threshold (source: NPWS guidance documents).

Application of 15% habitat disturbance threshold:

- On the understanding that development within Natura sites is not excluded, this is a reference point identified in the absence of specific EU guidance.
- The origins of this value are found in the NPWS Guidance documents for SACs: Conservation objectives supporting document - Marine Habitats – AA notes.
- This threshold has been applied since the 1st AA report for aquaculture, produced in 2011.
- It is considered a guide to trigger management actions when likely disturbing activities may spatially overlap Annex I habitats (QIs) as well as the finer resolution Marine Community Types (MCT)
- Disturbance acts on the structure and function of habitats and MCT – it is noted that it is highly precautionary and furthermore, it is important to acknowledge the effects of disturbance are considered reversible.
- A number of principles govern the application of this reference point:
    - All aquaculture applications in a Natura site are considered on a cumulative basis
    - This is not a 15% for aquaculture alone - all other likely disturbing activities (e.g. fishing, dredging) acting on habitats are considered in-combination with aquaculture activities.
    - Information underpinning these assessments are found in primary literature, review documents, and established risk frameworks (e.g. MarLIN, MarESA)
    - No spatial overlap is allowed over highly sensitive habitats (eel grass, maërl, biogenic reef) – sufficient buffer zones are also factored-in.
    - The process is precautionary in that the entire licence area is considered in spatial analysis

To this end and as a management response, it is noted a number of aquaculture sites have been redrawn, by DAFM, to remove licence area overlap with Mudflats and Sandflats not covered by seawater at low tide habitat (QI 1140) as well as to reduce the spatial overlap, with the QI Estuaries (1130).

2. *Mussels as historical ecosystem components in Wexford Harbour.*

The profile of aquaculture in the area in question[5] provides a historical perspective not only in relation to mussel culture activities within the harbour, but also some broader observations in relation to the extent of natural mussel populations in the harbour. Historically, it would seem that mussels have had a natural presence in the harbour and this is confirmed by fisheries reports from the 19th century. It is clear, from these records, that mussels would have been present in the harbour and likely

[5] BIM. 2014. Summary of shellfish aquaculture in Wexford Harbour. Report prepared by BIM for Wexford AA. 42pp. Appendix following

contributing to the ecosystem functioning of same. Within the conservation objectives (NPWS 2011a, b), no specific community type is designated (named) as mussel reefs; however, mussels are considered a component of the Mixed Sediment Community Complex found in the habitat feature Estuaries (1130). How much of the mussels currently in the harbour might be considered 'natural' as distinct from those introduced via aquaculture practices, is unknown? However, it is expected that the standing stock of cultured mussels in the harbour would appear stable (see seed inputs and production on Table 1 below). The inclusion of mussels as a component in the community type Mixed Sediment Community is appropriate. Whether the quantity of mussels would be retained within the system without the aquaculture intervention is unclear as the level and extent of natural recruitment is unknown?

Table 1. Mussel seed input and annual harvest in Wexford Harbour (Source: BIM)

Year	Seed Input (T)	Harvested (T)
2022	4,560	4,101
2021	3,735	2,384
2020	3,885	2,047
2019	4,650	2,107
2018	2,190	2,940
2017	3,258	3,258
2016	3,000	2,607
2015	3,825	2,211
2013	2,050	1,458
2012	3,185	2,855
2011	3,311	4,950
2010	2,283	5,256
2009	5,025	4,546
2008	3,885	3,473
2007	5,952	2,413
2006	2,168	3,493
2005	3,385	4,887

3. ***Trophic status in Wexford Harbour***.

Suspension-feeding bivalve molluscs feed at the lowest trophic level and influence the nutrient and organic coupling of benthic and pelagic systems. Bivalve molluscs graze on seston which consist of phytoplankton in the water column, re-suspended microalgae, detritus and zooplankton (a potential competitor for phytoplankton). Their ability to influence these components give bivalves an important role in the consumption and movement of energy within marine systems. More specifically, the ability to control/mediate excess phytoplankton is an important ability of bivalve molluscs. Numerous authors have concluded that bivalve filter feeders have the ability to control (i.e., reduce)

phytoplankton abundance in shallow water systems (Dame, 2013; Dame and Olenin, 2005; National Research Council 2010; Gallardi 2014; Filgueira et al 2015; Petersen et al 2015; Jansen et al 2019). Dame (2013) suggested that when conditions of shallow flowing water with adequate food supply are present, benthic bivalve feeders will tend to dominate a system. Such conditions are found in the Slaney River Valley SAC. The Environmental Protection Agency (EPA) uses the Trophic Status Assessment Scheme (TSAS; Toner et al., 2005) to measure of the health of system which reflects the loading in estuarine and coastal waters of nutrients and organic matter. The TSAS measures nutrient enrichment, algal concentrations and oxygen and based upon derived thresholds and provides a classification of the status of the waterbody ranging from unpolluted to eutrophic. The Lower Slaney River (parts of which are included in the Lower Slaney Valley SAC) has been classed as polluted or potentially eutrophic in the last number of cycles (Source: EPA) (Table 2). What is demonstrated is that the Lower Slaney River (Estuary) invariably has a lower trophic status than Wexford Harbour downstream. While the TSAS classification during 2010-2012 was similar for both Lower Slaney and Wexford Harbour (i.e. Potentially Eutrophic) it is important to point out that the threshold exceedance was considerably greater in the Lower Slaney than Wexford Harbour, 72% and 23%, respectively. The eutrophication effect is attributed to run-off from agriculture activities as well as some large urban areas upstream. This distinction in waterbodies is also apparent in WFD classification (EPA WFD Status 2016-2021 - https://gis.epa.ie/EPAMaps/Water). While dilution and a shift in nutrient balance (from marine waters) may be contributory factors for the observed differences between the waterbodies, O'Boyle et al (2015) propose a conceptual model on other factors influencing phytoplankton growth/proliferation in Irish Estuaries. Muylaert and Raine (1999) (reiterated by O'Boyle et al. (2015) suggest that grazing by macro-benthic organisms (e.g. mussels and infuanal suspension feeders) in estuarine/coastal systems play a role in regulating phytoplankton levels and hence, mitigate eutrophication status, *sensu*, Dame (2013). Given the ability of large aggregations of bivalve molluscs to filter large volumes of water and remove excess phytoplankton (Dame and Olenin 2005 and references therein; Dame 2013; see Smaal et al 2019) and enhance sediment denitrification (Pollack et al 2013; Kellogg et al., 2013, 2014; Smyth et al., 2015; Petersen et al 2019; Hillman et al 2021), it has been suggested that they would represent a realistic mitigation feature to control eutrophication of coastal waters (Dame and Olenin 2005 and references therein; Kotta et al 2004; Lindahl et al 2005; Gren et al 2009; Dame 2013; Bergstrom et al 2015; Marques et al 2013; Petersen et al 2015). Additionally, harvesting as a mechanism for removal of nitrogen from the system has also been postulated (Guyondet et al. 2014; Bergstrom et al. 2015; Petersen et al 2019) and promoted by Rose et al (2015). Given these observations, grazing by cultured and wild mussels in the Slaney River Valley SAC, is likely to be an important potential control mechanism of eutrophication in the system (Shane O'Boyle, EPA, personal communication).

Table 2. Trophic status of Lower Slaney River and Wexford Harbour (source EPA, Ireland).

	Waterbody Trophic Status (TSAS)	
Year	**Lower Slaney**	**Wexford Harbour**
2018-2020	Eutrophic	Intermediate
2017-2019	Eutrophic	Unpolluted
2016-2018	Eutrophic	Unpolluted
2015-2017	Eutrophic	Unpolluted
2014-2016	Eutrophic	Unpolluted
2013-2015	Eutrophic	Unpolluted
2012-2014	Eutrophic	Intermediate
2010-2012	Potentially Eutrophic	Potentially Eutrophic
2007-2009	Eutrophic	Unpolluted
2001-2005	Eutrophic	Intermediate

4. *Habitat provided by shellfish*.

Shellfish assemblages (particularly epibenthic forms) provide important structure and enhance habitat heterogeneity in marine systems (Walles et al 2015). The bivalve shells provide an important attachment site for other epifaunal species. In addition, the structure can provide refuge for a range of mobile taxa. Numerous studies have documented considerable diversity of attached species and nekton associated with shellfish reefs, when compared with surrounding sedimentary habitats (Lehnert and Allen, 2002; Tolley and Volety 2005; Boudreaux et al 2006; Humphries and LePeyre 2015; Scyphers et al 2011; Kritzer at al 2016) and specifically for mussels (Borthagaray and Carranza 2007; Norling and Kautsky 2007, 2008; McDermott et al. 2008; NRC 2010; Drent and Deker 2013; Norling et al 2015, Benjamin et al 2022; see review by Guitierrez et al., 2003 and Craeymeersch, and Jansen, 2019). Yet, under high densities (e.g. intertidal mussel beds) the diversity of associated biota can be lower than expected (Palomo et al., 2007) which may be due to intensive filtration which prevents larval settlement of any associated organisms (Woodin 1976) or a lack of interstitial space for colonisation. In addition, it has also been proposed that zooplankton and larval fishes which depend on phytoplankton can compete with bivalves; also, mussels have the ability to reduce the abundance of zooplankton by filtering; however, the importance of this is still as yet unknown. It should be noted, any impact on fisheries might be offset by the value of heterogeneous habitats created by mussel patches to fishes (McDermott 2008). Craeymeersch, and Jansen (2019) consider the biodiversity value of cultured and natural bivalve assemblages, and conclude similarities are likely however, the ultimate removal of culture species will prevent the culture assemblages from achieving climax biodiversity levels. However, they concluded the biodiversity of culture assemblages was higher than surrounding sedimentary habitats in temperate waters.

In Wexford Harbour, mussel culture practices appear to result in a mottled distribution of mussels on the seabed resulting in a heterogenous habitat structure (See Figure 1). These patches are found at

various stages of development throughout the culture sites. Such a structural arrangement is likely to benefit overall system diversity (Norling and Kautsky 2008; Kritzer at al 2016), which is broadly in keeping with the conclusions of Buschbaum et al (2009) that mussel reef systems (on sedimentary habitats and as found in Wexford) enhance habitat heterogeneity and species diversity if considered at the level of the ecosystem (i.e. the harbour).

Figure 1. Patchiness associated with mussel culture activity in Wexford harbor (source: Bing maps - Accessed September 12th, 2023).

In summary, based upon the information presented above, the MI concludes that bottom mussel culture, at current levels, could conceivably have a positive role in ecosystem function in terms of nutrient and phytoplankton mediation as well as provision of habitat (Smaal et al 2019). The ongoing addition of mussels to the system may have additional benefit in terms of reducing effects of eutrophication, and may further improve status in the outer parts of Wexford Harbour relative to the Lower Slaney waterbody; however, this all remains to be determined/confirmed and, if found to be so, is subject to continued availability of mussel seed being introduced to the system.

In addition to the points outlined above; other mitigating/qualifying factors that are important to clarify are that;

1) there is a clear distinction between current licence extent and current levels of activity in that mussel culture only occurs in deeper subtidal areas of the SAC and with one exception, it is anticipated that no culture (and disturbance from same) will occur in intertidal and shallow subtidal areas. This is an important consideration, particularly in the outer parts of the waterbody where the qualifying feature is Mudflats and sandflats not covered by seawater at low tide (1140) which resulted in a number of redrawn boundaries resulting in minimal or no coverage of this qualifying feature;
2) given the patchy nature of shellfish distribution on the seafloor, the areas where mussel culture will occur will not result in 100% cover of the seabed; however, it is expected that disturbance (dredging relating to harvest and/or maintenance) will occur over the entire area where mussels are placed;
3) if mussels are retained in the system for approximately 3 years then, based upon the seed input for the last 3 years of records (Table1), there is the potential for the standing stock in

the bay to reach 12,000 tonnes. If a conservative stocking density of 30 tonnes per hectare is applied, then this would require approx. 400ha to be used for culture at any one time. However, given the hydrodynamics in the Harbour (e.g., shifting channels or sediments) that may result in the existing areas for culture being deemed unsuitable, it would be important that redundancy is built into the licensing such that additional seafloor (licenced area) is available to the operators.

References

Benjamin, E.D., Sean J. Handley, R. Hale, T.A. Toone, A. Jeffs, J.R. Hillman. 2022. Biodiversity associated with restored small-scale mussel habitats has restoration decision implications. Biodiversity and Conservation (2022) 31:2833–2855

Bergstrom P, Susanne Lindegarth S, Lindegarth M. 2015. Modeling and predicting the growth of the mussel, *Mytilus edulis*: implications for planning of aquaculture and eutrophication mitigation. Ecology and Evolution doi: 10.1002/ece3.1823

Bolam, S.G., T. F. Fernandes, M. Huxham. 2002. Diversity, biomass, and ecosystem processes in the marine benthos. Ecological Monographs, 72(4) 599–615

Borthagaray AI, Carranza A. 2007. Mussels as ecosystem engineers: Their contribution to species richness in a rocky littoral community. Acta Oecologica 31:243-250

Boudreaux ML, Stiner JL, Walters LJ. 2006. Biodiversity of sessile and motile macrofauna on intertidal oyster reefs in Mosquito Lagoon, Florida. J Shellfish Res, 25(3):1079-1089.

Buschbaum C, Dittmann S, Hong J-S, Hwang I-S, Strasser M, Thiel M, Valdivia N, Yoon S-P, Reise K. 2009. Mytilid mussels: global habitat engineers in coastal sediments. Helgol Mar Res 63:47–58

Craeymeersch, J.A., Jansen, H.M. (2019). Bivalve Assemblages as Hotspots for Biodiversity. In: Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) Goods and Services of Marine Bivalves. Springer, Cham.

Dame R, Olenin S. (ed-s). 2000. The Comparative Roles of Suspension-Feeders in Ecosystems, NATO Science Series. Earth and Environmental Series, Vol. 47, Springer, 359 pp.

Dame RF (2013) Ecology of marine bivalves: an ecosystem approach. 2nd Edition. CRC press. 271pp

Drent, J. R. Dekker. 2013. How different are subtidal *Mytilus edulis* L. communities of natural mussel beds and mussel culture plots in the western Dutch Wadden Sea? NIOZ-Report 2013-6 Royal Netherlands Institute for Sea Research

Gallardi D (2014) Effects of Bivalve Aquaculture on the Environment and Their Possible Mitigation: A Review. Fish Aquac J 5: 105. doi: 10.4172/2150-3508.1000105

Gren, I-M, Lindahl O, Lindqvist M, 2009. Values of mussel farming for combating eutrophication: an application to the Baltic Sea. Ecol. Eng. 35, 935–945.

Gutierrez JL, Jones CG, Strayer DL, Iribarne OO. 2003. Mollusks as ecosystem engineers: the role of shell production in aquatic habitats. Oikos 101: 79–90.

Guyondet T, Comeau LA, Bacher C, Grant J, Rosland R, Sonier S, Filgueira R. 2014. Climate Change Influences Carrying Capacity in a Coastal Embayment Dedicated to Shellfish Aquaculture. Estuaries and Coasts DOI 10.1007/s12237-014-9899

Hillman J.R., T. A. O'Meara, A.M. Lohrer, S.F. Thrush. 2021. Influence of restored mussel reefs on denitrification in marine sediments. Journal of Sea Research 175: https://doi.org/10.1016/j.seares.2021.102099

Humphries AT, La Peyre MK. 2015. Oyster reef restoration supports increased nekton biomass and potential commercial fishery value. PEER J DOI: 10.7717/peerj.1111

Jansen, H.M., Strand, Ø., van Broekhoven, W., Strohmeier, T., Verdegem, M.C., Smaal, A.C. (2019). Feedbacks from Filter Feeders: Review on the Role of Mussels in Cycling and Storage of Nutrients

in Oligo- Meso- and Eutrophic Cultivation Areas. In: Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) Goods and Services of Marine Bivalves. Springer, Cham.

Kellogg, M.L., Cornwell, J.C., Owens, M.S., Paynter, K.T., 2013. Denitrification and nutrient assimilation on a restored oyster reef. Mar. Ecol. Prog. Ser. 480, 1–19.

Kellogg ML, Smyth AR, Luckenbach MW, Carmichael RH, Brown BL, Cornwell JC, Piehler MF, Owens MS, Dalrymple DJ, Higgins CB. 2014. Use of oysters to mitigate eutrophication in coastal waters. Estuar Coast Shelf Sci, 151, 156–168.

Kotta J, Simm M, Kotta I, Kanošina I, Kallaste K, Raid T. 2004. Factors controlling long-term changes of the eutrophicated ecosystem of Pärnu Bay, Gulf of Riga. Hydrobiologia 514: 259–268

Kritzer, J.P., M-B. Delucia, E. Greene, C. Shumway, M.F. Topolski, J. Thomas-Blate, L.A. Chiarella, K.B. Davy, K. Smith. 2016. The Importance of Benthic Habitats for Coastal Fisheries. BioScience Vol. 66 No. 4

Lehnert, R. L. & D. M. Allen. 2002. Nekton use of subtidal oyster shell habitat in a southeastern U. S. estuary. Estuaries 25:1015–1024.

Lindahl O, Hart, R., Hernroth, B., Kollberg, S., Loo, L.-O., Olrog, L., Rehnstam-Holm, A.-S., Svensson, J., Svensson, S., Syversen, U., 2005. Improving marine water quality by mussel farming – a profitable solution for Swedish society. Ambio 34, 129–136.

Marques L, Carric A¸ Bessa F, Gaspar R, Neto JM, Patrício J. 2013. Response of intertidal macrobenthic communities and primary producers to mitigation measures in a temperate estuary. Ecological Indicators 25:10–22

McDermott, S, Burdick D, Grizzle R, Greene J., 2008. Restoring ecological functions and increasing community awareness of an urban tidal pond using blue mussels. Ecol Restor 26(3) 254-262.

Muylaert, K., Raine, R., 1999. Import, mortality and accumulation of coastal phytoplankton in a partially mixed estuary (Kinsale Harbour, Ireland). Hydrobiologia 412, 53-65

National Research Council (2010) Ecosystem concepts for sustainable bivalve mariculture. The National Academy Press, Washington, DC.

Norling P, Kautsky N (2007) Structural and functional effects of *Mytilus edulis* on diversity of associated species and ecosystem functioning. Mar Ecol Prog Ser 351: 163–175

Norling P, Kautsky N (2008) Patches of the mussel *Mytilus* sp. are islands of high biodiversity in subtidal sediment habitats in the Baltic Sea. Aquat Biol 4: 75−87

Norling P, Lindegarth M, Lindegarth S, Strand A. 2015. Effects of live and post-mortem shell structures of invasive Pacific oysters and native blue mussels on macrofauna and fish. Mar. Ecol. Prog. Ser 518: 123–138,

NPWS. 2011a. Conservation Objectives for Slaney River Valley SAC (000781). Version 1.0. Department Arts, Heritage and the Gaeltacht. Version 1 (21st October 2011); 27pp.

NPWS. 2011b. Slaney River Valley SAC (000781): Conservation Objectives supporting document – marine habitats and species. Department Arts, Heritage and the Gaeltacht. Version 1 (August 2011)17pp.

