SIMAtlantic:
Supporting implementation of maritime spatial planning in the Atlantic region

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Table of contents

1 Introduction

The island of Ireland consists of the Republic of Ireland (ROI) and Northern Ireland (NI), a devolved administration of the United Kingdom (UK). In this document for clarity we use ROI and NI to differentiate between the two jurisdictions.

Carlingford Lough is a sea lough at the mouth of the Newry (or Clanrye) River on the east coast of Ireland, bordering both the ROI (County Louth) and NI (Counties Down and Armagh). Carlingford Lough is one of two transboundary sea loughs located between NI and the ROI. The upper reaches of the Lough are shallow and dominated by fine muddy sand and intertidal mud-flats, whilst the seaward entrance to the Lough is a mixture of boulder, cobble and bedrock forming numerous small islands and reefs. Carlingford Lough is one of five sea Loughs located within Northern Irish waters, all of which are aquaculture production areas.

Carlingford Lough is host to aquatic estuarine fauna of considerable interest including extensive beds of sea-pens (*Virgularia mirabilis*) in the inner part of the Lough north of the navigation channel, sand and rock reefs in the central section and fast-water communities near the mouth. The Lough supports a number of noteworthy marine species, some of these being warm-water species which in Northern Ireland, are found only at this location (Taylor *et al* 1999). The Lough supports an internationally important population of wintering light-bellied brent geese (*Branta bernicla hrota*), and nationally important populations of eight species of wintering waterfowl (within Northern Ireland). Green Island, in the lower reaches of the Lough, supports important breeding populations of terns. A small population of common seals breed within the Lough, and grey seals feed within the outer parts of the Lough.

Towards the mouth of the Lough, there are small areas of saltmarsh between Carlingford and Greenore, and at Mill Bay where the White Water River flows into the Lough. Landward, there is a transition in the vegetation from saltmarsh to fen and in certain areas, the saltmarsh is showing symptoms of erosion. There are two saltmarsh habitats listed in Annex 1 of the EU Habitats Directive, reflecting its importance for nature conservation.

Areas of Carlingford Lough within Northern Irish jurisdiction have been designated as a Special Protection Area (SPA) (the boundary of which is currently under review and an extension to the site boundary has been proposed), an Area of Special Scientific Interest (ASSI), an Area of Outstanding Natural Beauty (AONB), a proposed Marine Conservation Zone (pMCZ), and a Ramsar site (as designated under the Convention on Wetlands of International Importance (also known as the Ramsar Convention)). The areas of Carlingford Lough within the jurisdiction of the ROI have been designated as a Special Area of Conservation (SAC), a SPA and a proposed Natural Heritage Area. A map showing the locations of all the designated sites within Carlingford Lough is shown in Figure 1.

In recent years Brexit has been a feature of discussion when considering the border and possible implications for trade, people and many other aspects of daily life. Whilst the position of the land border is known, the position of where maritime boundaries *could* lie are much more complex and, in relation to Carlingford Lough, have never been formally agreed. Because of the central geographical position of the navigation channel in the inner part of Carlingford Lough, this is used by regulatory authorities as a *de facto* border when carrying out their responsibilities, while the outer Lough more usually has a *de facto* line equidistant from Greenore to Greencastle Point and Ballagan Point to Cranfirld Point respectively.

Brexit will impact upon sustainable planning and management of the ‘shared’ Loughs and wider marine environment, influenced by historical legacy, the legal solutions generally applied and the realities of on the ground practice, in light of changing approaches to marine management internationally.

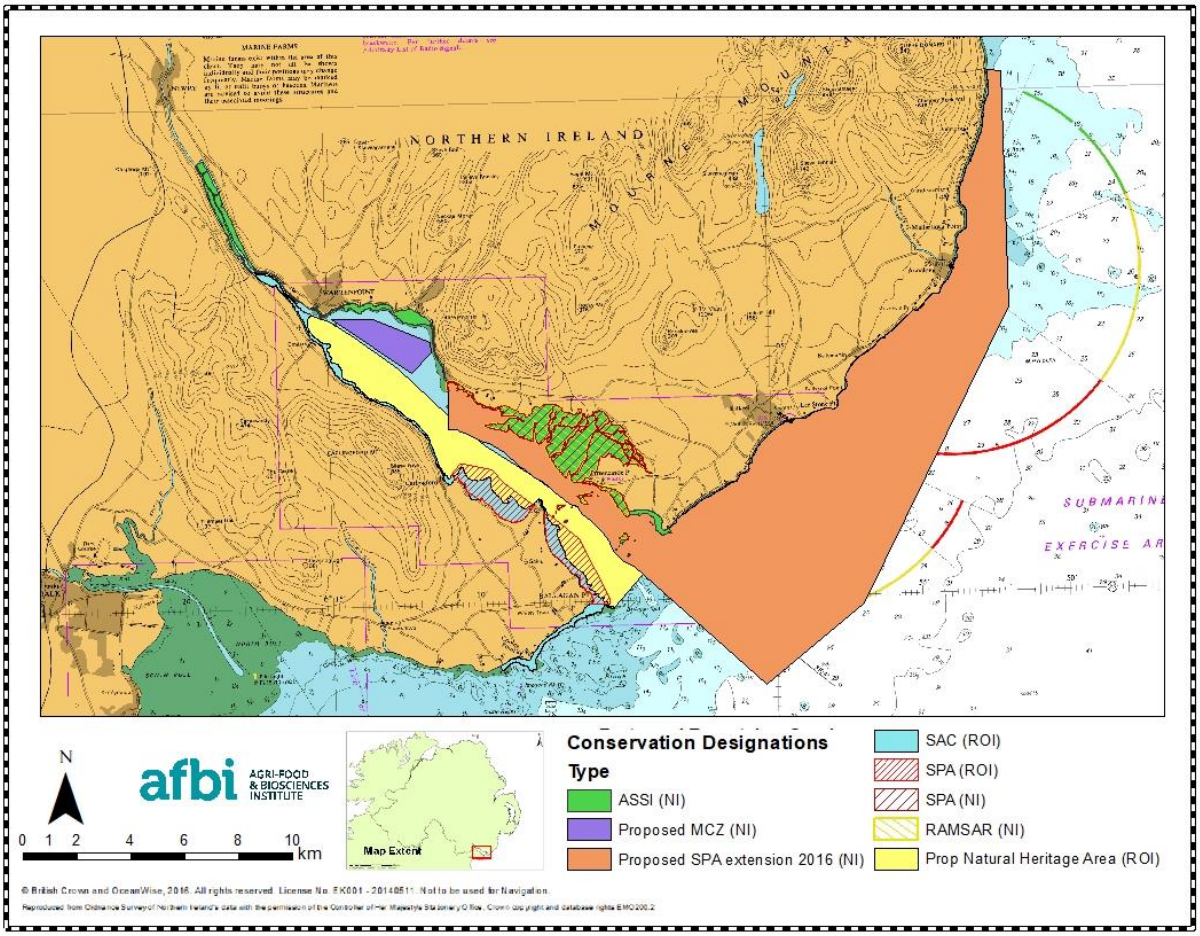


Figure 1: Map showing the locations of the Conservation designated sites within Carlingford Lough

1.1 Legal approaches

Generally maritime delimitation is governed by the United Nations Convention on the Law of the Sea (UNCLOS). Article 10 of this Convention deals with bays, in this instance the Loughs, but only those that belong to a single State, meaning Carlingford Lough falls outside its scope. In border contexts, under UNCLOS, a shared territorial sea tends to be divided according to a median line, taking equidistant points from the baselines (usually the low water mark) following the sinuosities of the coast. Delimitation of territorial seas between States with opposite or adjacent coasts is governed by Article 15 of the Convention and provides that neither coastal State can claim an area of territorial sea beyond the median line, except where there is “historic title or other special circumstances to delimit the territorial seas of the two States in a way which is at variance therewith”.

In a move to promote transboundary management of Carlingford Lough and Lough Foyle the Loughs Agency (an agency of the Foyle, Carlingford and Irish Lights Commission (FCILC)) was set up as one of the North-South Implementation Bodies under the 1998 Agreement between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of Ireland (also known as the Belfast Agreement or the Good Friday Agreement, GFA https://www.gov.uk/government/publications/the-belfast-agreement).

Legally, the Agency’s responsibilities are to promote the development of the Loughs for commercial and recreational purposes in respect of marine, fishery and aquaculture matters; to manage, conserve, protect, improve and develop the inland fisheries of the Foyle and Carlingford Areas; to develop and licence aquaculture; and to develop marine tourism.