O'Boyle, S, Wilkes R, McDermott G, Ní Longphuirt S, Murray, C. 2015. Factors affecting the accumulation of phytoplankton biomass in Irish estuaries and nearshore coastal waters: A conceptual model. Estuar Coast Shelf Sci 155 (2015) 75-88

Palomo MG, People J, Chapman MG, Underwood AJ. 2007. Separating the effects of physical and biological aspects of mussel beds on their associated assemblages. Mar Ecol Prog Ser 344: 131–142

Petersen, JK, Hasler, B., Timmermann, K., Nielsen, P., Tørring, D.B., Larsen, M.M., Holmer, M., 2014. Mussels as a tool for mitigation of nutrients in the marine environment. Mar. Pollut. Bull. 82, 137–143.

Petersen JK, Saurel C, Nielsen P, Timmermann K. 2015. The use of shellfish for eutrophication control. Aquaculture International DOI: 10.1007/s10499-015-9953-0

Petersen, J.K., Holmer, M., Termansen, M., Hasler, B. (2019). Nutrient Extraction Through Bivalves. In: Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) Goods and Services of Marine Bivalves. Springer, Cham.

Pollack JB, Yoskowitz D, Kim H-C, Montagna PA. 2013. Role and Value of Nitrogen Regulation Provided by Oysters (*Crassostrea virginica*) in the Mission-Aransas Estuary, Texas, USA. PLOS ONE Volume 8; Issue 6;e65314

Rose, JM; Bricker, SB; Tedesco, MA; Wikfors, GH (2014) A role for shellfish aquaculture in coastal nitrogen management. Environmental Science and Technology 48(5): 2519-2525. doi: 10.1021/es4041336.

Scyphers SB, Powers SP, Heck KL, Byron D. 2011. Oyster Reefs as Natural Breakwaters Mitigate Shoreline Loss and Facilitate Fisheries. PLoS ONE 6(8): e22396. doi:10.1371/journal.pone.0022396

Shojaei, M. G., Gutow, L., Dannheim, J., Schroder, A., and Brey, T. (2021). Long-term changes in ecological functioning of temperate shelf sea benthic communities. Estuar. Coast. Shelf Sci. 249:107097. doi: 10.1016/J.ECSS.2020. 107097

Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) 2019. Goods and Services of Marine Bivalves. Springer, Cham.

Smyth AR, Piehler MF, Grabowski JH. 2015. Habitat context influences nitrogen removal by restored oyster reefs. J Applied Ecol. doi: 10.1111/1365-2664.12435

Solan, M., B.J. Cardinale, A.L. Downing, Engelhardt, K.A.M., Ruesink, J.L., Srivastava, D.S., 2002. Extinction and Ecosystem Function in the Marine Benthos. Science 306: 1177-1180

Strand, Ø., Ferreira, J.G. (2019). Introduction to Regulating Services. In: Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) Goods and Services of Marine Bivalves. Springer, Cham.

Tolley SG, Volety AK (2005) The role of oysters in habitat use of oyster reefs by resident fishes and decapod crustaceans. J Shellfish Res 24: 1007−1012

Toner, T., Bowman J, Clabby K, Lucey J, McGarrigle M, Concannon C, Clenaghan C, Cunningham P, Delaney J, O'Boyle S, MacCárthaigh M, Craig M, Quinn R. 2005. Water quality in Ireland, 2001–2003. Wexford: Environmental Protection Agency.

Tsikopoulou, I., Dimitriou, P.D., Karakassis, I. Lampadariou, N., Papadopoulou, N., Smith, C.J. 2021. Temporal Variation in the Ecological Functioning of Benthic Communities After 20 Years in the Eastern Mediterranean. Frontiers in Marine Science 8- 768051

Woodin SA. 1976. Adult-larval interactions in dense infaunal assemblages: patterns of abundance. J. Mar. Res. 34: 25-41

Appendix – BIM profile of aquaculture activity in Wexford Harbour

A profile of Aquaculture activities in Wexford Harbour BIM-2014

History

It is worth dwelling on the shellfish and mussel industry history somewhat for Wexford Harbour as it was important from a national and European perspective. The birthplace for the bottom mussel industry today in Ireland was in Wexford and the saviour of the European oyster industry in the mid-nineteenth century was from the coastal waters off County Wexford. The pelagic fishing fleet and the schooner fleet also have a rich history but that would be beyond the scope of the Aquaculture Profile.

Shellfish

Shellfish, Wexford Harbour and the Irish Sea off the Wexford coastline have a long and rich history together spanning several centuries. Initially in the 18th and 19th century native oyster beds were the foundation of the shellfish industry in the southeast and this gave way in the late 19th century to mussels and the establishment of the mussel industry particularly in the latter part of the 20th century to the present day.

Natural Oyster Beds off Wexford Harbour

There were several natural (native) oyster beds situated at various parts of St Georges Channel, the principal of which were in Brittas Bay (North of Mizen Head), Arklow Bay (North of Arklow Head), Ballyvaldon Oyster Fishery (off County Wexford between Cahore Point and Blackwater Head) and the fourth at the entrance to Wexford Harbour to the east of Raven spit and Dogger Bank and extending between north and south bays. Although some reports say that dredging for oysters was in a continuous line from Arklow to Carnsore Point.

The Ballyvaldon and the Wexford oyster bed are shown on **Map 1** along with the location of cockle and mussel beds within Wexford Harbour as documented in the Browne Report published in 1904 but researched in 1898.

Ballyvaldon Oyster bed.

The Ballyvaldon bed was the largest (8 miles in length and about 2-3miles in breadth) and was probably the largest oyster bed in Europe. It was situated in five to nine fathoms of water and about half a mile distant from the shore. The quantity of starfish on the bed was enormous. At its height the bed had 100 boats dredging on it and apart from sales to UK and Ireland oysters were sent to France for breeding purposes. However, by the time of the Browne report in 1904 the total take of oysters was under 5000 from only 3-4 boats fishing occasionally and oysters had become large and coarse and the demand was poor. There were signs that the population of oysters was in a crash scenario as there was no sign of small oysters.

Map 1: Location of shellfish beds in Wexford Harbour and vicinity as approximated from the Browne Report (1904).

Wexford Harbour Oyster bed

This oyster bed is situated about two miles to the east of the entrance to Wexford Harbour, between the north and south Dogger Buoys, and is about three miles in length by half a mile in width in from three and a half to seven fathoms of water. The bottom formation is similar to that of the Ballyvaldon Bed. Four boats were engaged in dredging for oysters on this bed during the past season (1903). The quantity of oysters taken was about 30,000. Twenty men were employed on the boats. The oysters were purchased by Mr Armstrong, Main-Street, Wexford, and are disposed of locally and in Dublin and Waterford, some being also sent by steamer to Bristol. The oysters as a rule are large-sized and plump well-flavoured fish. The fall of spat is said to be considerable.

In 1859 on September the 01st first day of the oyster season. Oysters fished off the Long Bank just east of Wexford Harbour. Good fishing achieved due to the bringing into law of not using a dredge from May 01 to 1st September off the Wexford Coast. 15000 to 30000 oysters caught that day which would equate to up to 2.55 tonnes of oysters which at today's price would be 12,500 euros.
Some 30 to 60 boats belonging to Wexford, Arklow, Cahore and Rosslare Strand generally fished the grounds. The market for the oysters was in the town, further inland and the Dublin and Cross Channel markets of Liverpool and Bristol.

Wexford Mussel bed (at the end of the 19th century).

(Browne Report) Mussels are dredged from the bed of the river Slaney in Wexford Harbour from a point opposite the Dock Yard at Wexford to near the Raven Point at the entrance to the Harbour.

About 20 persons were engaged in dredging operations from October till the end of April. The quantity taken during the season would amount to about 30 tons. They are shipped directly to Bristol and Liverpool (consigned to Beavis, fish dealer, Bristol and Balfour Liverpool). Mr Des Lett, Lett & Company Ltd. handed me a photocopy of a receipt for mussels sold by John Lett (Fish and Shellfish Dealer, Batt Street, Wexford) to E Beavis for the sum of Two pounds and 5 shillings on Feb 7th 1897, **Figure 1**. Indeed he mentioned that they have a receipt dating back to 1890.

The author could not find any records regarding mussel fishing using cots from 1900 to 1967, however it can be assumed that they were used prior to and after setting up of the mussel

Figure 1: Copy of receipt from 1897 showing sale of mussels from Mr John Lett to E. Beavis in England (courtesy of Mr Desmond Lett, Lett and Co.)

processing plant by Lett and Company Ltd. in 1967. There were apparently 15 berths for cots in the harbour around 1964. Each cot was worked by two men who either towed a 2 foot wide dredge or an alternative technique was to anchor and winch in a dredge from the front of the cot towards the anchor point. Presumably in shallow areas sprongs (rakes) were used also to lift mussels into the cots.

Wexford Cockle beds (at the end of the 19th century).

Cockles are collected on the strand at low water from the eastern side of the breakwater opposite Wexford to Raven Point and on the strand inside Rosslare point at the entrance to the Harbour. About 50 persons are engaged collecting them all year. Over 1,000 gallons are collected annually and disposed of in Wexford. Periwinkles are collected around the coast outside Wexford Harbour. About 9 tons were shipped annually to Bristol and Liverpool.

Holt in his Report to the Department of Agriculture and Technical Instructions for Ireland: **The Public Oyster Beds on the Coasts of Counties Wicklow and Wexford 1901** attempts to chart the history of the oyster beds. He states that: *I have not been able to learn at what period the fishery commenced to assume importance, and have no knowledge of the number and class of boats by which it was prosecuted in the first half of the nineteenth century. In or about the year 1806 there were complaints of exhaustion of the stock, which may probably have referred only to the beds in the immediate*

neighbourhood of the ports. It was evident that there was a considerable industry, even in the late 1830's of which Arklow was the headquarters. Wexford men seem also to have occupied in dredging to a considerable extent.

The Arklow men relayed a considerable proportion of their catch to Beaumaris (Wales) where the oysters were relayed to fatten for the English market. Others were probably relayed in Sutton and Clontarf for the Dublin market. In the 1840' English buyers arrived in Arklow to carry off stock to replenish the Kent and Essex beds. At that time the Dutch and French beds were in bad condition. The habit of relaying at Beaumaris was abandoned when English buyers appeared at Arklow in 1843.

In 1856 marked the inception of oyster culture which resulted in the complete rehabilitation of the French and Dutch Oyster Trades.

In 1862 there were reports of a general scarcity of large deep-water oysters and it seems that French buyers in Arklow working on behalf of their government who were spending considerable money on restocking their public beds and providing broodstock for oyster culture experiments from which resulted the seed industries of Arcachon and Auray.

In 1863 the first actual figures from the beds appeared although at the time the Jersey boats were not landing all of their catch. In fact the Jersey boats were said to have fished day and night weekdays and Sunday, their boats were larger and more efficiently equipped for dredging and were able to fish grounds not accessible by the Irish industry. Needless to say they were not popular with the local industry.

In the 1863 Deep Sea and Coast Fishery Commissioners (Ireland) Report, the fishery by the Arklow boats commenced on the 14th January and ended on the 24th of May. The total catch was 34038 barrels, of which 7988 were disposed of on the Irish coast-chiefly Dublin station; 2,860 on the Welsh coast; 2,600 to France; and the remainder, 20,590, to London and Kent. The total sum realised was £10,829 16s; about 6s. 4d. per barrel, the ordinary herring barrel, holding 6 to 7 hundred, and weighing 1 ¾ cwt. full.

It was probable that the take of 1863 was considerably exceeded in years before and the records show that the take declined in every succeeding season.

So it was in 1901 in response to a request to revive the great oyster beds off the east coast that Holt determined in his survey work that the beds were not only incalculably smaller than in their peak but that the rejuvenated and thriving French and Dutch oyster fisheries (rejuvenated from oysters taken from Ireland!) were now supplying not only their own countries but also England. So it was not feasible to regenerate the oyster industry.

Apart from the shellfish industry Wexford Harbour was an extremely busy Harbour for schooners and trawlers.

Deep Sea and Coast Fishery Commissioners (Ireland) report, 1863 appendix to the report on the state of the registry of fishing vessels on the coast of Ireland to 1st January 1864 states that for the Wexford district from Sluice River to Bannow there are 34 first class vessels employing 161 men and 1 boy and 212 2nd class vessels employing 946 men and 31 boys totalling 243 vessels, 1107 men and 32 boys. By 1864 there was an increase of 5 vessels, 24 men and 8 boys with the observations that Slight improvements in boats in the port of Wexford. Produce must less than the preceding year. Supply and quality of oysters good. No curing establishments. Fishermen orderly and peaceable. Registry perfect. Trawling practised without contention.

History of the Mussels and the Dredger Fleet in Wexford Harbour.

As mentioned previously the mussel industry was well established in the Harbour in the 19th century and continued through the 20th century presumably using cots.

1845 - Act Passed that allowed the Commission of Fisheries could grant licences for oysters.
There may have been a pre-1870 oyster licence.
1884 - mussels were added to the act
The extended Lett family continued to fish the harbour for mussels through the 20th century and traded in fresh mussels.
1959 - Fisheries Act
1964 - Lett & Company Ltd started experimenting with cooked mussel meats and jarring them.
1965 - Lett and Company Ltd set about securing a factory. At this point the Slaney Mineral plant and a shed alongside it were being used to process some mussels.
In 1967 Lett and Company Ltd mussel processing plant opened in Batt St Wexford Town. At this time there were berths for 15 cots. Mussels were cooked and meats jarred.
1967-8 - 6 mussel boats commissioned with inboard engines. 24.5 feet long: St Quentin, Mallard, The Claire, Mussolini, St. Catherine and one other.
1967, 1969 and 1970 BIM, Dept. of Marine and Lett and Company Ltd. explored the best relay areas.
1968-69 - Lett and Company Ltd. started to blast freeze some mussels on trolleys and then packed into bags.
1968-1974 - Scallans working grounds with cots and small wooden hull boats.
1970's Processing of mussels also took place at Kilmore Quay for a few years. But the vast majority of processing occurred in the Lett and Company Ltd. factory.
1970 The Countess built in Cork and brought in by Ryans.
1972 - mussels from East Coast relayed into Harbour in bags.
1973 - 'Lena Jozina' the first dredger in Ireland was brought in by Letts.
1974 - first transplant of seed from East Coast to Wexford Harbour by 'Lena Jozina' (23 loads (40T each) 1200-1300T in total.
1975 - Wexford Mussel Fishermen's Association was formed. Noel Scallan was Chairman and Sean Ryan Secretary. Renamed to the Wexford Mussel Growers Association in 1990's but have reverted to the old name since.
1977 - 'Sea Maid' Ryans
1977 - 'Naomh Caith' Noel Scallan sold on in 1978 to Waterford
1978 - Lett and Company Ltd. brought in the 'Zeemiew'
1978 - Lett and Company Ltd. started to experiment with half-shell mussels.
1978 - 'Vertrouwen 1' brought in by Lett and Co.
1979 - 'Vier Gebroeders' brought in by Ryans
1979 - 'Geertruide brought' in by Lett and Co.
1979 - Test on growing of pacific and native oysters
1979 - Sea Maid to Billy Gaynor
1979 - 'Lena Jozina' sold to Noel Scallan sold to Waterford in 1993
1980 - Fisheries Act.
1982 - 'Vertrouwen II' brought in by Lett and Company Ltd.
1984 - 'The Rapid'- Billy Gaynor
1985-1990 - The height of the processing factory run by Lett and Company Ltd. 370 people employed mainly full-time in the factory
1986 - 'Enterprise I' brought in by Lett and Co.

1987 - 'Ostrea' brought in
1989 - 'Ostrea' sold to Billy Gaynor
1989 - 'Cornelia' brought in by Ryans
1994 - 'Vertrouwen II' sold to Noel and Albert Scallan.
1992 - 'Vier Gebroeders' sold to Noel and Paddy Cullen
1992-3 - 'Cornelia' sold to John Foley (left the harbour)
1993 - 'Jana Maria' brought in by Ryans
1993 - 'Lena Jozina' sold to Waterford mussel co-op
1996 - 'Olive Rachel' Flor Sweeney brought in from Holland
1996 - 'Crescent Warrior' brought in by Crescent Seafoods Ltd.
1997 - 'Janny' bought by Billy Gaynor off John Lett.
1998 - 'Laura Anne' brought into Wexford by Alex Mc Carthy for use by John Lett
1998 - 'Noordster' brought in by Flor Sweeney from Holland
2000 - 'Ebenezer' brought in by Crescent Seafoods Ltd.
2005 - 'Branding' brought in by Crescent Seafoods Ltd.
2005 - 'Edenavle' bought by the Ryans. New boat with stern dredges
2005 - 'Hibernia' bought by Riverbank mussels.
2005 - 'Laura Anne' purchased by Scallans and still in operation
2007 - 'Cecilia' brought in by Loch Garman Harbour Mussels Ltd.
2011-2012 - 'Vertrouwen II' sold on by Scallans.

Current Functioning Mussel Dredging Fleet

Due to Certificate of Compliance Regulations either new boats were purchased with assisted grants from the State or substantial investments were made to upgrade existing boats to the required standards. The six functioning boats in the Harbour are the Edenvale, Hibernia, Enterprise, Laura-Anne, Cecelia and, Branding. Total dredge width per boat ranges from 7m to 14m with an average of 9.03m. The drafts range from 0.75m unladen to 2m laden with an average unladen draft of 1.04m and an average laden draft of 1.58m. All but one dredger has 4 dredges operating from the sides of the boats. There has been movement out of the harbour in recent times of some of the older boats. During seed fishing periods sometimes dredgers from outside Wexford are paid to help fish and relay seed, but harvesting is only by the boats listed above. The boats tie up at the town side quay and unload over at the Ferrybank quay which has undergone significant redevelopment. On the Ferrybank Quay there are lock ups for equipment and electricity.