The Foyle and Carlingford Fisheries (Northern Ireland) Order 2007 and the Foyle and Carlingford Fisheries Act, 2007 (ROI) provided for a new regulatory system for aquaculture in the Foyle and Carlingford areas. To date those powers have not been enacted, in the form of a management agreement, so as to enable the Loughs Agency to manage, on behalf of both Governments, marine aquaculture in Lough Foyle. Evidence to the House of Commons Northern Ireland Affairs Committee, published in 2018, says that this situation has led to the number of unlicensed oyster trestles in Lough Foyle growing from around 2,500 in 2010-11 to approximately 50,000 in 2016. The recommendation from that Committee was that the UK's Foreign and Commonwealth Office conclude a management agreement with the Irish Government, within the next 12 months, to enable the Lough's Agency to fully implement the 2007 Foyle and Carlingford Fisheries Order.

At time of print, the powers to undertake all these functions have not yet been transferred to the Loughs Agency. They currently have no regulatory authority within the marine waters of Carlingford Lough.

1.2 New approaches to marine management

Ecosystem-based management (EBM) is advocated internationally as an interdisciplinary management approach that recognises the complex nature of ecological systems and integrates social, ecological, and governance principles to achieve sustainable use of natural resources in an equitable way. Its implementation is critical to better management of our marine and coastal spaces. EBM is a fundamental underlying principle of Maritime Spatial Planning (MSP). MSP is a process whereby human activities in marine areas are analysed and organised to achieve ecological, economic and social objectives.

MSP has been a legal requirement under EU law since 2014 and for Northern Ireland, under UK law, since 2010, with additional Northern Ireland legislation enacted in 2013. Both the Republic of Ireland and Northern Ireland are currently working on the implementation of MSP in their respective marine areas. The full implications of Brexit for implementation of MSP in the border region are still unknown.

Carlingford Lough was selected as a case study area for the SIMAtlantic project because of its transboundary context and provides an excellent example of the need to operationalise ecosystem-based management. The objective of this guidance document is to provide information on activities within the Lough, their governing legislation and policy, and their responsible bodies in each jurisdiction.

Within Carlingford Lough stakeholders include, but are not restricted to local aquaculture producers, fishermen, boat and yacht clubs, conservation authorities, NGOs, Government departments and local harbour authorities.

In Northern Ireland, the Department of Agriculture, Environment and Rural Affairs (DAERA), Northern Ireland Environment Agency (NIEA), Food Standards Agency (FSA), NI Water and local councils all contribute to management, licensing and enforcement of activities in the Lough. In the Republic of Ireland, the Department of Agriculture, Food and the Marine (DAFM), the National Parks and Wildlife Service (NPWS), Environmental Protection Agency (EPA), Inland Fisheries Ireland (IFI), the Department of Housing, Local Government and Heritage (DHLGH), Irish Water and the Food Safety Authority of Ireland (FSAI) are the competent authorities for the management and regulation of activities within Carlingford Lough.

2 Maritime uses and selected activities within the transboundary area

2.1 Aquaculture within Carlingford Lough

Aquaculture in Carlingford Lough occurs on licensed sites within both the intertidal and subtidal areas of the Lough. Subtidal aquaculture involves the bottom culture of the blue mussel *Mytilus edulis*, whilst intertidal aquaculture occurs predominantly in the form of off-bottom (trestle) culture of the Pacific oyster (*Magallana gigas* formally known as *Crassostrea gigas*). *M. edulis* seed is dredged from naturally settled wild seed mussel beds (outside Carlingford Lough) then re-laid onto licensed aquaculture beds within the Lough for on growing to harvestable size. The location of the current licensed aquaculture sites within Carlingford Lough is shown in Figure 2.

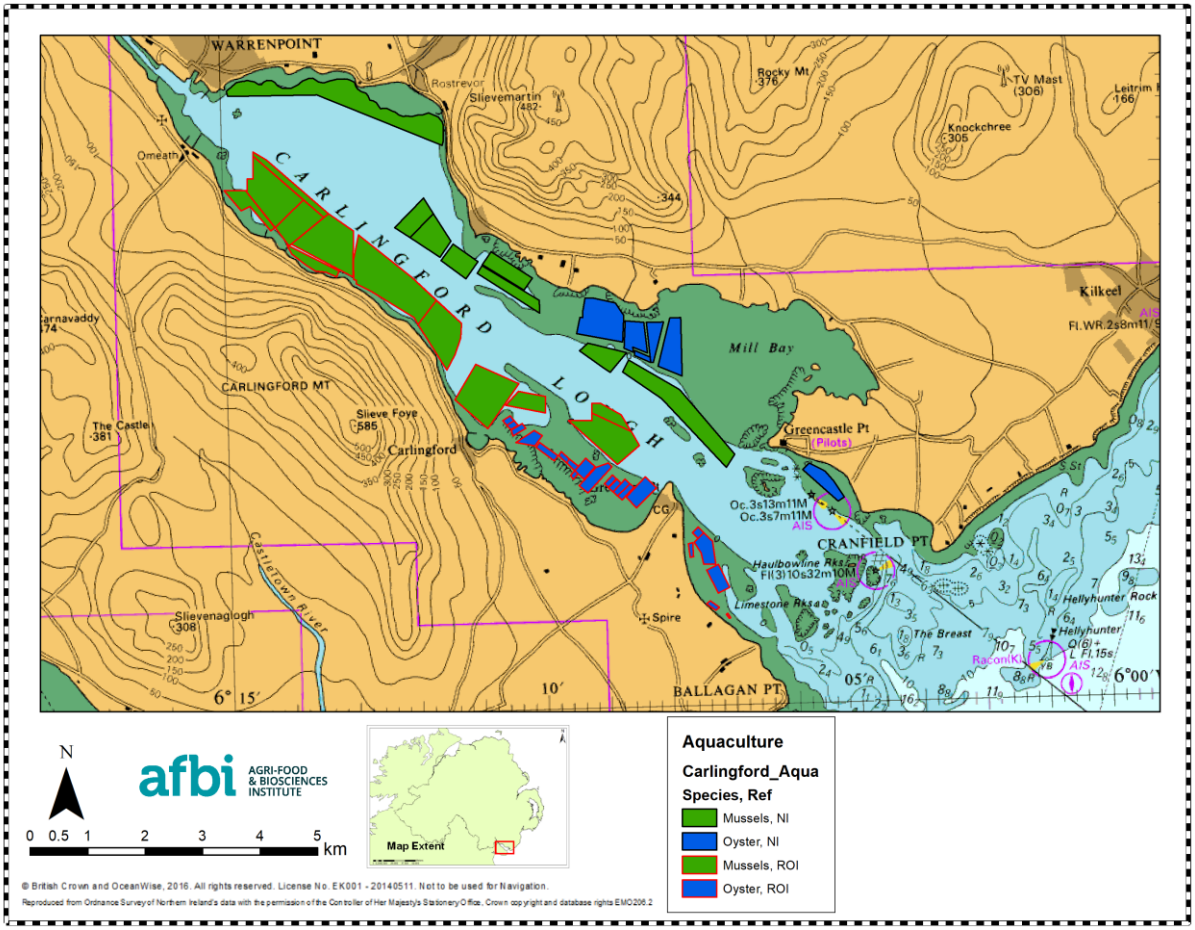


Figure 2: Map showing the currently licensed aquaculture sites within Carlingford Lough

Aquaculture sites licensed for bottom culture of shellfish cover approximately 943 hectares of the subtidal area of Carlingford Lough. Approximately 218 hectares of the intertidal area of the Lough is licensed for the off bottom (trestle) culture of oysters. The total area of Carlingford Lough (both intertidal and subtidal) is estimated to be approximately 4,890 hectares (as calculated in ArcGIS V 10.6) Therefore, approximately 23.7% of the total area of the Lough is licensed for aquaculture. However not all of these licensed sites are currently active and of those sites that are active, not all of the licensed area is utilised. These figures are correct at time of publication.

Within the Northern Ireland area of Carlingford Lough, the Marine and FIsheries Division of DAERA, is responsible for the granting of fish culture licences, shellfish fishery licences and marine fish fishery licences under the Fisheries Act (Northern Ireland) 1966. In the Republic of Ireland area of Carlingford Lough, the Aquaculture and Foreshore Management Division of DAFM is responsible for aquaculture

licensing under the Fisheries (Amendment) Act, 1997. Aquaculture and fishing operations existed in coastal areas prior to this legislation. Ireland is thereby assessing both existing and proposed aquaculture and fishing activities in all designated sites. This is an incremental process, as agreed with the European Commission in 2009, and will eventually cover all fishing and aquaculture activities in all Natura 2000 sites (Marine Institute, 2019).

Due to the conservation status of Carlingford Lough (as outlined in Section 1), all applications for new aquaculture sites under Northern Irish jurisdiction are subject to assessment under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995, known as a Habitat Regulations Assessment (HRA). This is then followed by a consultation period. Therefore, before a new aquaculture site within or adjacent to a SPA or SAC can be licensed it must first be demonstrated (by means of the HRA report) that this site will not impact upon the conservation objectives of the designated site in question. If this cannot be demonstrated, then the licensing department (DAERA) cannot grant a licence.

In the ROI, a National Strategic Plan for Sustainable Aquaculture was published in 2015. This contains 24 actions to grow production in the sector by 45,000 tonnes by 2023 – almost doubling production. The Plan specifies its 2020 vision for aquaculture licensing as being: *"A streamlined and efficient licensing system that provides greater business certainty to applicants, and transparency to the general public".* A review of the aquaculture licensing process was carried out in 2017 (Independent Aquaculture Licensing Review Group, 2017), and though licence applications continue to be processed, there have been no fundamental changes to the licensing system.

The Aquaculture and Foreshore Management Unit of the Department of Agriculture, Food and the Marine (DAFM) is responsible for the granting of aquaculture licences under the Fisheries (Amendment) Act, 1997 and Foreshore Acts, 1933-2011 and relevant EU legislation (Habitats, Public Participation and EIA Directives). The Marine Institute (MI) provides scientific advice on a range of marine environment and aquaculture matters and in the case of applications which require Appropriate Assessment (AA) under EU Birds and Habitats Directives, the MI prepares scientific reports. If the AA or the Risk Assessment (RA) process deems there is a likelihood of negative impact on the designated features of the lough, then such activities will need to be mitigated if they are to continue. In situations where there is no obvious mitigation to reduce the risk of significant impact, it is advised that caution should be applied in the licensing decision.

2.2 Water Quality

The EU primarily regulates the water environment through the Water Framework Directive (WFD, 2000/60/EC). The WFD acts as a framework for the development of integrated water management plans which address the issues of water use, water quality, river morphology, and the ecological value of waterbodies and their surrounding areas (NIEA, 2015a)

The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 have introduced a holistic approach to the management of water quality and require the protection and improvement of all aspects of the water environment including rivers, lakes, estuaries, coastal waters and groundwater. This is achieved through the production of River Basin Management Plans (RBMP), which exist for both jurisdictions.

A key requirement of the WFD is that surface water bodies attain at least good surface water status, requiring both ecological status and chemical status to be at least good, and that there should be no deterioration in existing status. To achieve this, River Basin Management Plans (RBMPs) set water quality targets which encompass both traditional chemical measures, and biological indicators of water quality, split into five classes: High, Good, Moderate, Poor and Bad (NIEA, 2015a). Member states are required to classify the overall status of the water body by the lowest status from all the standards that are assessed. This is known as the 'one out, all out' rule. To have high status, for example, a water body cannot fail any of the standards associated with high status (NIEA, 2015a).

There are strong links between the UK Marine Strategy (which is expanded upon in Section 3) and RBMPs. The RBMPs address the improvement and protection of the chemical and ecological status of surface waters over the whole river basin ranging from rivers, lakes and groundwaters through to estuaries and coastal waters out to one nautical mile at sea and overlap with the UK Marine Strategy in coastal waters.

The Carlingford Catchment falls within the southern end of the cross border Neagh-Bann River basin district. It stretches from Acton (north of Poyntzpass) at the top of the catchment to the Newry estuary which drains into Carlingford Lough. The main freshwater input is the Newry (Clanrye) River, which runs parallel to Newry canal until Victoria lock, where both waterbodies merge. Other rivers include the White water, Cassy water, Kilbroney River, Moygannon River and Ghann River. The majority of these are Spate Rivers which feed off the mountains and generally do not affect the salinity of the Lough (Loughs Agency, 2011). At the southern end of the lough, there are approximately nineteen small streams and rivers that drain directly to the lough. The three WFD river sub basins include the Knocknagornan (26.2km), Carlingford River (12.5 km) and Greenore River (7.4 km). These river sub basins form part of the 'Big' sub-catchment managed by the Environmental Protection Agency (EPA) within the Newry, Fane, Glyde and Dee catchment. For Carlingford Lough, a coordinated approach to management is undertaken between various parties in Northern Ireland and the Republic of Ireland *inter alia* Loughs Agency, NIEA, Local Authorities/Environmental Protection Agency (EPA), and Inland Fisheries Ireland (IFI).

The River Basin Management Plan (RBMP) for the Neagh Bann River Basin District 2015-2021 prepared by the NIEA outlines the ecological status of the water bodies. The area covered within this RBMP alongside the WFD surface waterbodies is shown within Figure 3. This considers biological elements supported by physio-chemical, specific pollutants, hydromorphology, and protected areas status. The status for Newry estuary (a transitional water body) and Carlingford Lough can be found in Table 1.

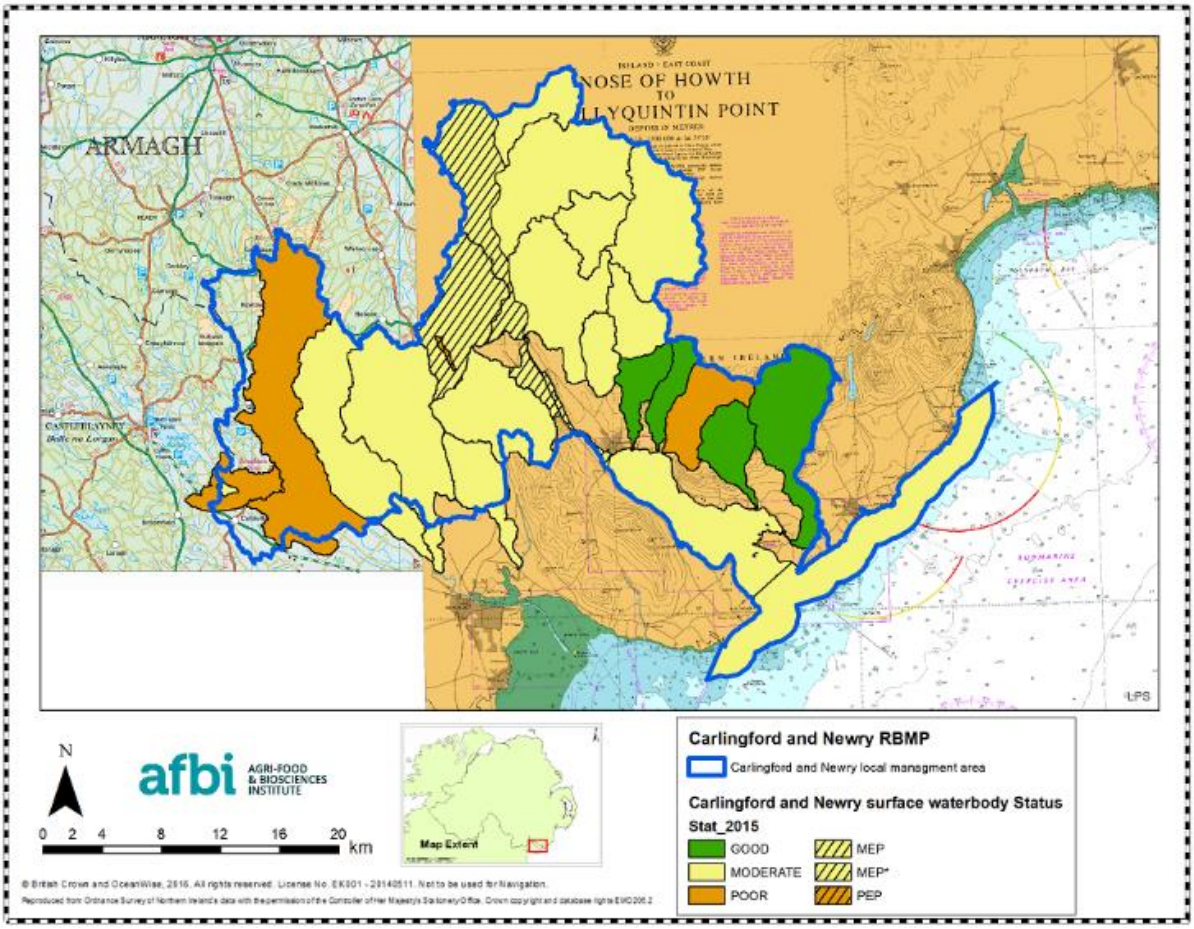


Figure 3: Map showing the location of the Newry and Mourne River Basin Management Plan area and the Water Framework Directive surface water bodies and their Status as of 2015.