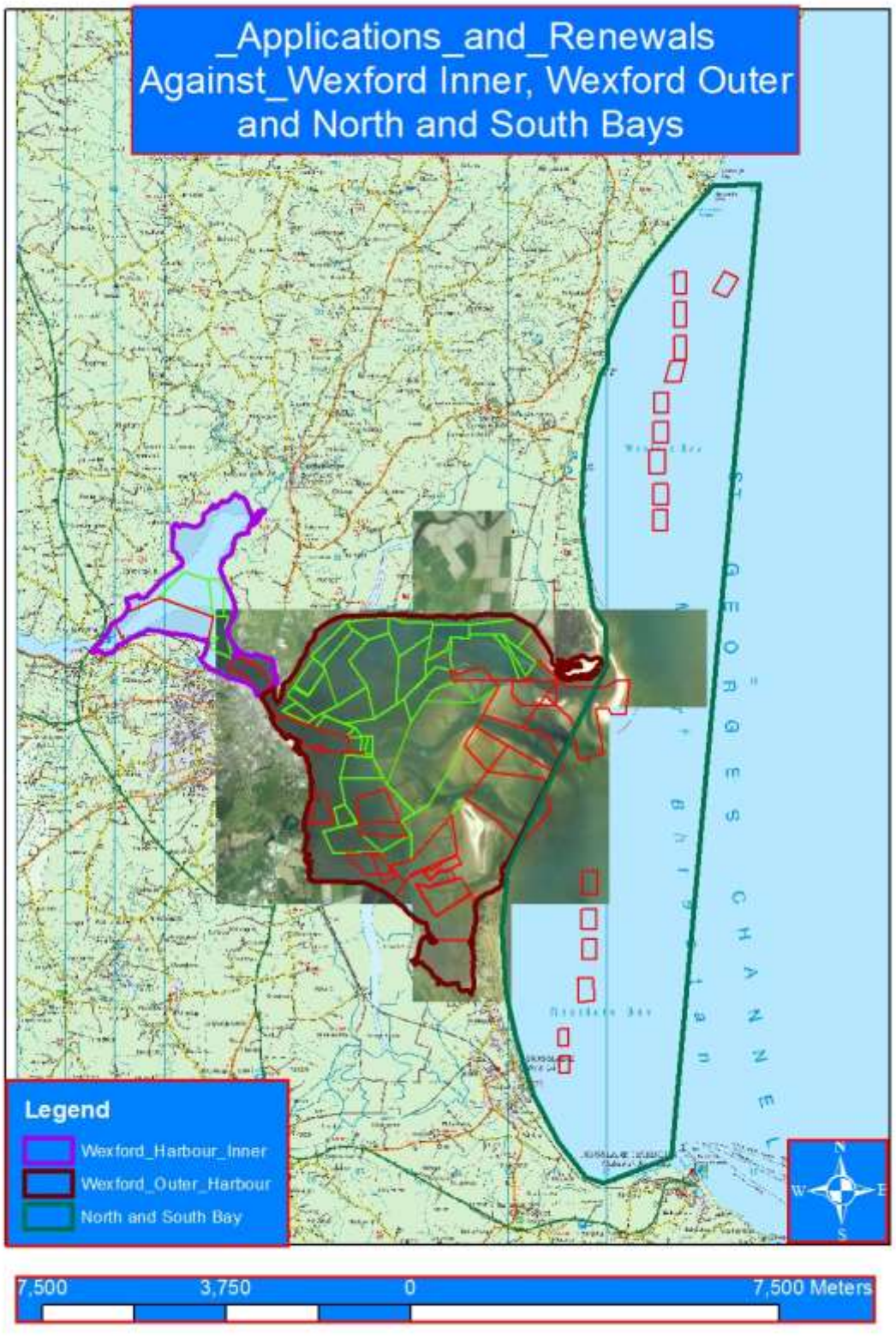
History of Licences.

In 1981 Letts attempted to apply for a licence for mussel farming. It led to a hearing and witnesses were called to give evidence. At this point the fishery was public but as it had never been designated under the 1980 Fisheries Act, but was in the 1959 Act. Designation under the 1980 act would have facilitated the licensing of ground to individual producers/companies or at least stood a better chance against being overturned. That attempt faded away and in June 1991 an application for a fish culture licence on parts of Wexford Harbour for farming mussels was made by Sean Ryan. Significant time was spent by the aforementioned dealing with the legal obstacles to licensing and assistance was given by the Irish Farmers Association and private solicitors. Various routes such as forming a Co-op were

discussed that might strengthen the application(s). Years passed with still no licences and in 1995 the Department of Marine were in the process of redrafting the legislation relating to aquaculture and a test case was coming up from the West of Ireland which would shed light on the actual definitions in legal terms of a public fishery. In August 1995 applications on behalf of all the major mussel producers with the exception of Letts were submitted by the Wexford Mussel Growers Association (WMGA). The concern with lack of licences was that stock in the harbour brought in by the WMGA or bona fide mussel fishermen could be fished by anybody and that this might lead to confrontations where somebody might get hurt. Again due to legal difficulties the 1959 and 1980 Fisheries Acts it was felt by the Department that licences (including foreshore licences) could be overturned. By May 1997 the Fisheries (Amendment) Bill had passed all stages of the Dail which would provide a facility to licence aquaculture developments on a site by site basis and designation would no longer be required. Applications from 9 different companies were on the record as of November 1998 and issues began to appear in the form of overlapping applications, a new outfall pipe for the new town sewerage scheme and a lack of berthing space on the new town quay which was being built. The new legislation arrived in 1998 which finally provided comprehensive measures for the processing of aquaculture licences. However mapping issues had to be addressed and in 1999 a Departmental Engineer mapped out the application sites accurately using GPS technology. When the applications were finally advertised publically there were objections which had to be addressed by the Department and industry. After considerable effort from the producers, BIM and the Department of Marine in addressing these objections licences were issued in 2002 although there were contested overlaps which never got licenced along with some licences applications that had strong objections against them and thus didn't proceed. The licences were issued for a 10 year period.

Current Status of Renewals and Applications within Wexford Harbour and North and South Bays.

Map: 2 shows the status of renewals and applications. There are **30 Renewal Applications covering 1473.03 Ha and 37 Applications covering 1263.86 Ha.** However as in 2002 overlaps in applications have occurred and the area of ground covered by an application only once is 1270.6 Ha. A detailed area analyses is shown in **Table 1.** Renewals are only dealing with bottom mussel culture whereas applications are dealing with bottom mussel culture (dredger, barge boat and cot), intertidal Pacific Oyster Culture and Mussel Seed Settlement on Ropes suspended in the water column **Map 3.**



Map 2: Renewals and Applications within Wexford Harbour Inner and Outer and North and South Bay.

Map 3: Renewals (Green Outline) and Applications (Red Outline) for bottom grown mussels (hollow), rope seed mussel (blue fill) and Intertidal Pacific Oyster farming (turquoise fill).

Table 1: Area Analyses of Renewals and Applications

	Area (Ha)	% of Wexford Harbour	% of Inner Harbour	% of Outer Harbour	% of North South Bay
Area of Wexford Harbour (Ha)	3545.65	100	-	-	-
Area of Wexford Inner Harbour (Ha)	517.23	14.59	100	-	-
Area of Wexford Outer Harbour (Ha)	3028.42	85.41	-	-	-
Area of Renewal Applications (Ha)	1473.03	41.54	-	-	-
Area of Renewal Applications in Inner Harbour (Ha)	100.84	-	19.50	-	-
Area of Renewal Applications in Outer Harbour (Ha)	1372.19	-	-	45.31	-
Area of Renewal Applications in North and South Bay (Ha)	0	-	-	-	0
Area of Applications (Ha)	1387.49	-	-	-	-
Area of Applications (Ha) adjusted for overlaps	1270.6	-	-	-	-
Area of Applications In Wexford Harbour (Inner and Outer)	980.82	27.66	-	-	-
Area of Applications In Wexford Harbour Inner (Ha)	131.22	-	25.37	-	-
Area of Applications In Wexford Harbour Outer (Ha)	849.6	-	-	28.054	-
Area of Applications in North and South Bay (Ha)	289.78	-	-	-	4.99
Area of Renewals Intertidal (Ha)*	228.2	6.44	-	-	0
Area of Applications Intertidal (Ha)*	315.1	8.89	-	-	0
Area of Applications for mussel seed collection (Ha)	196.14	0	0	0	3.38
Area of Applications for Oyster Farming (Ha)	33.6	0.95	0	1.11	0
Area of Applications for Very shallow boat dredging and spronging of Mussels (Ha)	226.52	6.39	0	7.48	0

*More time needs to be spent on this calculation. If anything this is an overestimate

Renewals and Applications in Relation to Protected Areas

The relevant protected areas in Wexford Harbour and adjacent coastal areas are:
The Raven SPA (004019)
Wexford Harbour and Slobs (WHS) SPA (004076)
Slaney River Valley (SRV) SAC (000781)
Raven Point Nature Reserve (RPNR) SAC (000710)
Longbank SAC

The Blackwater Bank SAC has been omitted due to the distance from the applications and renewals. The Longbank SAC has been assessed on a separate appropriate assessment for seed fishing. **Map 4** shows the location of all protected areas in relation to the applications and renewals. The mussel seed collecting applications in the South Bay are not within any protected area. The North Bay ones are within the Raven SPA. The Slaney River Valley SAC and the Wexford Harbour and Slobs SPA overlap. The renewal applications are all within the former but not all within the latter. A detailed analysis of areas of renewals and applications within each protected area is presented in **Table 2.**

Table 2: Area analyses of renewals and applications within protected areas.

	Area (Ha)	Area of Renewals in Protected area (Ha)	% of Protected Area as Renewal	Area of Applications in Protected Area (Ha)	% of Protected area as Application
Raven SPA (004019)	2610.62	7	0.27	298.14	11.42
Wexford Harbour and Slobs SPA (004076)	4751.05	1315.52	27.69	728.62	15.34
Slaney River Valley SAC (000781)	5383.76	1443.77	26.82	975.9	18.13
Raven Point Nature Reserve SAC (000710)	594.52	31.65	5.32	30.18	5.08
Longbank SAC (2161)	3372.38	0	0	0	0

Map 4: Renewals and Applications against Protected Areas

Physical

The River Slaney is the main river flowing into Wexford Harbour. There are two smaller rivers, the Sow and the Assaly, which flow in at the north of the inner Harbour near Castlebridge and at the south of Wexford town respectively. The River Slaney has a catchment area of 1860km2 and includes parts of Counties Wexford Wicklow and Carlow. The River Slaney is tidal from Enniscorthy downstream. The estuary extends over a distance of 26km from Enniscorthy to Wexford town. The estuary widens where the River Sow meets the Slaney just downstream of Ferrycarraig but narrows again between Carcur and Wexford Town. Below Wexford town training walls extend out from the shore confining the main flow. However the training walls are covered by water on certain high tides. The transition from Estuarine waters to Coastal Waters occurs just below Wexford Town and the estuary widens into the broad shallow expanse of Wexford Harbour. See **Map 5.**

Wexford harbour is approximately 35.46 Km2 from Ferrycarraig bridge to a line drawn between the Raven Point to Rosslare Point. Wexford has about 4% littoral area and is dominated by shallow (<2m), coarser grained sand, gravel and shell sediments. The low % of littoral zone can be accounted for by the reclamation of land from the sea in the mid-19th century which now form the north and south slobs. The slobs are drained into the harbour by pumped drainage channels. Mixing in the harbour is good so stratification only occurs slightly in some of the deeper sections.

- Estuary at high water is 3431Ha.
- Estuary length 9.48km.
- Tidal prism 49 million cubic meters.
- Volume 136 million cubic metres.
- Ratio of prism to volume 0.36.
- Freshwater catchment area 184000Ha.
- Annualised catchment rainfall (mm) 528.
- Annual freshwater inputs (cubic metres per second 31).

Hydrography.

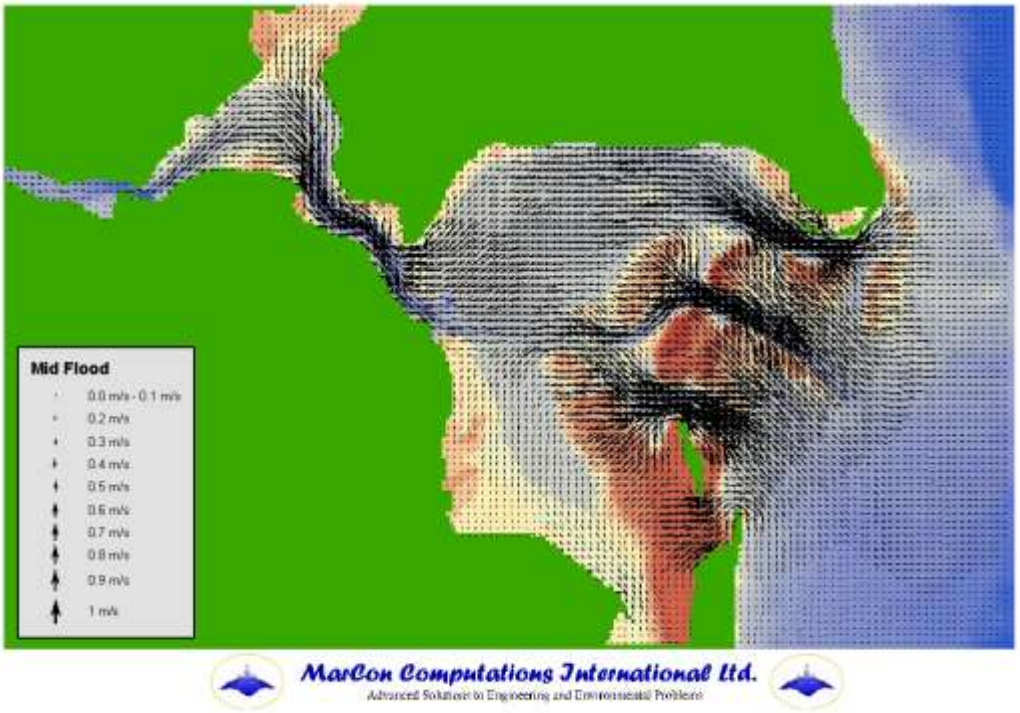
The average tidal excursion is 4.7km on neap tides and 7.1km on spring tides. Ebb tide duration exceeds that of flood by approximately 45-60mins and is typical of the prevailing situation throughout the harbour. The rise and fall of the tide in Wexford Harbour is small by comparison with many Irish coastal areas. The mean tidal range is 1.5m for Spring tides and 0.9m for neap tides.

Current Speeds throughout the harbour.

From the UISCE project the model for Wexford Harbour gave mid-flood predictions as graphically presented below **(Figures 2-5**). The UISCE project undertook a bathymetric survey of the harbour and calibrated the model with prolonged current readings from numerous sites throughout the inner and outer harbours.

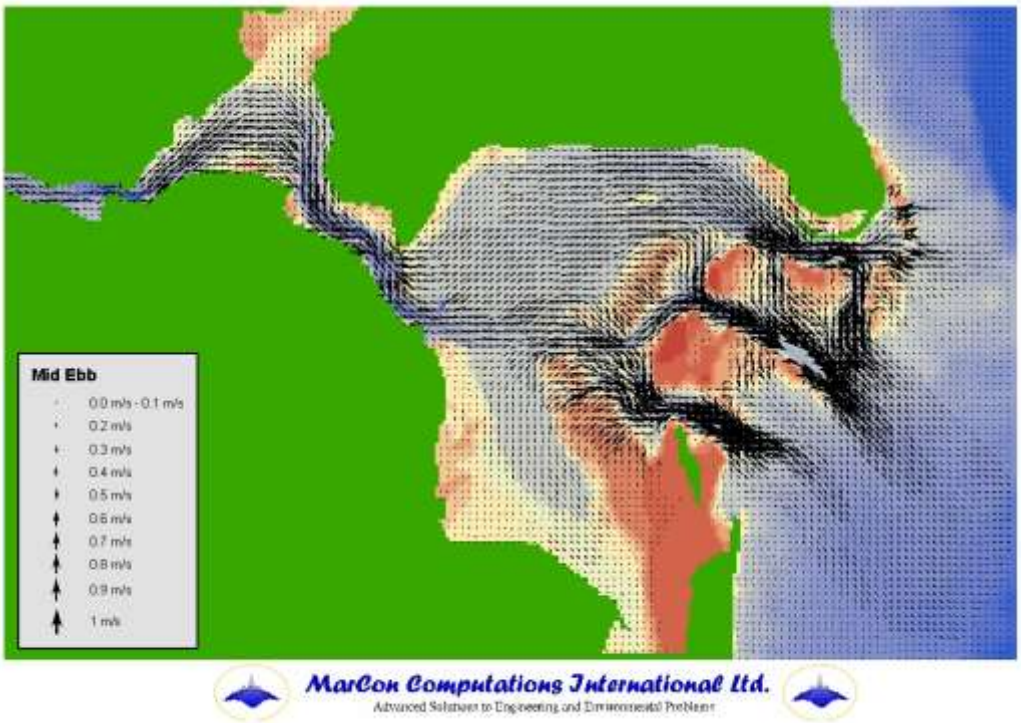
Map 5: Renewals and Applications in Relation to Water Framework Classified Waterbodies.

Figure 2: Mid-flood



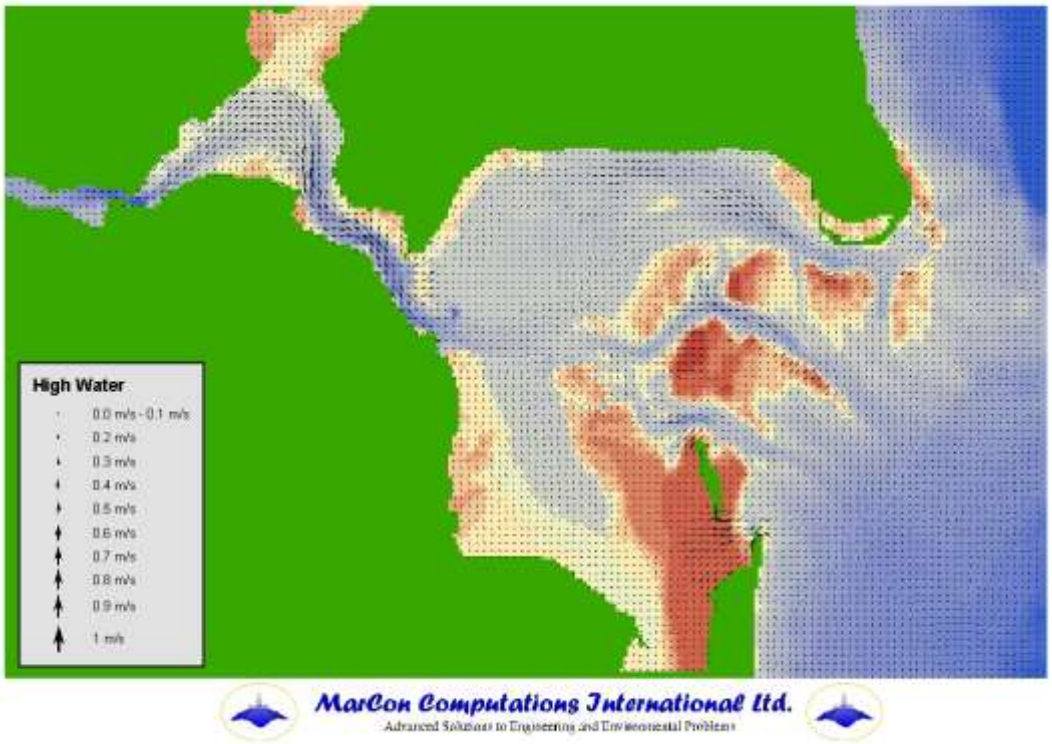
Southern harbour slackest.

Figure 3: Mid Ebb.