Table 1. WFD Classification of Carlingford Lough and the Newry estuary 2015 (Source: NIEA River basin Planner 2018)

	Coastal	
2015 Classification	Carlingford Lough	Newry Estuary
Overall Status:	Moderate	MEP*
Alien Species	Present	Absent
Angiosperms	Moderate	Moderate
Benthic Invertebrates	Moderate	Moderate
Dissolved inorganic Nitrogen	Moderate	Poor
Dissolved oxygen	High	High
Fish		Moderate
Hydromorphology	Moderate	
Priority hazardous substances	Fail	Fail
Specific Pollutants	Moderate	Moderate
Objective 2021	Good	GEP**

*MEP = Maximum Ecological Potential **GEP = Good Ecological Potential

Carlingford lough (49 km^2) is a coastal water body which leads to a relatively short coastline where the Newry estuary joins the Irish Sea (Table 2). It is approximately 15 km in length and approximately 3.7 km in width at its widest point. The Lough is generally shallow with water depths ranging from 2 to 5 m. The narrow navigation channel can extend to depths of 25 m with the deepest part of the Lough (35 m) located approximately 2.3 km north of Carlingford Harbour, Co. Louth and 1.3 km south of Killowen

Point, Co. Down. The main freshwater input is the Newry (Clanrye) River, which runs parallel to Newry canal until Victoria lock, where both waterbodies merge with a small flow rate that can vary from 1 $m^3 s^{-1}$ in summer to 9 $m^3 s^{-1}$ in winter (Ferreira *et al*., 2007). The residence time within the Lough varies between 14 and 26 days.

Table 2. Physical properties of Carlingford Lough

	Volume ($x10^6$ m^3)	Area (km^2)	Maximum depth (m)	Temperature (°C)	Mean Salinity	River Flow ($m^3 s^{-1}$)	Water residence time (d)
Carlingford Lough	460	49	35	Mar-20	32.5	43344	14-26

In terms of water quality status for these water bodies, Carlingford lough was designated 'Moderate' status in 2015. Alien species present include tunicates (*Didemnum sp.)*, Japanese wireweed (*Sargassum muticum)* and the Common cord-grass (*Spartina angilca).* These species are established in the coastal communities and reduce the overall surface water classification from 'high' to 'good' (NIEA, 2015a). The presence of numerous priority hazardous substances detected in the coastal areas of Carlingford included trace metals, trace organics, pesticides and hydrocarbons (PAH) from 2013 -2015.

A significant factor influencing water quality within the Lough is Dissolved Inorganic Nitrogen (DIN), in this regard Carlingford Lough was assigned 'moderate status' in 2015. Numerous nutrient budget studies show that agriculture significantly contributes the largest loading source of DIN to Newry River and Carlingford Lough (DAERA, 2015; Ferreira et al, 2007).

Since 1995 AFBI has maintained instrumented moorings in Carlingford Lough for the purpose of monitoring the annual cycle of nutrients and trends in general water quality parameters. These moored instruments routinely monitor:

- Temperature
- Salinity
- Chlorophyll concentrations
- Dissolved oxygen
- Turbidity
- Surface Seawater fluorescence

Likewise, periodically, monitoring studies have been undertaken to assess allochthonous sources of nutrients from inland catchments in response to hydrological conditions. However, instrumented catchments for continuous monitoring of freshwater systems are limited.

In the Republic of Ireland, a National Marine Monitoring programme is co-ordinated and regulated by the Environmental Protection Agency (EPA) and an equivalent programme is carried out for the northern part of the Lough by DAERA Marine and Fisheries Division. Sites are monitored for biological and chemical parameters within both jurisdictions.

2.2.1 Bathing Waters

Working both with in-house teams and with other organisations, the Department of Agriculture, Environment and Rural Affairs (DAERA) Marine and Fisheries Division survey, monitor and assess the marine and coastal environment of Northern Ireland, including bathing water quality. The bathing season runs from June-September, during which time samples are collected on 20 occasions and assessed by the Division. Results are displayed at identified recreational bathing water sites (in the case of Carlingford Lough, Cranfield) via colour-coded posters on a weekly basis. In 2020, Cranfield was identified as "excellent".

Bathing water quality in ROI falls within the scope of the National Marine Monitoring Programme, coordinated by the EPA with input from the Marine Institute, Inland Fisheries Ireland and the National

Parks and Wildlife Service. Local authorities collect water samples for analysis just before the bathing season begins and then at regular intervals (at least once a month but may be fortnightly or weekly in some areas) during the season. Within the ROI the bathing season runs from the 1st of June to the 15th of September. There are no bathing beaches within the ROI area of Carlingford Lough.

2.2.2 Toxic Phytoplankton Monitoring

Carlingford Lough supports a bivalve aquaculture industry in both the intertidal and subtidal regions of the Lough. The predominant species cultured are blue mussels and Pacific oysters. Mussels and oysters are filter feeders, filtering phytoplankton from the water column. Some phytoplankton species within the marine environment can be harmful to humans if eaten, therefore routine monitoring is carried out by AFBI on behalf of the Food Standards Agency to determine if toxic phytoplankton is present in the water column within the shellfish production areas. The toxins have no visible effect on shellfish and many toxins are resistant to processes such as freezing or cooking, resulting in the need for routine testing. If toxins are found to be present in a given sample, harvesting is suspended at the site until two consecutive samples taken no less than 48 hours apart are found to be toxin free. Results are published on the FSA website (Biotoxin and phytoplankton monitoring | Food Standards Agency).

In the ROI, the Marine Institute monitor phytoplankton under a national programme. A key focus is on harmful species; but phytoplankton as an indicator of water quality is also analysed and is a key component of the Water Framework Directive. Officers from the Sea Fisheries Protection Authority Sea or other assigned personnel take samples from designated sampling areas which are then analysed in labs in Bantry (Co. Cork) or Galway and subsequently reported on the Marine Institute website.

2.2.3 Wastewater Treatment

There are approximately 25 wastewater treatment works (WWTWs in-service) registered within the Carlingford Catchment, which discharge treated effluent to adjacent waterbodies. In NI NIEA are responsible for authorising and regulating urban wastewater discharges and in the ROI this role is undertaken by the EPA.

There are a number of sewage discharges to the Lough with treatment facilities located at Newry, Warrenpoint, Cranfield and Carlingford and various other diffuse sources associated with agricultural land use, tourism and wildfowl. In addition to these there are a number of additional untreated discharges (Omeath and Greenore), intermittent discharges from storm storage tanks, and sewer overflows that discharge dilute wastewater during periods of heavy rainfall which could be impacting on water quality.

Through the INTERREG VA programme (administered by the Special EU Programmes body (SEUPB)) €35 million in European funding has been awarded to the Shared Waters Enhancement and Loughs Legacy project (SWELL). The programme aims to improve the water quality in Carlingford Lough and Lough Foyle through the upgrade of wastewater assets in both jurisdictions. A unique ecosystem model will be developed through this project that will support further future improvements within the shared waterbodies of Carlingford Lough and Lough Foyle.

2.3 Ports and Harbours

Warrenpoint Harbour is a large commercial port, the second largest in Northern Ireland, the location of which is shown in Figure 5. It is a designated Competent Harbour Authority (providing pilotage). Its revenue exceeded £5.9 million in 2019. It is a Trust Port, not owned by the government but operates autonomously in a commercial manner. As a Trust Port, it has a statutory obligation to dredge its approach channels and berths so that vessels can access the Port safely. For the past 40 years the Port has carried out a major maintenance dredging campaign approximately every 5 years, with more localised dredging within the port every 2 years in the areas where the loss of navigable water depth is most severe. Dredged material is currently placed at a licensed offshore site 26km from the port and 11km outside of the sheltered waters of Carlingford Lough.

The council-run Carlingford Harbour is approximately 1km south along the shoreline from Carlingford Marina, which dries to soft mud at low tide. Greer's Quay and slipway were constructed for commercial fishing and are still utilised as such. Further small anchorages are located at various points along the coastline (Figure 4).