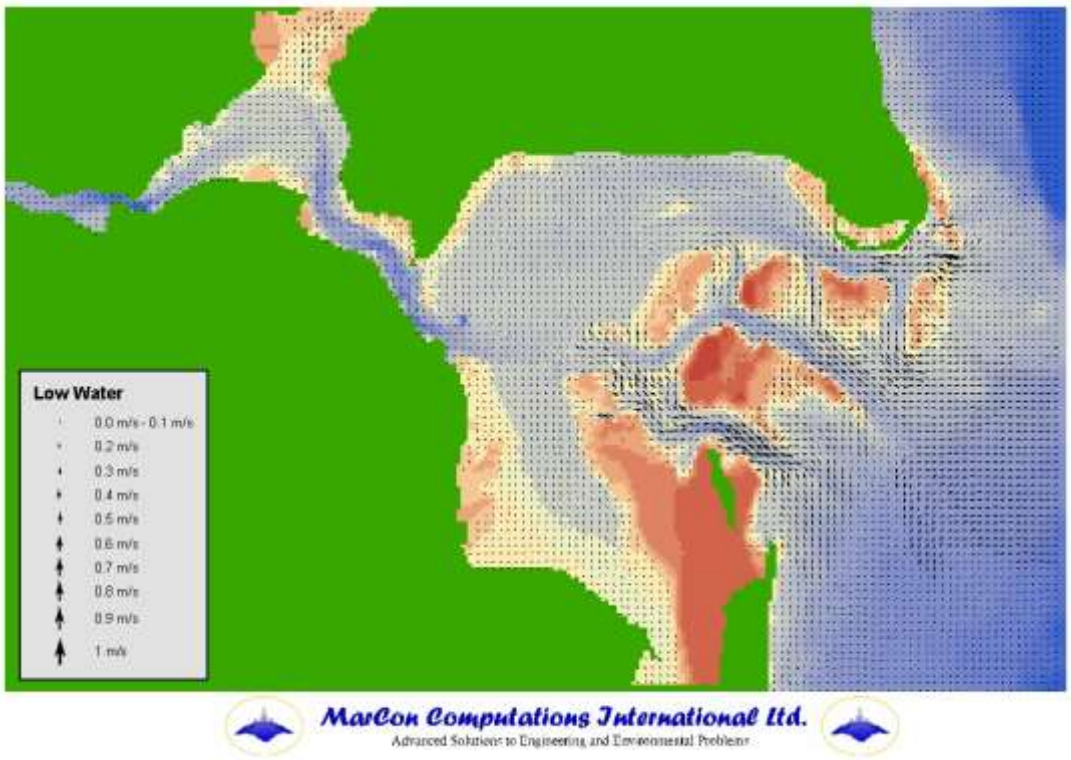
Note that at mid-ebb more intertidal area is revealed than at mid-flood.

Figure 4: High Water.



High-water current speeds are very slack throughout most of the harbour.

Figure 5: Low Water



Low-water current speeds as predicted by the UISCE model. Large areas of the southern harbour and middle outer harbour are revealed.

Bathymetry

Bathymetry is one of the great mysteries of Wexford Harbour. Sandbanks and channels are always dynamic in the harbour and combined with the shallow nature of the harbour means that navigation can be difficult and surveying for bathymetry next to impossible.

The differences between the Ordinance Survey 1:50000 (**Map 6**), the NPWS Slaney river valley SAC intertidal map, the Admiralty Chart (**Map 7**), OSI 2005 orthophotography (**Map 8)**, the GSI Bathymetric Satellite Data (2010) **(Map 9**) the UISCE Bathymetric Data of 2008 (**Figure 7**) and Google Earth Satellite Image (08_09_2012) (**Figure 8**) the Wexford Harbour Masters Chartlet (16th April 2014) (**Figure 9**,) are substantial and significant. This is due to surveying at different times with different equipment and also the very dynamic nature of banks and channels in Wexford Harbour. Channel marking buoys have to be updated regularly. However there are two groupings with the admiralty chart not in either of these groups.

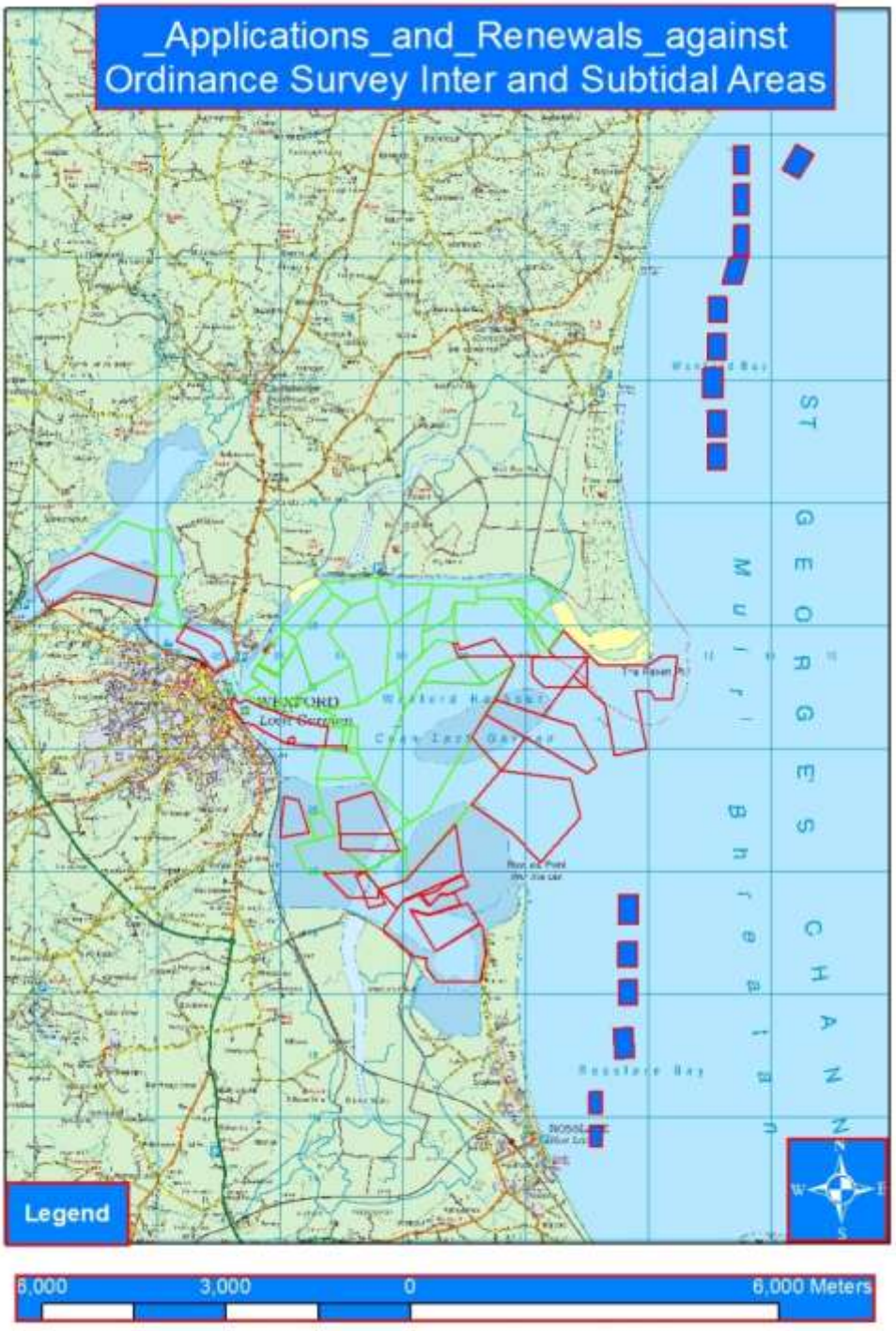
In general the NPWS intertidal interpretation is more aligned to the 1:50000 OS Background and both are incorrect. Apart from the admiralty chart the other sources of bathymetry are closely aligned. Two examples of the differences between the NPWS bathymetry and the other group are firstly they indicate a large intertidal bank in the middle of the bay covering about 35% of application T03/71A. This is clearly not the case as a subtidal channel runs right through the application unbroken from start to finish and is actually the main channel in and out of the harbour and is marked by buoys.

The second main example is the difference between the NPWS's interpretation of the coal channel (in the southern section of the harbour) in that they have it running Northeast to Southwest which would put substantial areas of mussel beds in the intertidal category. This is the same interpretation as the Ordinance Survey 1in 50000 background whereas in the Harbour Masters Chartlet , GSI Bathymetric Satellite Data, the UISCE bathymetric chart, 2005 Orthophotography and google earth would have the coal channel running NW to SE and therefore the same mussel beds would be largely subtidal. Over the years is has been stated by the industry that the channel into the southern section of the harbour has been gradually getting stronger (deeper). The Harbour Masters Chartlet, the GSI Bathymetric Satellite Data and even the 2005 Orthophotography would indicate that a small continuous channel now exists from Rosslare Point into the southern harbour which might improve flow in the area. One bottom mussel producer went as far as to say that the Ordinance Survey Discovery series interpretation of the bathymetry of Wexford and that of the Admiralty chart can be regarded as ridiculous and totally unacceptable. Therefore the NPWS bathymetric interpretation is likewise unacceptably wrong. These can be seen in Maps 6, 7 and 10.

Map 10 shows the difference between the OS and Admiralty intertidal Zones.

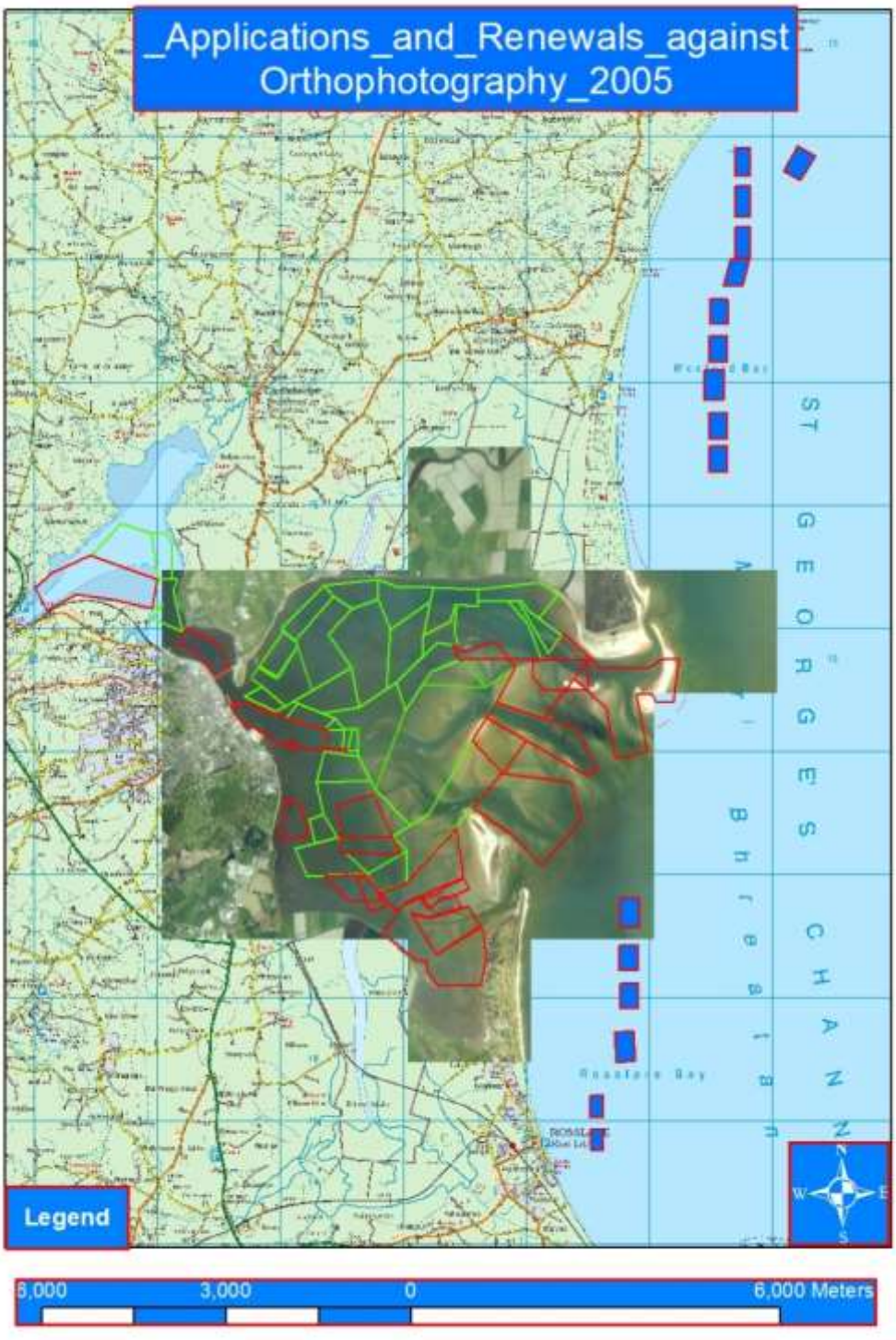
So the extent of the harbour that is intertidal is quite difficult to calculate.

Due to the shallowness of the harbour, dilution and transparency values are low. Intermixing of waters from the southern part of the harbour with the main channel is a relatively slow process also.



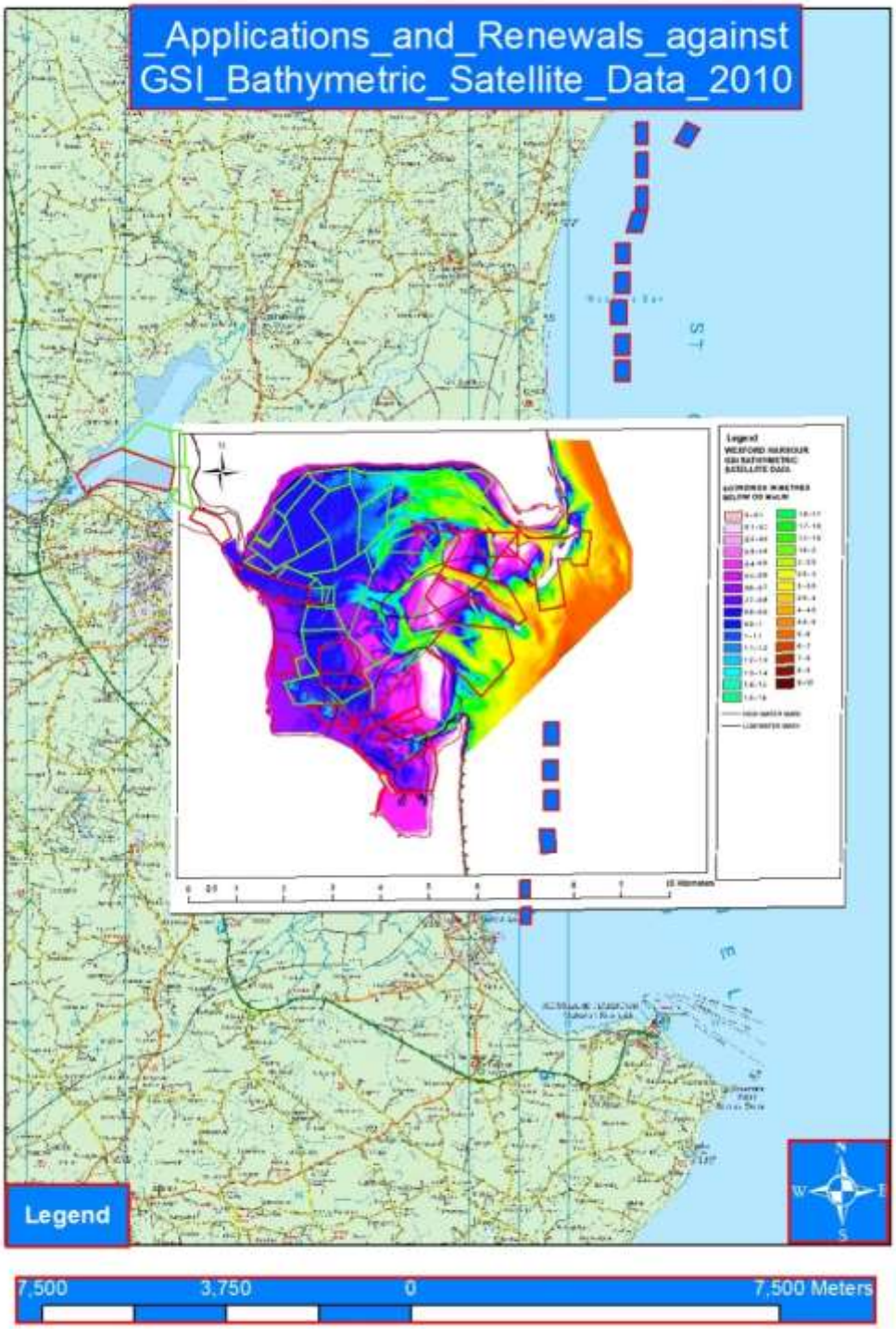
Map 6: Renewals and Applications in Relation to Ordinance Survey 1:50000 Background Map

Map 7: Renewals and Applications in Relation to Admiralty Chart for Harbour.



Map 8: Renewals and Applications in Relation to 2005 Orthophotography OSI

Map 9: *Satellite imagery derived bathymetric data for Wexford Harbour courtesy of Archie Donovan* Geological Survey of Ireland undertaken in 2012 in conjunction with Proteus, EOMAP and DigitalGlobe as published in *Developments and Benefits of Hydrographic Surveying Using Multispectral Imagery and georeference as best as possible by the author onto Arcview.*



By: Helen Needham, Technology Director, Proteus Robert Carroll, Representative, Proteus

The data generated by the GSI spectral Imagery Anlaysis should be viewed with the following levels of confidence as shown in **Figure 2.** (Red indicates a low degree of confidence, Green a high degree of confidence and yellow an intermediate degree of confidence.

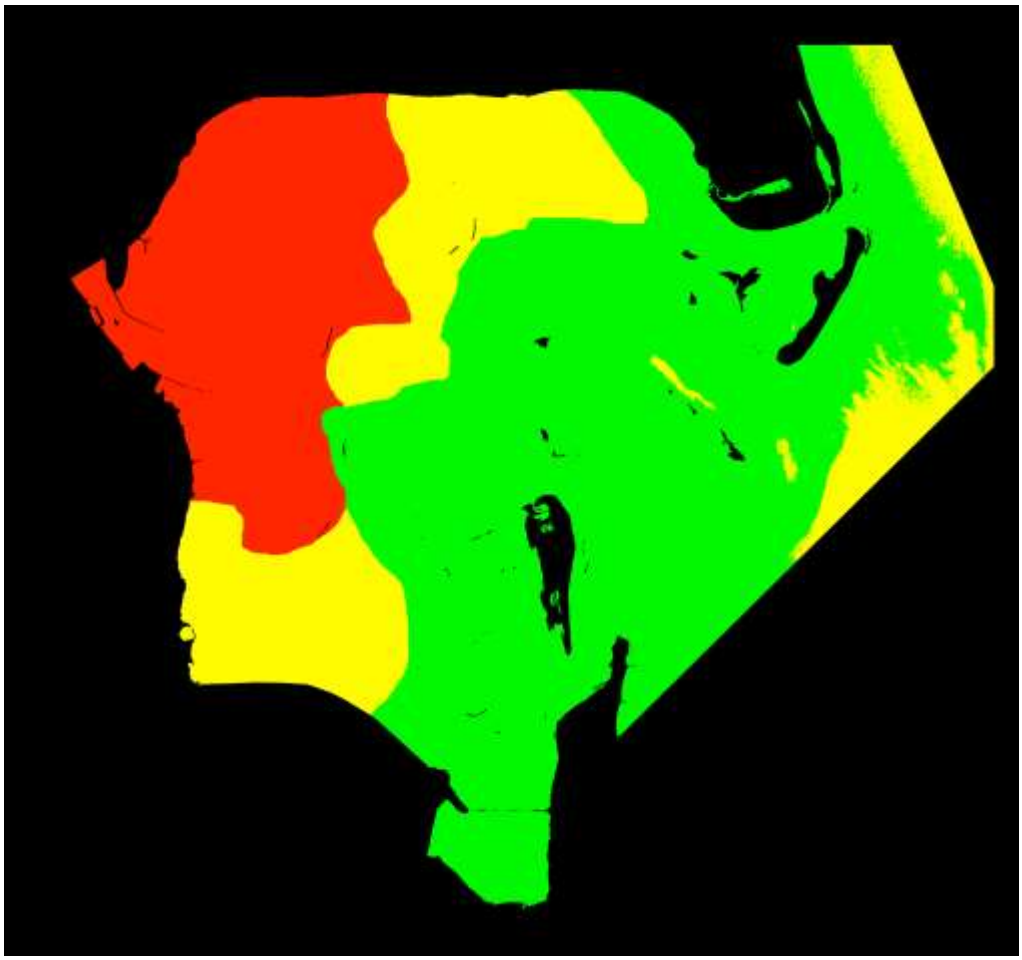


Figure 6: Data accuracy confidence map as from *Developments and Benefits of Hydrographic Surveying Using Multispectral Imagery By: Helen Needham, Technology Director, Proteus Robert Carroll, Representative, Proteus*

Figure 7: Wexford Bathymetry as Generated in 2008 by UISCE project.