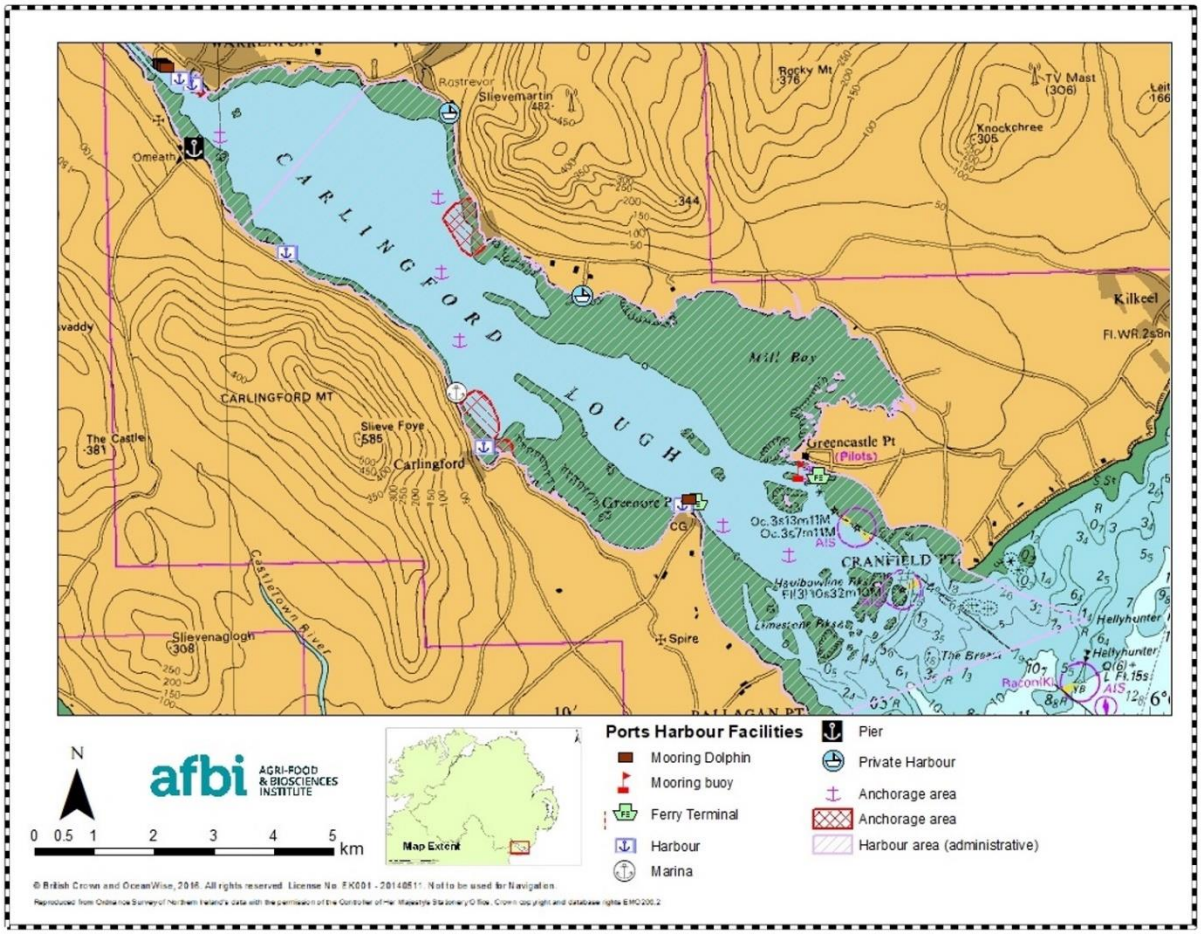


Figure 4: Map showing the location of the Ports, Harbours and anchorages within Carlingford Lough.

2.4 Tourism and recreation

The Carlingford Catchment hosts a population of approximately 61,000 and attracts tourists year round. The catchment caters for tourists with an abundance of recreational activities available. Some of these coastal and water based recreation activities are discussed within the following paragraphs and highlighted within Figure 5.

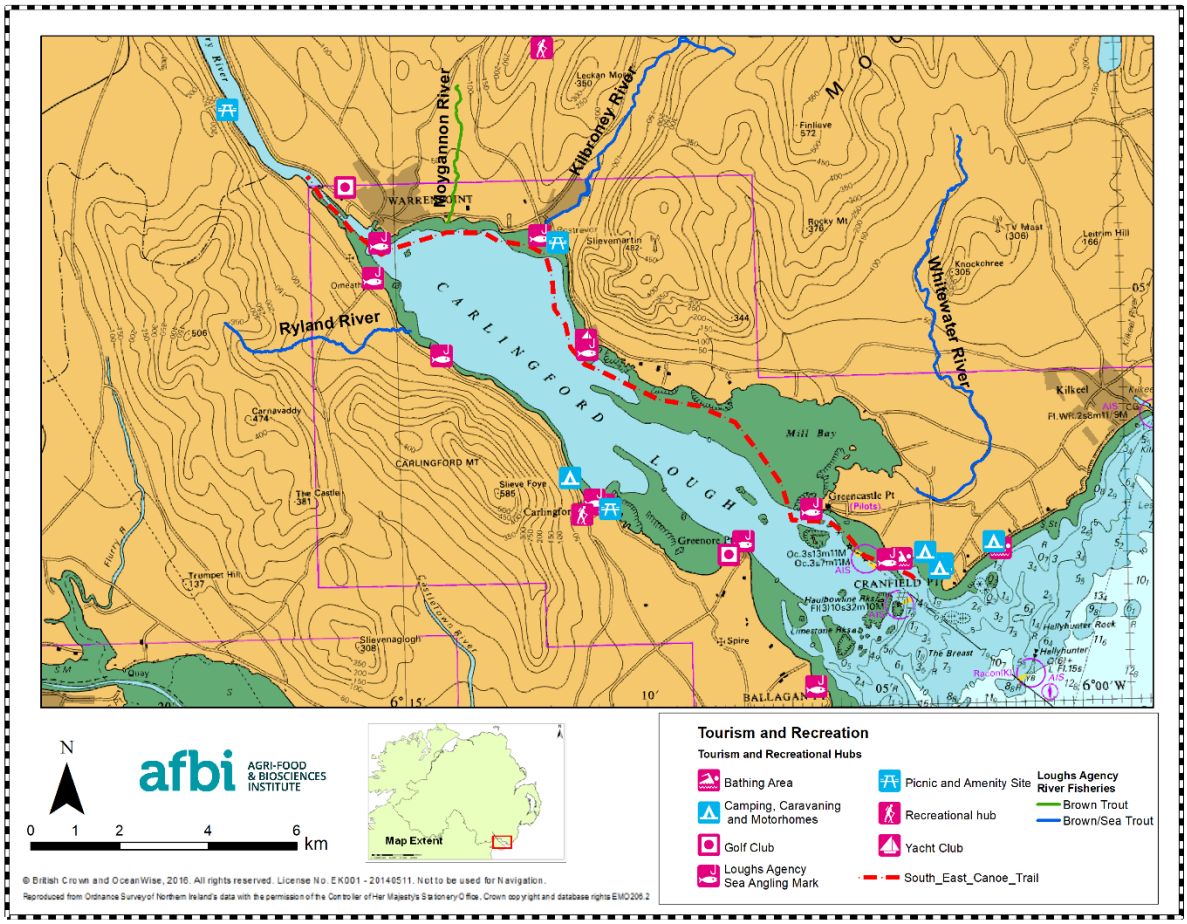


Figure 5: Map highlighting the Tourism and Recreation areas within Carlingford Lough.

2.4.1 Boating

Boating is widespread throughout Carlingford Lough and ranges from dinghy and yacht racing to cruising, sail and powerboat training. Moorings and boating facilities are in abundance, available at Rostrevor, Warrenpoint, Greencastle, and The Albert Basin (the main water-based recreation resource in Newry).

Carlingford Marina is located a short distance west of Carlingford, the exact location of which is shown within Figure 5. It has a 300 berth marina, boatyard, café and 8 self-catering apartments. The town is home to Carlingford Sailing Club, Carlingford Sail Training Centre has floating moorings outside harbour.

In Killowen, County Down (NI) the yacht club has a clubhouse, boat storage and slipway. The club has also hosted major sailing events.

2.4.2 Angling

Newry and Mourne District Council has installed several fishing stands alongside the Newry to Omeath Road. Shore angling is also popular at Ballylagan Point. Angling licences are obtained and regulated for both jurisdictions from the Loughs Agency.