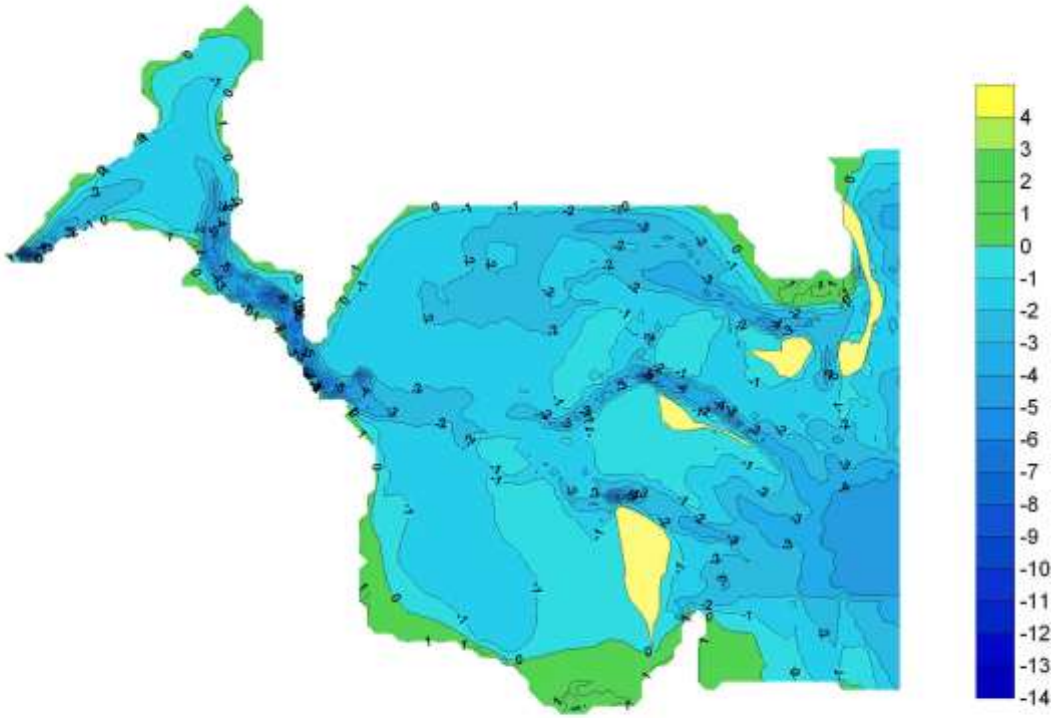
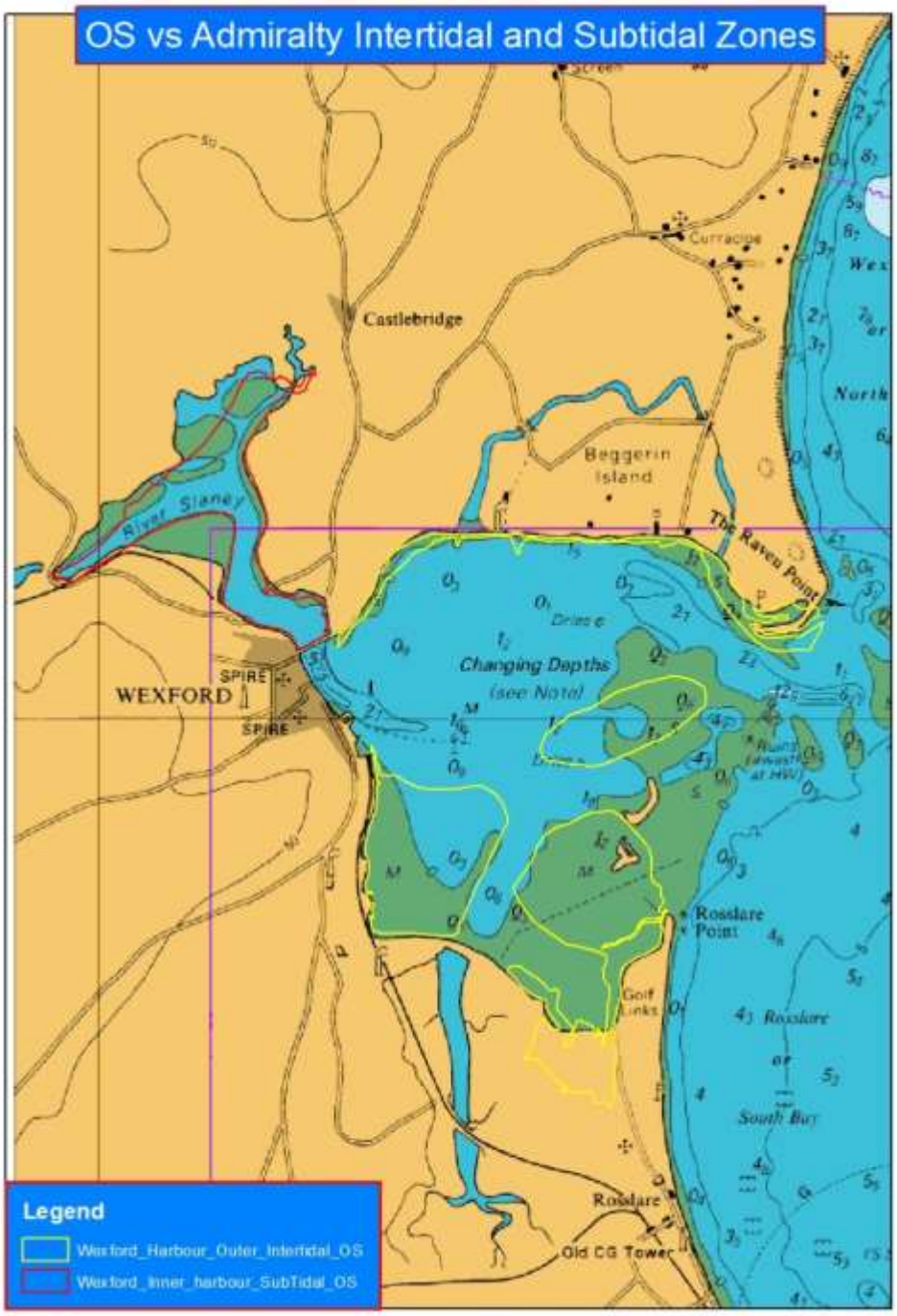


Figure 8: Google Earth Satellite Imagery taken on 08/09/2012

Figure 9: Wexford Harbour Chartlet as produced by Harbour Master on April 26th 2014.

Figure 10: Wexford Harbour Bathymetry by G.A. Frazer of 1845 and corrected by same in 1856 presumably after the embankments for the north and south slobs were built in 1847-1849 and 1853 - 1854 respectively. The Rosslare point ran up much closer to the Raven Point before it was washed away in the early 19th Century (?)



Map 10: Comparison of OS and Admiralty Intertidal and Subtidal Zones.

In-Farm Hydrography from UISCE Field Data

The UISCE model predicted current speeds throughout the harbour but actual data taken over prolonged periods at 5 sites located on farms was collected in 2007 and 2008 **Map 11**. RCM9 current meters reading for Current Speed, Direction, Salinity, Temperature and Pressure at 70cm off the seabed were deployed and sometimes were complimented by datasondes which were reading for salinity, temperature and chlorophyll a. There were two campaigns: 30/11/2007 to 17 January 2008 for Wexford Inner and Outer and then 14 March to 28 March at WXNMS2, WXMMS2 and WXFSS5 concurrently. Readings were taken every 20 minutes. Datasonde readings occurred about 15cm above the mussel beds. The March 08 data covered a neap spring cycle.

Map 11: Location of Current Meter (and Datasondes) during the Winter 2007/2008 and Spring 2008 Campaigns.

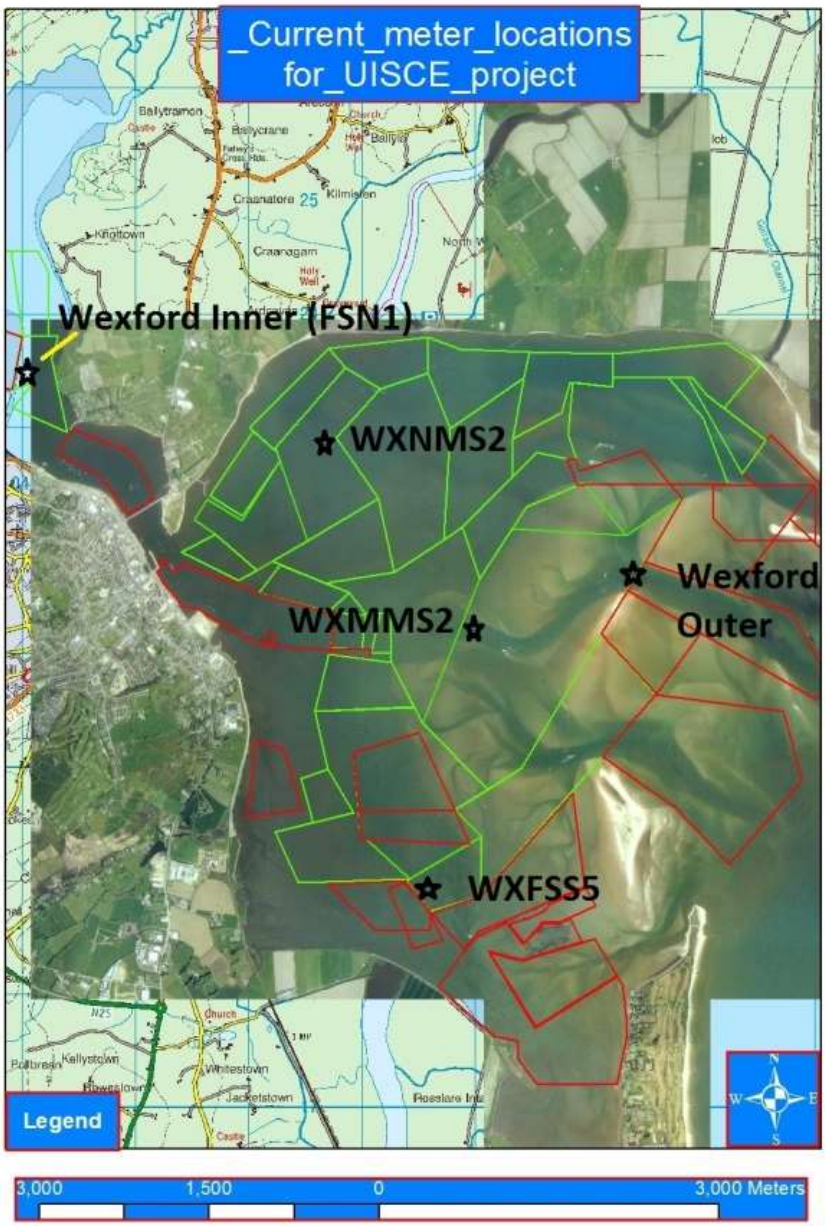


Figure 11: Wexford Outer All Data 30th Nov 07-17 Jan08

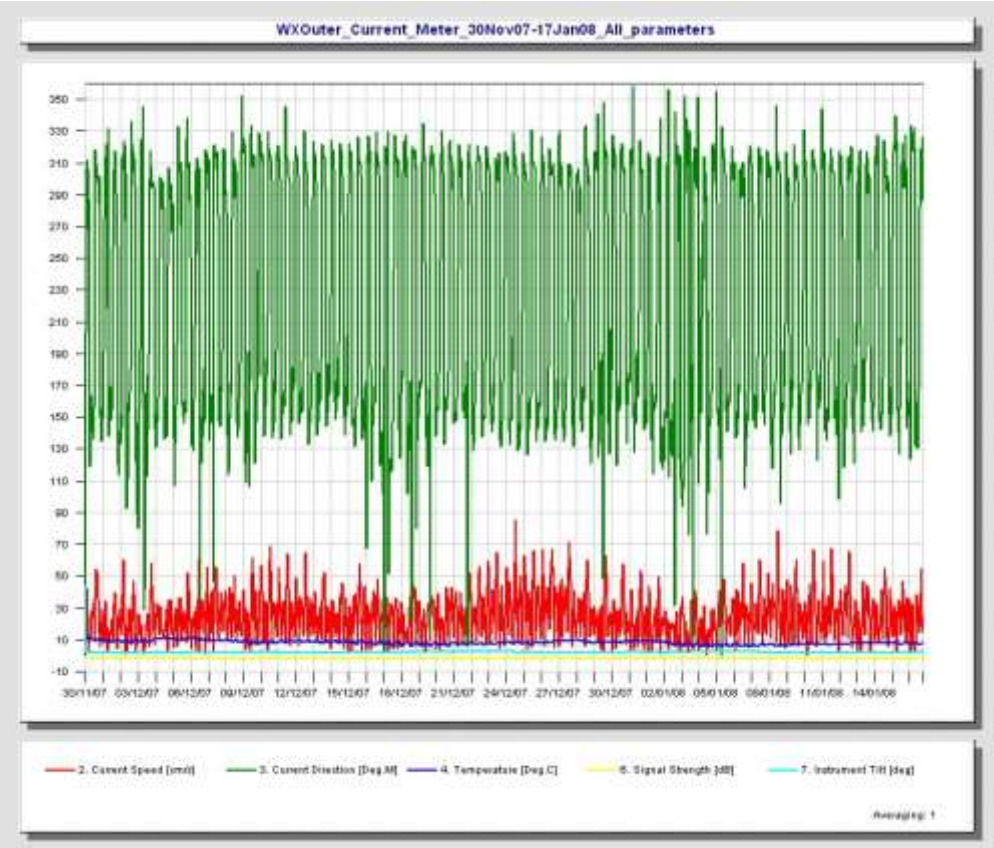


Table 4: Wexford Outer 30th Nov07-17 Jan08 Summary Stats for Current Speed and Salinity

Statistic	*WX Outer Current Speed (cm/s)*	*WX Outer Salinity (ppt)*
Mean	25.09	31.43
Standard Error	0.23	0.07
Median	23.76	32.38
Mode	25.22	34.32
Standard Deviation	13.62	3.25
Sample Variance	185.40	10.56
Kurtosis	0.39	2.50
Skewness	0.68	-1.43
Range	85.06	21.33
Minimum	0.00	13.90
Maximum	85.06	35.23
Sum	86337.31	68932.57
Count	3441	2193

Figure 12: Wexford Outer Current Scatter 30th Nov 07-17Jan08.

Flood is at about 325 degrees from North and Ebb about 140 degrees from North.

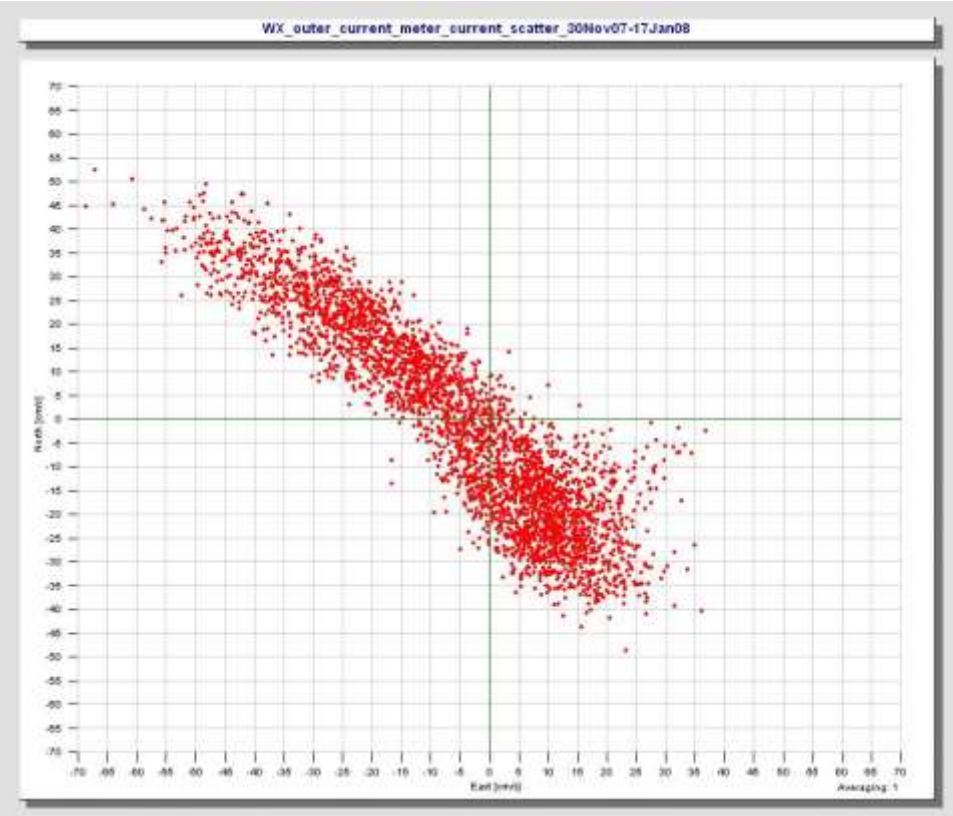
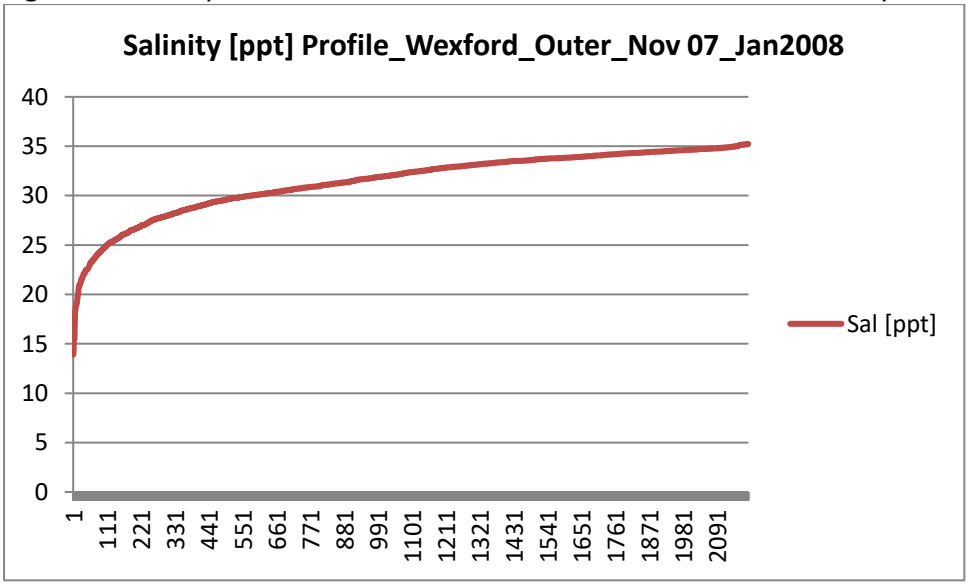


Figure 13: Salinity Profile Wexford Outer 30th November 07 to 17th January 08



Very few readings below 20ppt salinity. About two thirds of readings above 30ppt.