2.4.3 Bathing

As mentioned with regards to water quality, bathing waters are areas protected for recreational bathing use and must meet mandatory and guideline standards for microbial quality in order to protect human

health. In the Carlingford catchment, Cranfield is the only identified bathing water and was recently designated “Excellent” between June and September (weekly assessment) 2020.

The EU SWIM Project is a cross-border research programme aiming to develop a live bathing water quality prediction system. The system, currently in its pilot stage will enable short-term pollution events to be predicted, and these predictions will be communicated to the general public via electronic beach signage, an app, a website and social media.

The project has been funded by the EU’s INTERREG VA programme, managed by the Special EU Programmes Body (SEUPB), and match-funded by the DAERA in Northern Ireland and DHPLH in ROI.

Cranfield Beach is an identified bathing water with public facilities (managed by Newry, Mourne and Down District Council), such as car parking, a children’s play area, and toilets. Lifeguards from the Royal National Lifeboat Institution (RNLI) are on duty at Cranfield beach during July and August (https://www.thebeachguide.co.uk/northern-ireland/county-down/cranfield-bay.htm).

2.4.4 Day-Trip sailings

The small village of Omeath in Co. Louth (ROI) previously thrived as a day visit destination with many day trippers travelling from Warrenpoint, Co. Down (NI) by ferry. This tradition still remains with a single Ferry M.V Seascapes offering daily sailings from June to September. Access is provided by a sloping concrete jetty.

2.4.5 Water-Sports and Adventure Centres

The South East Canoe Trail stretches 90 kilometres along the southeast coast of Northern Ireland and into Co. Louth in the Republic of Ireland. Much of this trail traverses through Carlingford Lough, up to Narrow Water castle and on to Newry Canal. The scenery makes the lough a popular spot with local canoe clubs and activity centres, with the lough providing regular access and egress points at Omeath Road jetty, Narrow Water, Greer’s Quay, Carlingford Harbour, Ballylagan Point, Albert Basin Quay and Rostrevor. Many of these access points also offer parking and picnic benches.

Various water-sports and adventure centres exist on the shores of the lough, namely Carlingford Adventure Centre; Rostrevor Swimming and Boating Club; East Coast Adventure Centre operates a Watersports Centre from Warrenpoint Baths through a lease from Newry, Mourne and Down District Council.

Additionally, The Victoria Lock, a picnic and amenity site in Newry (owned and managed by Newry, Mourne and Down District Council) is a well maintained site with large car parking area and picnic tables.

2.4.6 Carlingford Lough Ferry

The Carlingford Lough Ferry terminals are located in Greencastle, County Down and Greenore, County Lough. The ferry carries foot passengers and all categories of vehicles. The journey across the Lough lasts approximately 20 minutes. The ferry departs every hour on the hour from Greencastle and every hour on the half hour from Greenore.

2.5 Marine Fisheries

On the northern shores of Carlingford Lough there a few small-scale wild fisheries. A wild fishery for the blue mussel (*Mytilus edulis*) operates within the Narrow water area of Carlingford Lough, north of Warrenpoint. Pot fishing occurs in the main body of the lough and is primarily for Green Crab (*Carcinus maenas*), both for market and as predator control over mussel beds. Small-scale intertidal collection of winkles, mussels and wild cockles also commonly takes place along the Co. Louth coast. The winter months of November to March appear to be the key period for harvesting of these species.

2.6 Marine Spatial Planning

In Northern Ireland, marine spatial planning will be implemented through the Marine Plan, to inform and guide the regulation, management, use and protection of the Northern Ireland inshore and offshore regions. The Marine and Coastal Access Act 2009 (MCAA) and the Marine Act (Northern Ireland) 2013 (The Marine Act), require the Department of Agriculture, Environment and Rural Affairs (DAERA) as the Marine Plan Authority (MPA), to prepare marine plans. The Marine Plan for Northern Ireland will be adopted when the DAERA (with agreement of the Secretary of State with regard to retained functions and agreement of the Northern Ireland Executive as a cross-cutting issue) publish the plan. (Marine Plan for NI (daera-ni.gov.uk). The UK Marine Policy Statement and the draft Marine Plan for Northern Ireland are both material considerations for planning.

In the Republic of Ireland, the National Marine Planning Framework covers marine spatial planning and is transposed into national legislation via Part 5 of the Planning and Development (Amendment) Act, 2018 (https://www.gov.ie/en/publication/60e57-national-marine-planning-framework/).

3 Marine Protected Areas within Carlingford Lough

EU environmental policy is based on Articles 11 and 191-193 of the Treaty on the Functioning of the European Union. Under Article 191, combating climate change is an explicit objective of EU environmental policy. Sustainable development is an overarching objective for the EU, which is committed to a 'high level of protection and improvement of the quality of the environment' (Article 3 of the Treaty on European Union).

At time of print, following the UK exit from the EU, the Maritime Spatial Planning Directive, Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), and the Birds and Habitats Directives remain relevant legislation in relation to the marine environment within the UK. These have been transposed into NI law through Marine Strategy Regulations 2010, Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019, and The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017.

The ROI also implement the aforementioned EU Directives through national law. In the autumn of 2019, the Department of Housing, Local Government and Heritage (DHLGH) within the ROI initiated a process aimed at expanding Ireland's network of Marine Protected Areas (MPAs). The first stage of this process was to set up an Advisory Group to provide independent expert advice and recommendations on the required process. This group met on a monthly basis from December 2019 until submitting its final report in October 2020. The public consultation process on the Advisory Group report began in February 2021 and remained open until the end of July 2021. The Advisory Group report can be found at the following https://www.gov.ie/en/publication/135a8-expanding-irelands-marine-protected-area-network/.

3.1 EU Legislation and Policy

In addition to the Maritime Spatial Planning Directive, other EU legislation relevant to Carlingford Lough are:

- Water Framework Directive
- Habitats Directive
- Birds Directive
- Marine Strategy Framework Directive
- Urban Wastewater Treatment Directive

3.1.1 Water Framework Directive

As stated within Section 2.2 the EU primarily regulates the water environment through the WFD (Directive 2000/60/EC). The WFD acts as a framework for the development of integrated water management plans which address the issues of water use, water quality, river morphology, and the ecological value of waterbodies and their surrounding areas (NIEA, 2015a).

Within Northern Ireland, The Water (Amendment) (Northern Ireland) (EU Exit) Regulations 2019 ensures that the Water Framework Directive (as transposed) and the various supporting pieces of water legislation continue to operate after the 1st January 2021 (the date when the UK left the EU). These supporting regulations are listed at Schedule 2 of The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017.

The Northern Ireland Environment Agency (NIEA) is the competent authority tasked with implementation of these regulations in Northern Ireland. The RBMPs delivered by NIEA identify where the water environment is in a good or excellent condition and sets out objectives for the improvement or the prevention of deterioration of individual river, lake, marine and groundwaters from 2015 to 2027. The plan is typically prepared and reviewed once every six years with the first cycle in both jurisdictions covering the period of 2009 – 2015. For the first cycle, this included the international districts of Neagh-

Bann and North Western, where waterbodies flowed between Ireland and Northern Ireland. For the 2nd cycle 2018-2021 there will be a single administrative area established in the Republic of Ireland to coordinate the management of the North Western and Neagh Bann International RBDs with the relevant authorities in Northern Ireland. The third cycle RBMP 2021-2027 is currently out for public consultation.

In the Republic of Ireland, the European Communities (Water Policy) Regulations 2003 (SI 722 of 2003), subsequently amended by SI 413 of 2005, SI 219 of 2008, and SI 93 of 2010, is the national legislation transposing the Water Framework Directive into Irish law. The Regulations are the key legislative instrument for the implementation of the objectives of the WFD. The current River Basin Management Plan covers the period 2018-2021 (DHPLG, 2018). This is described in section 3.2.10 below.

A new River Basin Management Plan for 2022-2027 is currently open for public consultation until March 2022 (DHLGH, 2021). The draft Plan explains how cross-border cooperation is approached and the complexities involved in light of Brexit, stating bilateral relations are now governed primarily by the Good Friday (or Belfast) Agreement and relations between the EU and the UK are governed presently by the Withdrawal Agreement. WFD cross-border coordination is still conducted on a bilateral basis through the Department of Housing, Local Government and Heritage's North South Water Framework Directive Coordination Group.