Figure 14: Wexford Inner (WXFSN1) 30th November 07-17th January 08

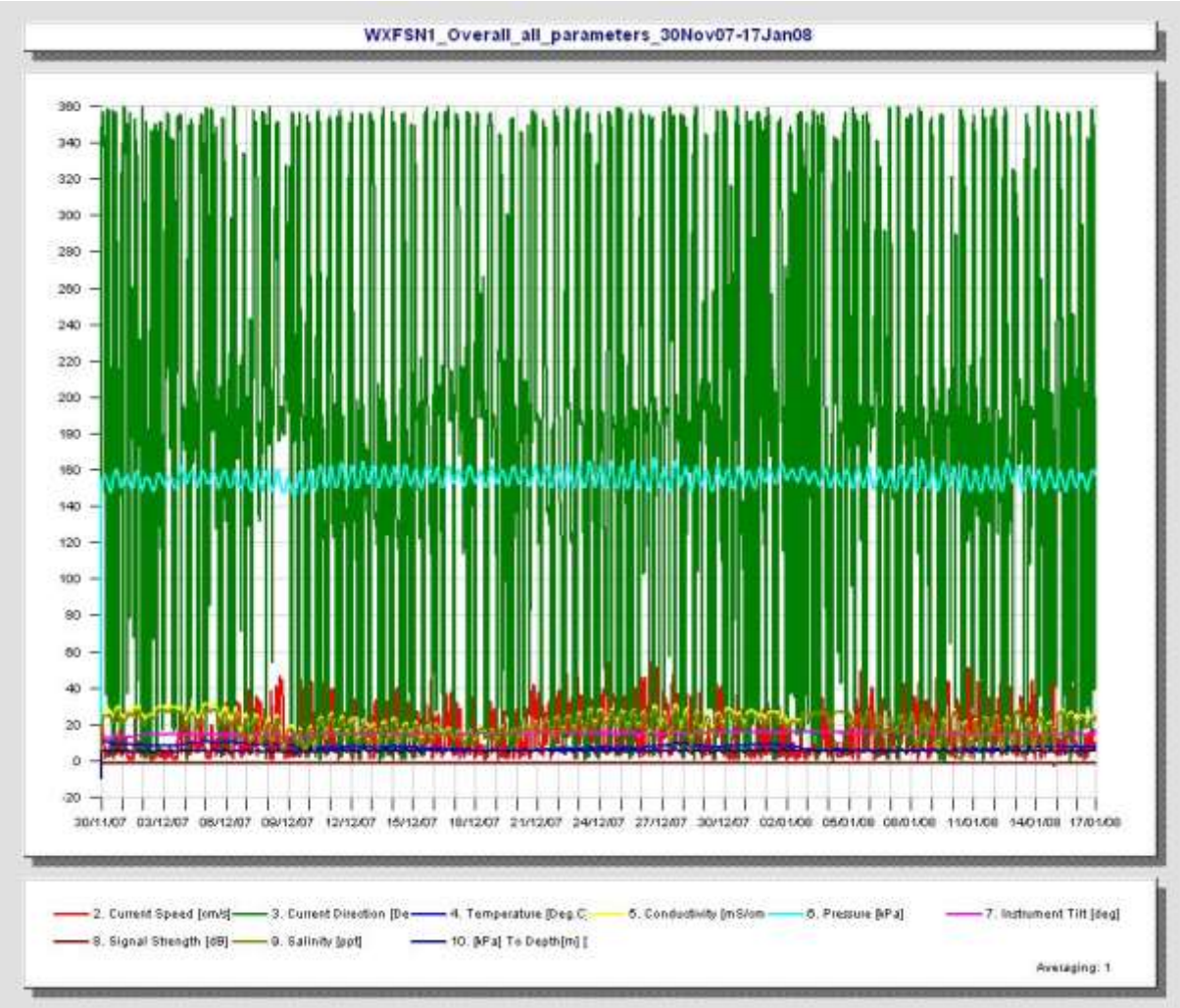
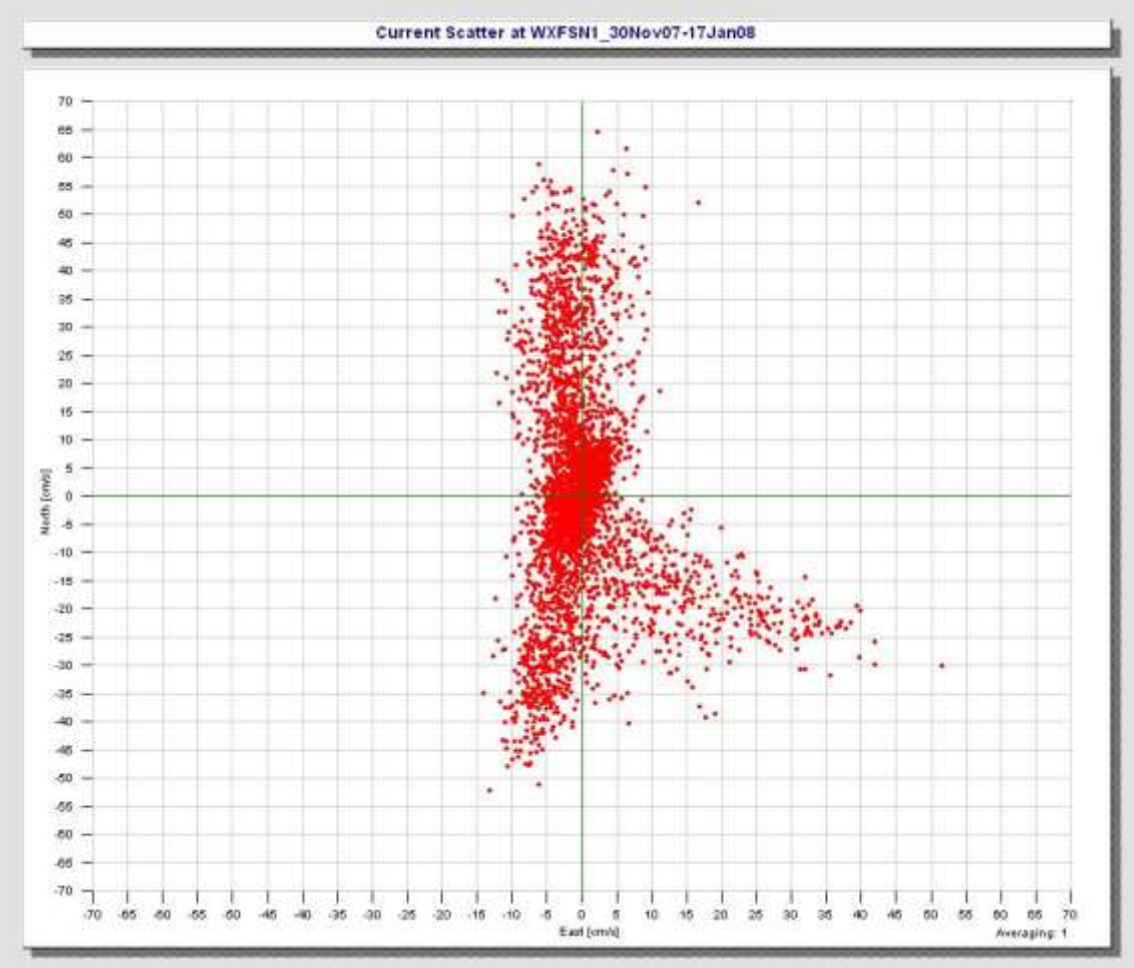


Table 5: Wexford Inner Summary Stats for Current Speed, Salinity and Depth 30th November 07-17th January 08. (note add 60cm to depth stats as sensor was 60cm above seabed)

Statistic	*Wex Inner Current speed (cm/s)*	*WeXInner_Salinity (ppt)*	*Wex Inner_Depth (m)*
Mean	16.43	19.13	5.38
Standard Error	0.23	0.10	0.01
Median	11.73	19.91	5.35
Mode	4.11	24.67	5.15
Standard Deviation	13.50	5.87	0.42
Sample Variance	182.15	34.46	0.17
Kurtosis	-0.43	-0.39	-0.87
Skewness	0.79	-0.53	0.09
Range	64.53	28.25	2.13
Minimum	0.00	0.67	4.38

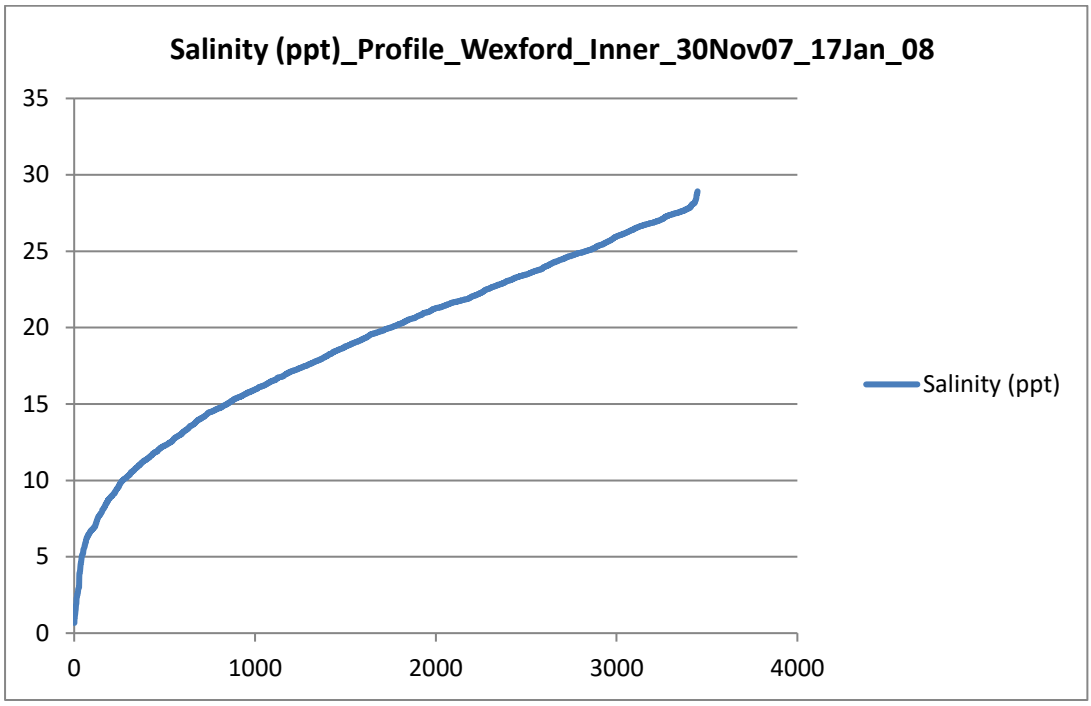
Maximum	64.53	28.92	6.51
Sum	56636.59	65943.06	18535.23
Count	3448	3448	3448

Figure 15: WX Inner Current Scatter 30th November 07- 17th January 08**.**



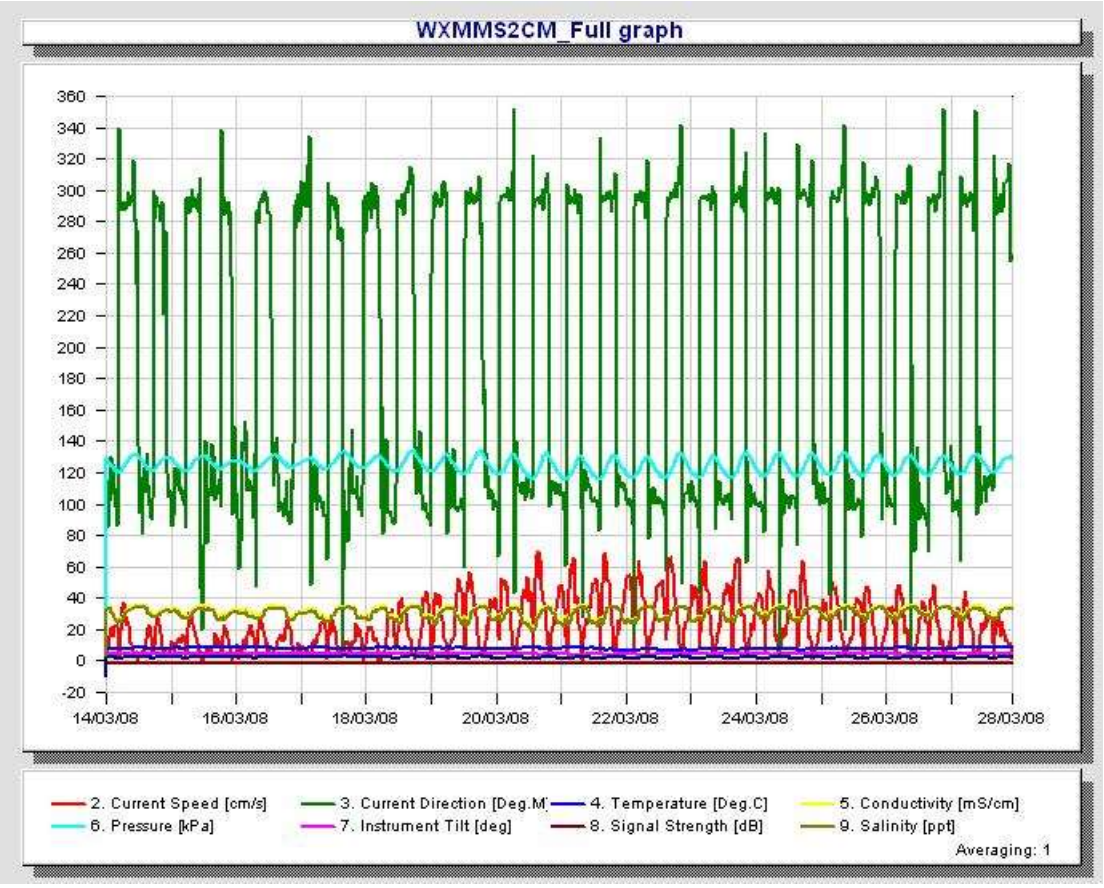
The flood is about 0 degrees from North and the ebb is about 190 degrees from North and is less well defined with changes in direction during the ebb probably to do with the bank at the point of park revealing at a certain stage in the ebb tide.

Figure 16: Salinity Profile for Wexford Inner (from 60cm above seabed).



On a strong spring ebb with wet weather the salinity readings can drop right down but only temporarily during the tidal cycle. However 1/5th of the readings are below 15ppt.

Figure 17:WXMMS2 Full Data Plot 14-28th March 08



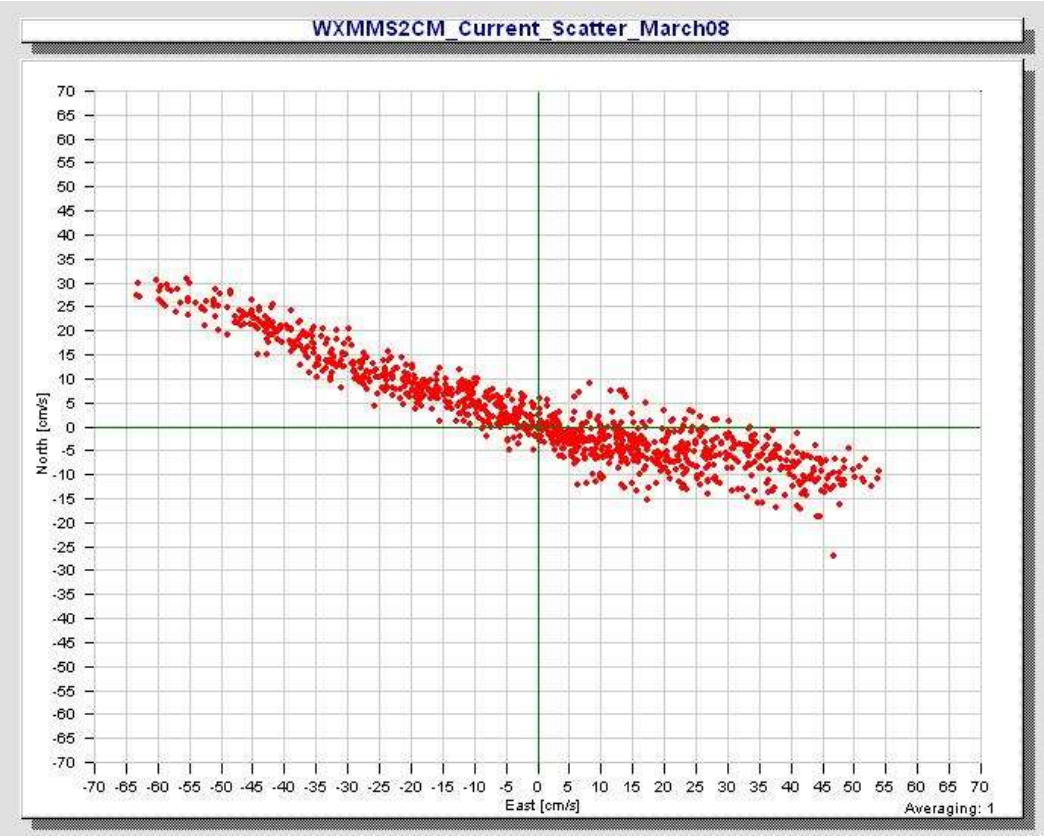
Very clearly defined flood and ebb directions (290 and 110 degrees from north). Spring tide current speeds considerably faster than neap.

Table 6: WXMMS2 Summary Stats for Current Speed, Salinity and Depth 14/03/08-28/03/08 (add 60cm to depth stats)

Statistic	*WXMMS2_Current Speed (cm/s)*	*WXMMS2_Salinity(ppt)*	*WXMMS2_Depth (m)*
Mean	23.81	28.24	2.34
Standard Error	0.50	0.15	0.01
Median	20.82	28.73	2.35
Mode	6.45	34.89	2.83
Standard Deviation	15.99	4.76	0.43
Sample Variance	255.61	22.62	0.18
Kurtosis	-0.54	-0.88	-1.04
Skewness	0.58	-0.38	-0.07
Range	69.52	18.26	1.74
Minimum	0.29	17.26	1.48
Maximum	69.81	35.52	3.22
Sum	23931.28	27958.37	2347.93
Count	1005	990	1005

Ave, Max and Min Depth (m) are 2.94, 3.82 and 2.08.

Figure 18: WXMMS2 Current Scatter 14-28th March 08.



Very clearly defined**.**

Figure 19: WXMMS2 Salinity Profile 14-28 March08

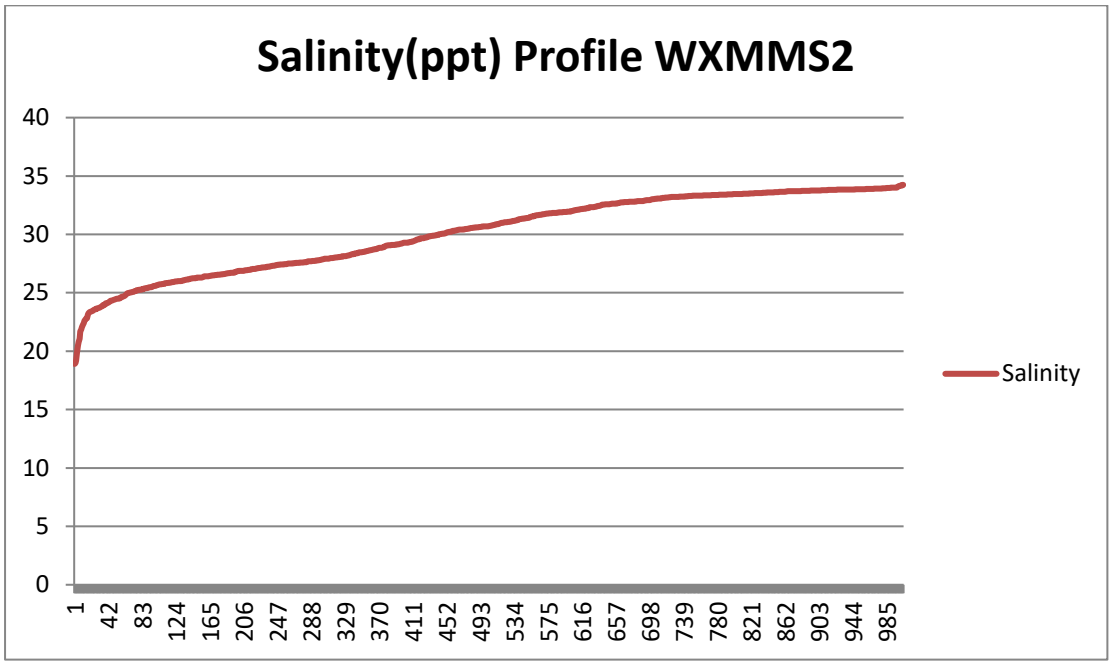


Figure 20: WXNMS2 Full dataplot 15/03/08-28/03/08
Flood about 250 and Ebb about 50 degrees from north but not tightly defined.

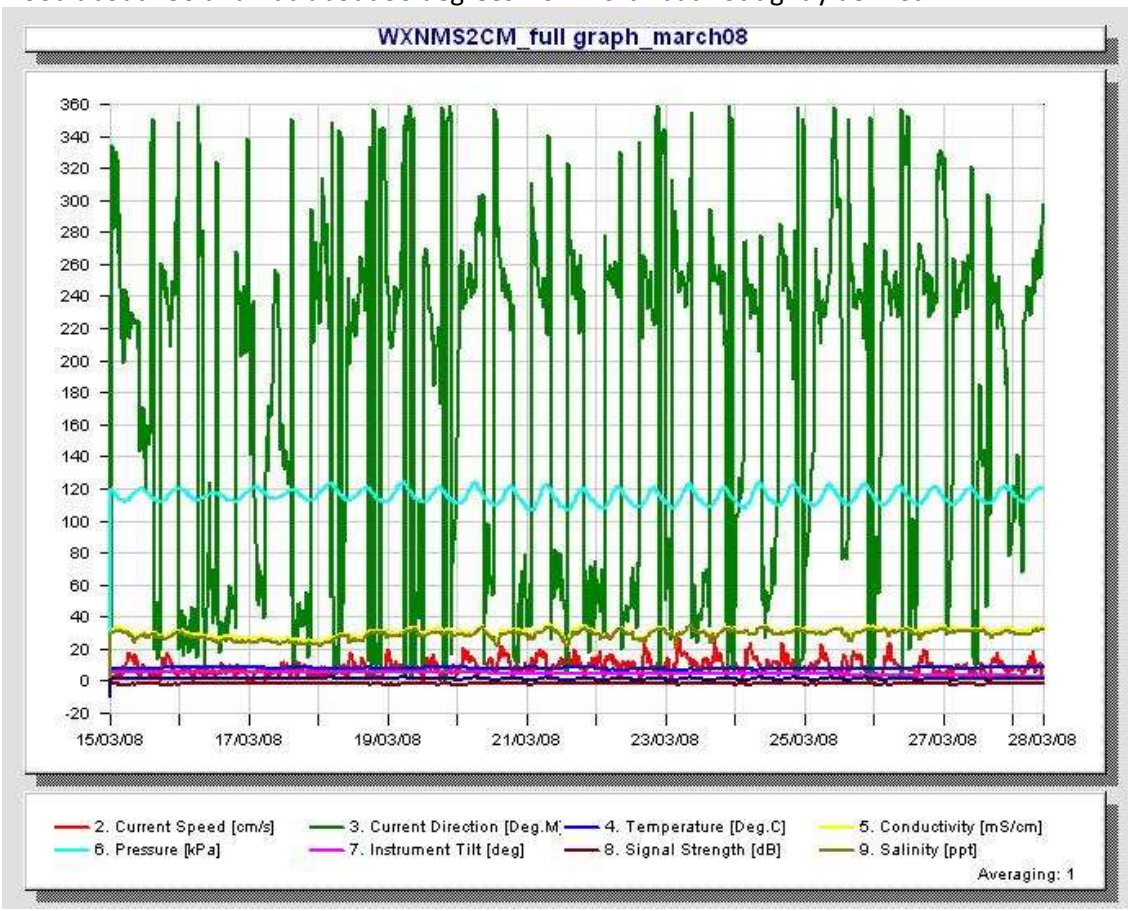


Table 7: WXNMS2 Summary Stats for Current Speed, Depth and Salinity 15/03/08-28/03/08 (add 60cm to depth stats)

Statistic	*WXNMS2_Current Speed (cm/s) Stats*	*WXNMS2_Depth (m)*	*WXNMS2_Salinity (ppt)*
Mean	8.98	1.41	30.67
Standard Error	0.15	0.01	0.08
Median	8.51	1.38	31.08
Mode	9.39	1.86	31.22
Standard Deviation	4.66	0.42	2.65
Sample Variance	21.69	0.18	7.02
Kurtosis	0.47	-1.00	0.22
Skewness	0.67	-0.04	-0.87
Range	28.16	1.74	12.52
Minimum	0.29	0.51	22.62
Maximum	28.45	2.25	35.14
Sum	8700.89	1364.57	30389.82
Count	969	969	991

Current speeds similar to south harbour. Ave, max and min depths: 2.01m, 2.85m and 1.31m

Figure 21: WXNMS2 Current Scatter 15/03/08-28/03/08

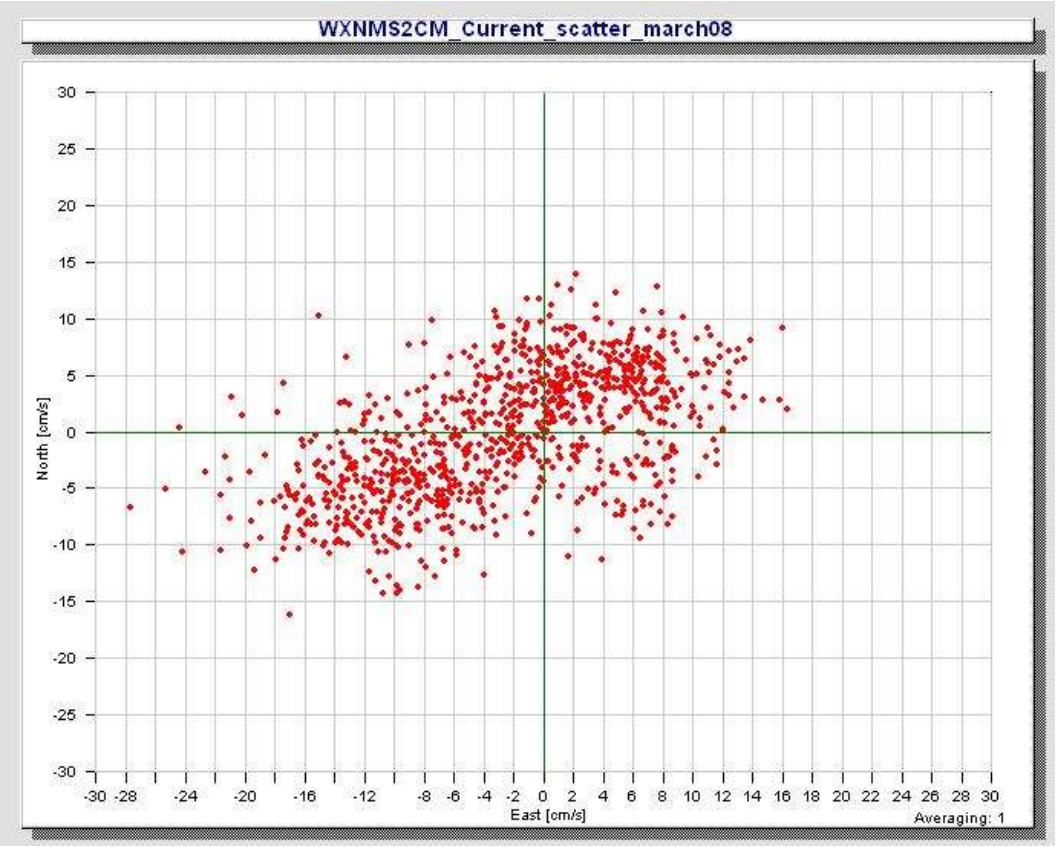


Figure 22: Salinity Profile WXNMS2 14-28 March08**.**

Profile not unlike that for southern harbour.

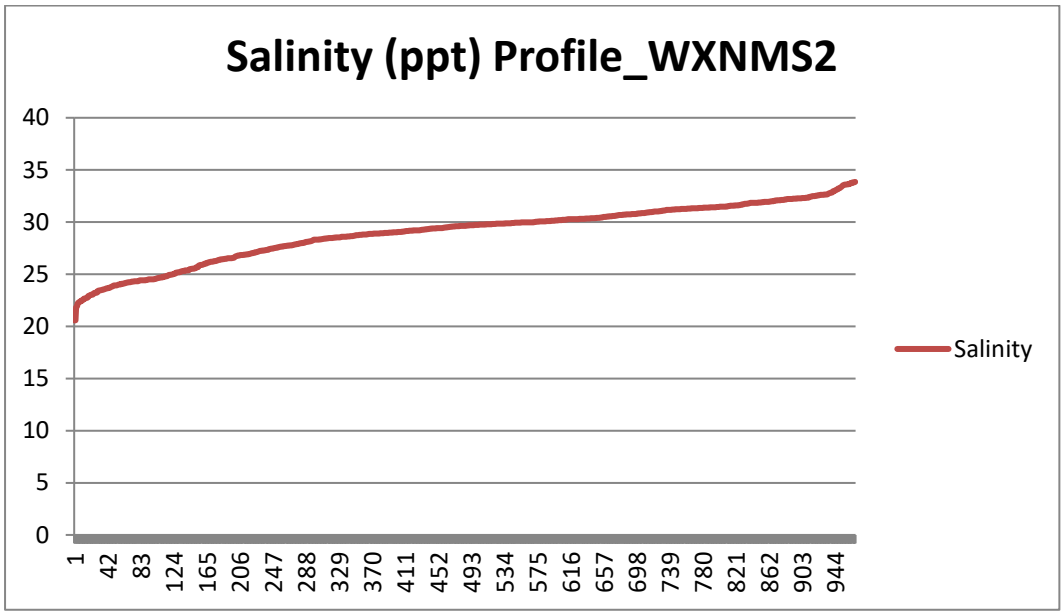


Figure 23: WXFSS5 Full dataplot 14/03/08 to 28/03/08

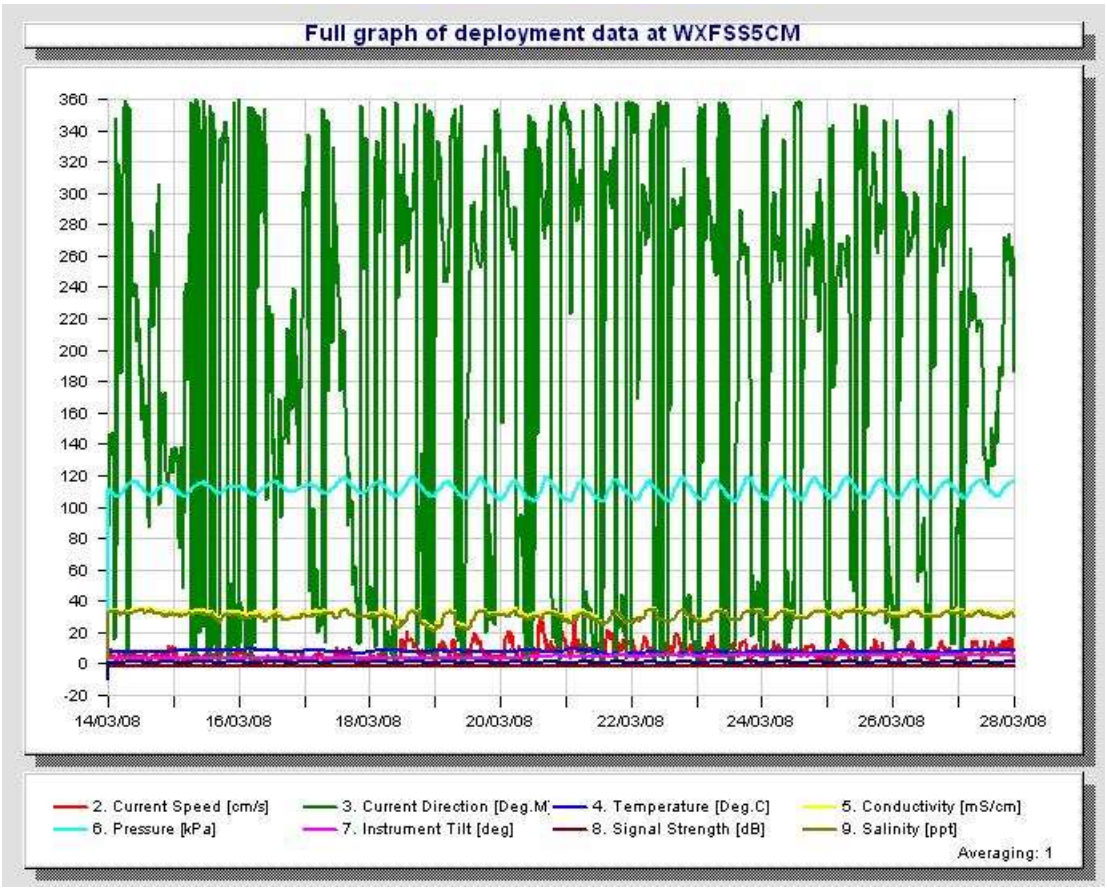


Table 8: WXFSS5 Summary Stats for Current Speed, Depth and Salinity 14/03/08-28/03/08 (add 60cm to depth stats).

Statistic	*WXFSS5_Current Speed (cm/s)*	*WXFSS5_Depth (m)*	*WXFSS5_Salinity (ppt)*
Mean	7.75	0.99	30.59
Standard Error	0.14	0.01	0.08
Median	7.04	0.99	31.04
Mode	5.28	0.80	32.89
Standard Deviation	4.41	0.41	2.54
Sample Variance	19.47	0.17	6.44
Kurtosis	1.77	-1.10	1.41
Skewness	1.02	0.06	-1.13
Range	29.33	1.55	13.41
Minimum	0.29	0.22	21.05
Maximum	29.62	1.77	34.46
Sum	7745.79	988.13	30555.13
Count	999	999	999

Average depth 1.59m, min depth 82cm and max depth 2.37m.