Shellfish Waters designated under the Shellfish Waters Directive (2006/113/EC) and subsumed into the WFD, constitute the whole of the Northern Ireland shore of Carlingford Lough. Primarily the main shellfish waters include Ballyedmond and Cassey Water. However, these have since been amalgamated with many small shellfish waters. This amalgamation is in response to pollution reductions programmes for shellfish waters, which have also guided discharge standards for wastewater treatment works and sewerage systems within the catchment.

3.1.2 Habitats Directive

The Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora was developed with the aim of protecting habitats and species considered to be of European interest. This is achieved through Member States designating sites as Special Areas of Conservation (SAC) for the protection of habitats and species (as listed in Annex I and Annex II of the Habitats Directive respectively).

In the Republic of Ireland, the Habitats Directive is transposed in the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). The National Parks and Wildlife Service (NPWS) is the competent authority for the management of SAC sites in Ireland.

Following the UK EU Exit and transition period, the level of protection afforded to habitats and species in the wider countryside and in the designated European sites within the UK remains unchanged. Special Areas of Conservation (SACs) will become part of the UK national site network. There is no practical difference to these designated sites, and the requirements of those that manage them or make decisions related to them remains the same.

To ensure The Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended) are operable after the end of the EU transition period, changes have been made by The Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019. The changes are largely procedural and affect government and include the transfer of functions from the European Commission to DAERA, the competent authority for management of SACs within NI.

3.1.3 Birds Directive

Directive 2009/147/EC (originally Directive 79/409/EEC, amended in 2009) on the Conservation of wild birds (often referred to as the Birds Directive) was developed with the aim of protecting habitats and species considered to be of European interest. This is achieved through Member States designating sites as Special Protection Areas (SPA) for the protection wild birds and the habitats of listed species.

In the Republic of Ireland, the Birds Directive is transposed in the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). The National Parks and Wildlife Service (NPWS) is the competent authority for the management of SPA sites in Ireland.

Similar to SACs as described above, the UKs exit from the EU doesn't impact the level of protection afforded to SPAs

SAC and SPA designated sites form the Natura 2000 network of sites (sometimes referred to as N2K) within the EU.

3.1.4 Marine Strategy Framework Directive (MSFD)

The aim of the EU's Marine Strategy Framework Directive (2008/56/EC) is to more effectively protect the marine environment across Europe. The MSFD was adopted in June 2008. The Commission also produced a set of criteria and methodological standards to help Member States implement the Directive. These were revised in 2017 leading to the new Commission Decision on Good Environmental Status (GES).

The UK Marine Strategy Regulations 2010 require the UK to take the necessary measures to achieve or maintain Good Environmental Status through the development of a UK Marine Strategy. The UK Marine Strategy, sets out a comprehensive framework for assessing, monitoring and taking action across the UK's seas to achieve the shared vision for 'clean, healthy, safe, productive and biologically diverse ocean and seas'. There are strong links between the UK Marine Strategy and River Basin Management Plans (RBMPs). The RBMPs address the improvement and protection of the chemical and ecological status of surface waters over the whole river basin ranging from rivers, lakes and groundwaters through to estuaries and coastal waters out to one nautical mile at sea and overlap with the UK Marine Strategy in coastal waters. The Department for Environment, Food and Rural Affairs (DEFRA) are responsible implementation of the Regulations within the UK, with devolved responsibility for NI delegated to DAERA.

In the ROI work required by the MSFD is led by the Department of Housing, Local Government and Heritage, working with four other government departments. These are the Department of Agriculture, Food and the Marine (DAFM), the Department of Transport, the Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media, and the Department of the Environment, Climate and Communications. The Marine Institute also contributes to the delivery of the Directive through a wide range of monitoring programmes. The Initial Assessment, Targets and Indicators under the MSFD were all completed prior to adoption of MSP Directive. The associated Monitoring Programme and Programme of Measures (PoM) were developed in 2015 and 2016 respectively. The latter states that there are no transboundary impacts from the development of the Irish programme of measures (DECLG, 2016).

3.1.5 Urban Waste Water Treatment Directive (UWWTD)

The Urban Waste Water Treatment Directive (91/271/EEC) is designed to: "reduce the pollution of freshwater, estuarine, and coastal waters by domestic sewage and industrial wastewater collectively known as urban waste water."

The UWWTD is transposed in Northern Ireland by the Urban Waste Water Treatment Regulations (Northern Ireland) 2007 (DAERA, 2015) and regulated by the NIEA's Water Management Unit (WMU).

In ROI the licensing or certification of wastewater discharges are transposed into law under the Water Services Act, 2007; the Urban Waste Water Treatment (Amendment) Regulations 2004 and the Waste Water Discharge (Authorisation) Regulations 2007. The Regulations identify the Environmental Protection Agency as the regulator that authorises discharges from wastewater treatment plants. The management of urban wastewater collection and treatment infrastructure transferred from local authorities to Irish Water. Compliance with the requirements of the Directive is monitored by the EPA, with reports produced annually.

Waters must be identified as a sensitive area if they fall into one of the following groups:

- surface water bodies which are found to be eutrophic or likely to become eutrophic if preventative action is not taken,
- surface fresh waters intended for the abstraction of drinking water which could contain 50 mg of nitrate per litre if action is not taken, and
- areas where further treatment than secondary or equivalent treatment is necessary to meet other EC Directives such as the bathing or shellfish water directives.

All waters draining the catchments of the sensitive receiving water are included in the sensitive area designations under the UWWTD. Once an area has been identified as sensitive, qualifying WWTWs discharging either directly or indirectly into the sensitive area must have in place, within seven years, more stringent processes for the treatment of urban wastewater (DAERA, 2015). Carlingford Lough is not currently deemed as a sensitive area.

The UK Marine Strategy Regulations 2010 require the UK to take the necessary measures to achieve or maintain Good Environmental Status (GES) through the development of a UK Marine Strategy.

3.2 National Policy

National legislation in Northern Ireland relevant to Carlingford Lough are:

- The Marine Act (Northern Ireland) 2013
- The Environment (Northern Ireland) Order 2002
- Nature Conservation and Amenity Lands Order (Northern Ireland) 1985
- The Wildlife (Northern Ireland) Order 1985 (the Order) and amendment The Wildlife (Amendment) (Northern Ireland) Order 1995
- UK Marine and Coastal Access Act 2009

3.2.1 The Marine Act (Northern Ireland) 2013

The Marine Act (Northern Ireland) 2013 includes provisions for establishing Marine Conservation Zones (MCZs).

An MCZ is a type of Marine Protected Area (MPA), designated in the Northern Ireland territorial waters to protect nationally important habitats, species and geological/geomorphological features, while fully taking into account any economic, cultural or social consequences of doing so. These MCZs fulfil the obligations of The Marine Act (Northern Ireland) 2013 to contribute to an ecologically coherent UK network of MPAs as well as wider biodiversity commitments at North-East Atlantic and global level.

The Act also allows DAERA to make byelaws to protect MCZs from damage caused by unregulated activities such as anchoring, kite surfing, jet skiing etc. It is an offence to intentionally or recklessly destroy or damage a protected feature of an MCZ or to contravene a byelaw. There is currently one MCZ within Carlingford Lough which has been designated as it supports the habitat white lobe shell *(Philine quadripartite)* and sea-pen *(Virgularia mirabilis)* in soft stable infralittoral mud (Figure 1).

As mentioned in section 2.6, this Act along with the MCAA require the DAERA as the Marine Plan Authority MPA, to prepare marine plans.

3.2.2 The Environment Order 2002

In Northern Ireland, under The Environment (Northern Ireland) Order 2002 Areas of Special Scientific Interest (ASSIs) are protected areas designated for their species, habitat and/or geological features. Many of these are in coastal areas, with the designated area extending to the Mean Low Water Mark (MLWM). Coastal ASSIs that have marine features contribute towards the Marine Protected Area (MPA) network. Some ASSIs are also subject to other designations - for example they can be designated as a Special Area of Conservation or Special Protection Area.

3.2.3 Nature Conservation and Amenity Lands Order (Northern Ireland) 1985

An Area of Outstanding Natural Beauty is designated under the Nature Conservation and Amenity Lands Order (Northern Ireland) 1985. Encompassing the Mourne Mountains, north of Carlingford Lough, the Mourne AONB was designated in 1986 It has a relatively "young" geological development and has a rich diversity of natural, cultural and built heritage.