Figure 24: WXFSS5_ Current Scatter 14-28/03/08: Poorly defined and slack

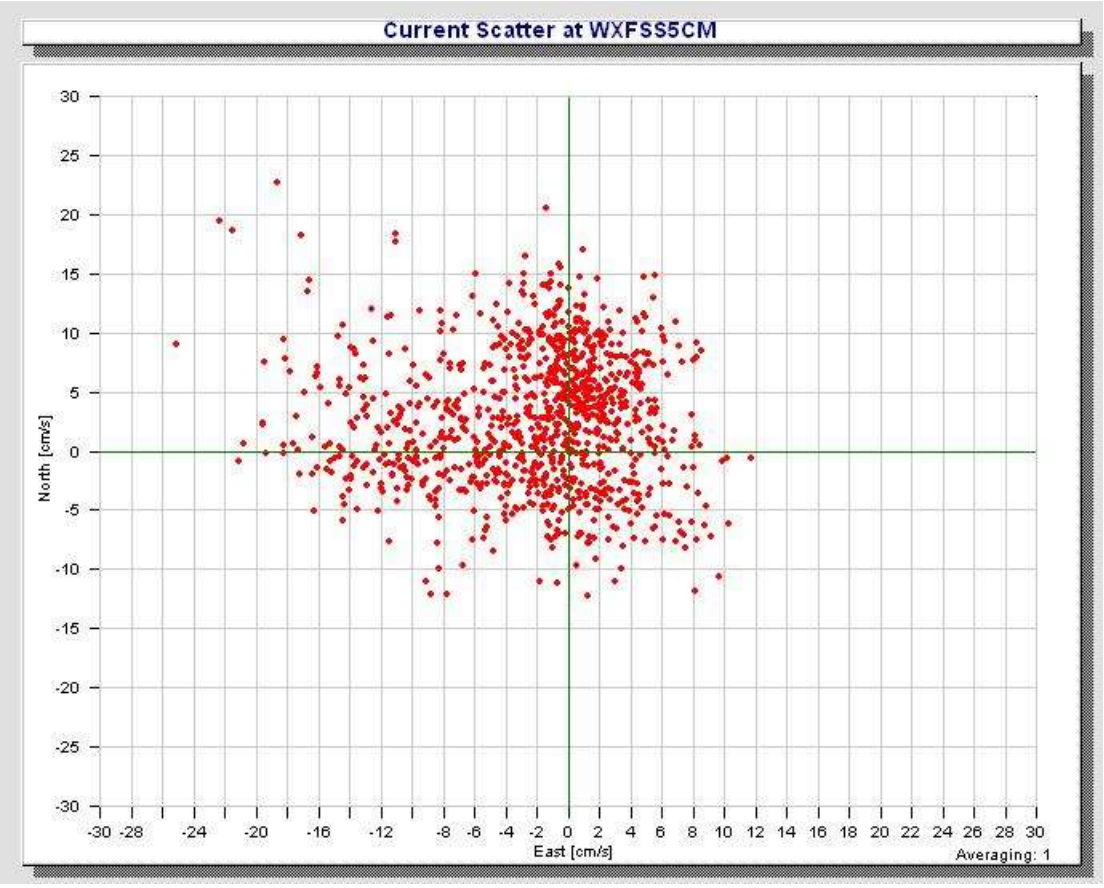
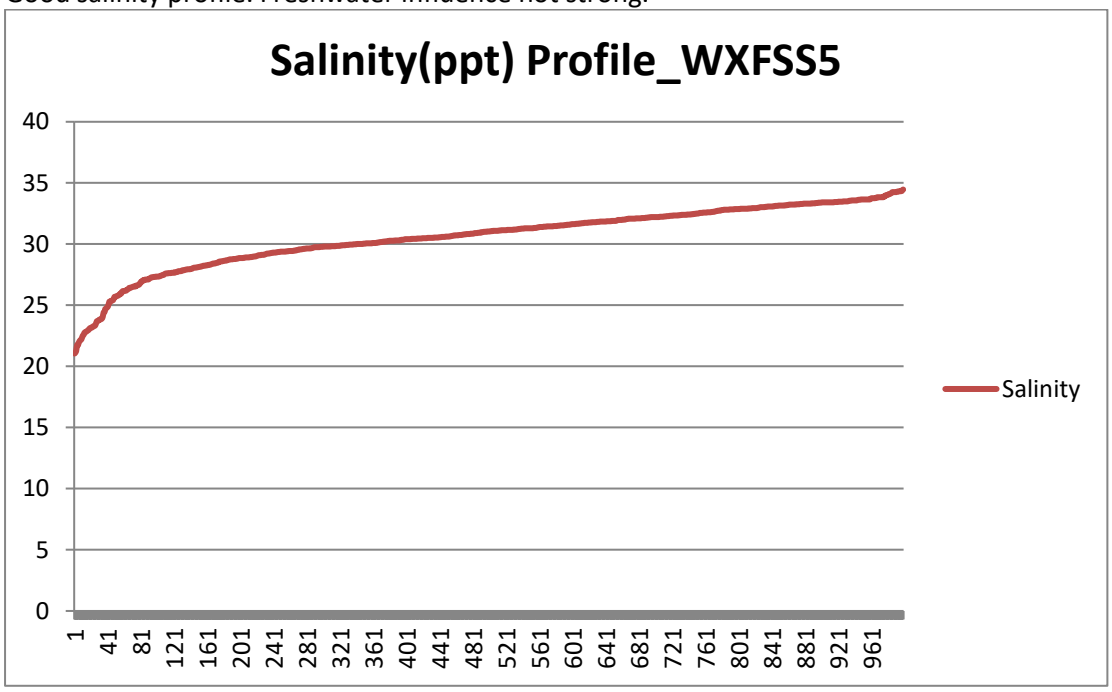


Figure 25: WXFSS5 Salinity Profile 14-28/03/08

Good salinity profile. Freshwater influence not strong.



Shellfish Designated Water Bodies.

Wexford Harbour Inner and Outer are two distinct shellfish designated water bodies. The inner body only covers the extent of the three renewal applications in the inner harbour. The inner harbour is classified as C. The outer harbour designated body again only covers the existing renewal applications plus the main channel opposite the town. It is currently classified as B but has come under threat in recent years. A meeting held recently between Wexford County Council, Irish Water, EPA, SFPA and BIM discussed some of the issues regarding the functioning and maintenance of the waste water collection system, waste water treatment plant and discharge pipe for the Wexford Town agglomeration. The issues raised are currently being addressed. Both designated areas have a pollution reduction programme in place. There is an onus on the Wexford County Council/Irish Water to maintain or improve the water quality in these areas through the operation of a pollution reduction program.

Figure 26: Wexford Harbour Inner Shellfish Designated Area

Figure 27: Wexford Harbour Outer Shellfish Designated Area

Transparency

In the EPA report for Water Quality in the Slaney Estuary and Wexford Harbour 2004 51 secchi disc (30cm diameter white disc) readings were made during the summer/autumn surveys and the overall range was from 0.7m to 2.4m. The average was 1.4m. Therefore the transperancy of the water is low

probably due to a combination of algae and sediment/sand being resuspended by wave and tide action in the shallow waters.

Salinity
There is a gradual increase in salinity from freshwater to full salinity between Macmine bridge at Oilgate to the mouth of the harbour. Data from the UISCE project shows the salinity profiles at key sectors within the harbour.

Ammonia concentrations have been shown to be high at Ferrycarraig Bridge in the EPA 2004 summer autumn sampling. The landfill site at Killurin was suspected to be the cause of high ammonia at the sampling site. Levels decrease towards the outer harbour.

Nutrient study (Measurement and Modelling of nutrient dynamics of two estuaries in Ireland, Wexford and Cork Harbours).

Water quality data showed significant sources of nutrients in the brackish waters that were not derived from the river or sea. These were presumably derived from outfalls. In this area nutrients were generally in excess of those needed for the growth of phytoplankton. In Wexford Harbour the model showed that phytoplankton biomass extended from the river mouth over the very shallow southern area. A dye release demonstrated the strong effect of wind on water movement in Wexford Harbour, reflecting its shallow depth, large fetch and short water residence time.
Chlorophyll a concentrations can be very high in the southern section of the harbour (up to 100mg/m3).

The drainage channels from the slobs can have elevated chlorophyll levels ammonia too. In past EPA reports it was suggested that the periodic release of the channels into the harbour should be subject to a discharge licence.

The EPA have demonstrated that P (Phosphorus) is the limiting nutrient throughout the estuary except were salinity is greater than 30ppt in which case either N(nitrogen) or P may be equally limiting at 35ppt or N may become limiting at above 30ppt. Dissolved inorganic carbon is not limiting at any salinity.

Mussel Farming in Wexford Harbour.

The vast majority of seed mussels are sourced off the east coast which is regulated by the DAFM. The range of seed size sourced is 15-40mm but the ideal range is 25-35mm. Variations in seed quality among the seed beds do exist within years and between years. For example Cahore seed was usually regarded as more delicate whereas Wicklow seed would in the past have been regarded as tougher. The quantity of seed available on the east coast varies considerably between years and the 2013 year was one of the worst on record. In poor seed years seed intake may be supplemented by rope seed from Ireland or bottom dredged/hand raked seed from Morcambe Bay. The preference is definitely for East Coast Seed.

In general the seed sourced on the east coast beds is brought back into the harbour on the same day for relaying. The opening of the seed beds varies and is dependent on when DAFM authorise it open but in general late summer is normally the seed fishing period.

The stocking density of seed within the harbour varies across each producer and is site dependent. At present the seed stocking density ranges from 10-60 T/Ha with the average around 30 T/Ha. Relaying of seed mussels from the hold is done by water jet through holes in the side of vessel. Once relayed it can take from 12-24 months to reach market size but the average is around 18 months. However the time on the relay plot can depend on the stock level from the previous year, the progression of sales from the previous year's stock, the progression of sales of the current year's stock, the market price and demand and the fluctuations of meat yield levels. Although sales of mussels from Wexford Harbour occur in Spain, Italy, France and Holland, the majority goes to Holland with France coming in second. Marketable mussels are measured by pieces per kg and % meat when cooked. So less than 50 pieces per kilo and meat yields over 35% are regarded as very good mussels and would normally go to Holland. Stock at 80 pieces per kilo and 20% meat yields would be at the lower end of the quality scale. Wexford Harbour has produced stock in the past of 46pieces/kg at 44% meat yields (apparently a record in Yerseke pers communication Mr Des Lett).

Prices achieved on the market depend not only on the quality achieved within the harbour but also the availability of mussels in Europe. Mussels sold have to be purified and degritted as Wexford Harbour outer is classified as B. Wexford Inner is classified as C and mussels from here would have to be moved out into the outer harbour for finishing to have them classified as B mussels. Otherwise they would have to be cooked before selling which does not happen as it is not economically viable.

During the ongrowing period after relaying of seed, stock can be fished for starfish and green crab although not all producers do this. There are two boats fishing for green crab across the harbour on sites where they have permission to or own. Starfish are generally confined to the outer sections of the harbour closer to the Raven Point.

Some producers move stock between sites e.g. they may have ground that is good for fattening and will ensure to finish their stock on such grounds however not everyone does this. Cleaning of the sites is normally done through the action of harvesting. Most harvesting is done from September to April with many operators finished up by Christmas. Some harvesting can also be done during the summer months also depending on the market. The slack time is normally February to June. During this time monthly sampling occurs to keep a track on the progression of the stock quality. However during the harvesting period sites would be accessed more frequently and this varies considerably among the producers and is probably dependent on the quantity of stock the producer normally exports. During the harvesting season access varies from 1 to 6 times per week. Access to sites usually happens between half flood to half ebb where the tidal restriction is 3 hrs either side of high tide and for some sites the restriction is greater (1.5 hours before and after high tide). On existing renewals it is important to note that dredgers do not access sites at low water unless the site is a deep site such as in parts of Wexford Inner Harbour and along the main channel from the bridge down to the end of the training walls.

During harvesting and relaying the dredgers move slowly over the site. With dredges trailing about 30m behind which when full are winched in and the contents emptied into the hold. Dredges do not dig deep into the seabed but rather lift the mussels and up off the bed of the layer of pseudofaeces that the mussels sit on. Once in the hold mussels are moved up a conveyor belt through a washer and crabs/starfish are picked off along with stones/waste. The mussels are then directed by conveyor to one tonne bags hanging in the other part of the hold. Normally about 20Tonnes are harvested for a

lorry going out to the continent. Unloading from the boat is either done by an onboard crane or using a crane on a lorry onto wooden pallets which are then loaded into a transport lorry.

Of the 8 companies and one sole trader that currently have renewal applications in place, there are 6 functioning dredgers within the harbour. They are the Edenvale, The Enterprise, The Hibernia, Cecelia, Laura Anne, Branding. The Ostrea is still moored on the quays but does not appear to be used. The number of meters of dredge per boat ranges from 7m to 14m with an average of 9m. All except one dredger have 4 dredges operated off the sides.

Production and Employment

There are currently 35 Full-time, 1 Part-time and 6 Casual jobs within the Wexford Bottom Mussel Industry. The companies involved in the harbour are either solely Irish owned or Dutch/Irish or Dutch owned. As mentioned there are 8 companies and one sole trader.

Table 10: Wexford Harbour Production History 1996-2013 (data provided by John Dennis BIM)

Years	Seed Input (T)	Production volume (tonnes)	Value (€)	Average price per ton (€)
2022	4560	4101	*These stats added in Sept 2023 (data source: BIM - John Dennis via Brian O'Loan)*	
2021	3735	2384		
2020	3885	2047		
2019	4650	2107		
2018	2190	2940		
2017	3258	3258		
2016	3000	2607		
2015	3825	2211		
2014	4260	_	_	_
2013	2050	1458	2,293,000	1572.702
2012	3185	2855	2,810,585	984.4431
2011	3311	4950	5,571,280	1125.511
2010	2283	5256	4,168,660	793.124
2009	5025	4546	3,685,700	810.7567
2008	3885	3324	4,090,015	1230.45
2007	5952	2213	3,255,485	1471.073
2006	2168	3433	6,592,615	1920.366
2005	3385	8316	7,480,350	899.513
2004	8180	6324	4,714,447	745.485
2003	7965	6222	4,701,855	755.6823
2002	8015	9246	6,854,850	741.3855
2001	11960	7501	3,747,866	499.6488
2000	6700	6854	2,935,800	428.3338

1999	6616	3675	_	_
1998	4630	4936	_	_
1997	4945	3563	_	_
1996	3710	3055	_	_

In general from a national viewpoint Wexford Harbour can produce anywhere from between 20-40% of the national production figure and is a stalwart of the national bottom mussel industry.

Industry Experience and Potential

Letts of course stand out with a mussel fishing/farming history of 115 years. N&A Scallan Mussel Suppliers have been in continuous operation since 1965. Wexford Mussels Ltd since 1969. Billy Gaynor farmed mussels on ground since 1979 and in the intervening years ground has exchanged ownership and the modern companies although relative newcomers (e.g. 2003) are working ground that has been worked since the early 1970's. So there are hundreds of years of company history invested in the mussel grounds of the harbour.

With the new applications one can see that there has been a shift towards other methodologies and species. The seed mussel settlement applications are ideally positioned in the north and south bays to potentially capture a percentage of the vast numbers of larvae that exit the harbour after spawning in Spring and sometimes Autumn. If it wasn't for the stock spawning in the harbour there would be very few seed beds on the East coast for the industry nationally to avail of. There definitely could be a role for locally sourced rope seed mussel to compliment the seed harvest from the east coast seed beds. Access to these applications would be concentrated in spring to late summer (in and around 100 days).

Oysters were brought into the harbour before in 1979 (both Ostrea Edulis and Crassostrea Gigas) and verbal accounts say they grew very rapidly. So there is the potential for good oyster production in the intertidal applications in the southern harbour. The southern harbour is high in food for shellfish although the currents are slack so an appropriate stocking density is important. Oyster farming in the harbour would be by boat access on fortnightly spring tides. It would be at low density due to slack currents in the southern section of the harbour to avoid sediment build up.

The intertidal/ very shallow water mussel farming in the southern harbour can potentially give those applicants (who either never had a dredger or had to sell out due to the cost of COC upgrades for their dredger) the chance to continue earning some income through mussel farming.

The UISCE project did show that channel areas further towards the mouth of the harbour would be productive so these areas could enhance production in the harbour if licenced.

It is important to emphasise again that as it stands at present none of the dredgers relay mussels onto intertidal areas of their licence. This is for two reasons. Firstly the mussel would grow slower intertidally and secondly relaying onto these areas would be very tricky due to a greatly reduced tidal window. However that does not mean that a licence shouldn't cover such areas because what is

intertidal in one season might not be in the next season due to the very dynamic nature of the sediments in the harbour.

As an example the Stock Assessment from the UISCE project showed that there were 13241 Tonnes of seed relayed in 2006 and 2007 combined over 515 Ha giving an average stocking density of 25.7 T/Ha. This included UISCE project test seed on test sites. 515 Ha is about one third of the licenced ground that was available in those years. So it is important to highlight that not all of the licenced ground is ever relayed with mussels in any given year due to (1) intertidal zones and (2) the lack of seed that would be required to fill all subtidal licenced ground. One might argue why licence anymore if that is the case well the case could also be made that opening up new grounds in areas of good flow will maybe give a more uniform level of stocking across the bay. The current mussel seed allocations for the companies with their existing ground is 9210 Tonnes from the east coast seed beds.

If all the applications were granted with the renewals it is possible that another 15 Full-time, 9 part-time and 10 casual jobs could be created after several years of successful production. Additional production might be in the order of 1500 tons of mussels, 200-300 oysters and rope seed mussels in the order of 1600-2600 T some of which would be sold as seed and some relayed within the harbour.

Wildfowl Reserve

The slobs have been in existence since 1847-1853. Greenland white-fronted Geese were first recorded in the area around 1910 and numbers built up to several thousand in the 1940s Greenland White-fronted Geese are the most numerous and important goose species on the reserve. Numbers fell by the 1970s to around 5,000 birds but increased protection resulted in an increase to up to 10,000; one third of the world's population. Since 1999 there has been a slight decrease, accompanied by smaller broods of young birds. The decline may be due to climate change in Greenland; displacement from nesting sites by Canada Geese and pressures on migration routes. Numbers have only been large since the 1940's. Mussel farming in the harbour is by the vast majority unseen and unheard by birds in the Wildfowl Reserve. Even boats that operate on sites that are close to the reserve can be hardly be heard and only partially seen from the reserve. The closer the flocks go towards the seawall the more of an impossibility it becomes to see a dredger due to the height of the seawall. The reserve also has active farming taking place and also organised shooting events.

Seals

By all accounts the seal population in Wexford Harbour is blossoming very well. Mussel farming does not appear to be hampering their activities.

Environmental Services Provided by Mussel Farming in Wexford Harbour

Nitrogen, Phosphate and Carbon removal.

Mussels are a sink for Nitrogen, Phosphate and Carbon. Mussels contain 1.0%N by weight and 0.1%P by weight. The average tonnage of mussels harvested from Wexford Harbour between 1996-2014 was 4873 tons. So removing 4873 tons of mussels from Wexford Harbour annually is the equivalent

of removing 48,730 Kg of N and 4873 Kg of P. In America the average person produces 5.44Kg N/year. So the annual harvest of mussels in Wexford harbour equates to the annual production of N from 8958 people (Americans). However a figure of 3.57kg of N per year is used in recent literature thus that would equate to the annual production of N from 13650 people (untreated). Wexford Town has 19,913 people as of the 2011 census. The cost of removing N from sewage has been estimated to be anywhere between 13 to 300 $ per kg of N removal. So 48730 kg of N removal equates to a removal cost of between 633490 – 14619000 $. Removal of phosphate from wastewater is even more expensive (about 10 times more) than N removal and mussels are about 0.1% Phosphate by weight. So 4873 Kg of phosphate is removed annually from Wexford Harbour through mussel harvesting and the cost of removing this would equate to the cost of removing the N removed through mussel harvesting annually. Apart from the cost of this service the mussel stock in the Harbour are controlling phytoplankton blooms by preventing algal cell counts reaching environmentally detrimental levels. The role of mussel farms in protecting Wexford Harbour from eutrophication should not be underestimated. Carbon sequestering is also a service provided by shellfish. In an era when agriculture is seeking to expand yet reduce carbon emissions already the idea of shellfish farmers selling carbon credits is being talked about.

Benthic-Pelagic Coupling

Unassimilated food from mussels is deposited to the bottom and is food for deposit feeders such as worms and crustaceans that are food in turn for fish. Increased biodeposition in turn leads to increased bacterial denitrification in which nitrate and ammonia are transformed into harmless nitrogen gas. There is the possibility that N removal via this pathway could dwarf that removed in mussels directly.

Water filtration

Mussels will remove viruses, bacteria and silt. They improve the clarity of water and thus light transmission to submerged aquatic vegetation and sea grasses. They improve the microbiological quality of the water body.

Increased biodiversity

The physical structure of mussel beds themselves can provide a habitat for other small species which in turn can be eaten by fish.

Social Cohesion and Economic Activity.

Coastal dwelling humans are an endangered species also in Ireland and one cannot discount the very positive affect mussel farming has to the economy of the area and the employment and social cohesion it provides in areas that would otherwise be quite depressed economically.

Increased monitoring and environmental awareness

The mussels are produced within a classified Shellfish Designated water body and as such are subject to strict monitoring to very high standards. Being designated means that there is an onus on the County and Town Councils(now Irish Water) to develop a pollution reduction programme and also maintain/ enhance the water quality within the designated area. Mussel farmers who have a lot

invested in their stock are usually the first to alert the relevant authority of pollution problems and incidents and as such are highly motivated and present guardians of water quality.

For the reasons above some researchers have argued that shellfish aquaculture in coastal waters is of significant ecological importance in efforts for mitigating the effects of coastal development and human induced increases in nutrient loading (Folke and Kautsky 1989, Ulanowicz and Tuttle 1992, Rice 2000).

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