3.2.4 The Wildlife (Northern Ireland) Order 1985 (the Order) and amendment The Wildlife (Amendment) (Northern Ireland) Order 1995

The Wildlife (Northern Ireland) Order, prohibits the intentionally killing, taking or injuring of certain species of wild birds and animals or the intentional destruction, uproot or picking of certain wild plants. Under the Wildlife (Northern Ireland) Order it is an offence to release into the wild non-native invasive species as listed in Schedule 9 Part II of the Order.

3.2.5 Marine and Coastal Access Act 2009 [UK]

The Marine and Coastal Access Act 2009 (MCAA) includes provisions for marine licensing, with an overall objective of regulating sustainable development in a cohesive and fair manner. The Marine and Fisheries Division of DAERA are responsible for licensing and enforcement functions. Such activities that require a marine licence include dredging, construction, removal and sea disposal.

As mentioned in sections 2.6 and 3.2.1, this Act along with the Marine Act (Northern Ireland) 2013 require the DAERA as the Marine Plan Authority MPA, to prepare marine plans.

National legislation and policies in Ireland relevant to Carlingford Lough are:

- Foreshore Acts, 1933-2011
- Wildlife Acts, 1976-2012
- National Biodiversity Action Plan 2017-2021
- Marine Protected Areas
- River Basin Management Plan 2018-2021
- Planning and Development (Amendment) Act 2018

3.2.6 Foreshore Acts, 1933-2011

The Foreshore Acts provide for the granting of licences and leases for activities occurring on State-owned foreshore which begins at the mean high water mark and extends to the 12 nautical mile territorial sea limit. A foreshore licence is required for non-exclusive and temporary uses of the foreshore such as environmental survey work, site investigation purposes, cable and pipeline laying, etc. A foreshore lease is required for exclusive and permanent uses of the foreshore such as infrastructural development relating to offshore energy, aquaculture, marinas, reclamation, etc. Under these Acts the Minister also has power to prohibit removal of beach material. A new marine management regime is being established under the Maritime Area Planning (MAP) Bill currently being considered by the Oireachtas (https://www.oireachtas.ie/en/bills/bill/2021/104/). This will update some elements of the Foreshore Acts.

3.2.7 Wildlife Acts, 1976-2012

The Wildlife Act, 1976, is the principal national legislation providing for the protection of wildlife and the control of some activities that may adversely affect wildlife. The Wildlife Act, 1976, came into operation on 1 June 1977. The aims of the Wildlife Act, 1976, are to provide for the protection and conservation of wild fauna and flora, to conserve a representative sample of important ecosystems, to provide for the development and protection of game resources and to regulate their exploitation, and to provide the services necessary to accomplish such aims. The 1976 Act did not provide for the conservation of fish species nor of aquatic invertebrates in general.

The Wildlife Acts provide for the designation of Nature Reserves and Refuges for Fauna. There has been limited use of the provisions in the Wildlife Acts for the protection of the marine environment to date. The Act applies to land and foreshore so it is limited in that it cannot provide for protection beyond 12 nautical miles (i.e. beyond Ireland's territorial seas). The Wildlife (Amendment) Act, 2000 strengthened a number of existing features, including broadening the scope to include most species (including fish and aquatic invertebrates), providing a mechanism to give statutory protection to Natural Heritage Areas (NHAs) and strengthening the protection regime for SACs.

3.2.8 National Biodiversity Action Plan 2017-2021

The National Biodiversity Action Plan contains seven key objectives that set out a clear framework for Ireland's national approach to biodiversity, ensuring that efforts and achievements of the past are built upon, while looking ahead to what can be achieved over the next five years and beyond. The objectives are:

1. mainstreaming biodiversity across the decision making process in the State,
2. strengthening the knowledge base underpinning work on biodiversity issues,
3. increasing public awareness and participation,
4. ensuring conservation of biodiversity in the wider countryside,
5. ensuring conservation of biodiversity in the marine environment,
6. expanding and improving on the management of protected areas and protected species, and
7. enhancing the contribution to international biodiversity issues.

The objectives are supplemented with 119 targets across each area. In relation to the marine environment, for example, targets relate to progress made towards good ecological and environmental status of marine waters and fish stock levels being maintained or restored to levels that can produce maximum sustainable yield. Under the objective relating to enhancing the contribution to international biodiversity issues (Objective 7) there is a target specifically for enhanced cooperation with Northern Ireland on common issues. The associated actions relate to harmonised actions at an all-island level on issues of common concern; cooperation and coordination (where possible and relevant) on Species and Habitat surveillance initiatives under the Habitats and Birds Directives; and cooperation on and coordination of All-Island Species Protection Plans and Red List assessments.

3.2.9 Marine Protected Areas

In mid-February 2021 the ROI undertook a public consultation on expanding Ireland's network of Marine Protected Areas. The consultation extended over more than five months and closed at the end of July 2021. This consultation was based on an Expert Advisory Group report that provided independent expert advice and recommendations on the processes required and the challenges to be addressed in expanding Ireland's MPA network. Currently all designated EU SACs and SPAs are assumed to be marine protected areas, but the intention is to begin developing new legislation to provide for the identification, designation and management of 'national' MPAs in November 2021.This work is expected to continue into 2022.

3.2.10 River Basin Management Plan 2018-2021

The Plan sets out the actions that Ireland will take to improve water quality and achieve 'good' ecological status in water bodies (rivers, lakes, estuaries and coastal waters) by 2027. The second RBMP introduces new structures for implementing the Plan during the next phase. A Local Authority Waters and Communities Office has been established to help people to get involved in improving water quality at a local level. An Fóram Uisce, also newly established, is a forum for stakeholders, community groups and sectoral representatives. It will assist in raising awareness of water issues. Key actions specified within the Plan relate to improved waste water treatment infrastructure, conservation and leakage reduction, scientific assessments of water bodies and implementation of local measures by additional personnel, and the development of water and planning guidance for local authorities.

Whilst there is no explicit mention of Carlingford Lough in the ROI's RBMP attention is drawn to the need to work on a cross-border basis on issues such as invasive alien species, and general need to

coordinate on International River Basin Districts (IRBDs). Accordingly, co-ordination arrangements have been established by Ministers in both jurisdictions, a North/South Water Framework Directive Co-ordination Group has been created under the auspices of the North/South Working Group on Water Quality, a number of technical working groups with joint representation from technical experts within State bodies (North- South rivers and lakes group, UKTAG and support groups) have been created and there is also cross-representation on respective national and RBD level groups. The RBMP notes that following Brexit the "co-ordinating arrangements for managing shared water bodies may need to be reviewed and revised to take account of the changed circumstances" (DHPLG, 2018, p.127).

3.2.11 Planning and Development (Amendment) Act 2018

Part 5 of Planning and Development (Amendment) Act 2018 currently underpins marine planning in ROI (https://www.irishstatutebook.ie/eli/2018/act/16/enacted/en/html). These marine planning provisions will be replaced by provisions in the Maritime Area Planning Bill when it is enacted (https://www.oireachtas.ie/en/bills/bill/2021/104/). The new Bill includes provisions for development of sectoral or geographically sub-national marine plans (Designated Maritime Area Plans – DMAPs). In addition the MAP Bill provides for a new Maritime Area Regulatory Authority (MARA) to take administrative responsibility for foreshore authorisations and generally oversee the enforcement of this Act.

4 Identification of potential impacts on the designated features of Natura 2000 sites in Carlingford Lough with specific focus on aquaculture practices

Natura 2000 is a network of protected areas covering Europe's most valuable and threatened species and habitats. It is the largest coordinated network of protected areas in the world, extending across all 27 EU countries, both on land and at sea. It is made up of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) designated under the Habitats Directive and the Birds Directive, respectively.

In ROI, the National Parks and Wildlife Service (NPWS) are the competent authority for the management of Natura 2000 sites. NPWS is part of the Heritage Division of the Department of Housing, Local Government and Heritage.

Following the UKs exit from the EU, designated SPAs and SACs in Northern Ireland now contribute to the UK National Site Network. DAERA Marine and Fisheries Division takes responsibility for the marine features and the designation process is carried out in co-operation with NIEA Natural Environment Division, who deals with the biological and geological terrestrial features and the freshwater features of the designated areas.

Many marine activities exert pressures on Natura 2000 features. Detailing pressures and impacts of all marine activities is outside of the scope of this document, however due to the extensive aquaculture practices being carried out in this case study area, this has been chosen as an example activity to examine in greater depth. The process of examining this one activity could be usefully applied when exploring other pressures and impacts of relevant marine activities in the Carlingford Lough context and in other transboundary areas.

The Conservation objectives for the Natura 2000 designated sites within the shared waters of Carlingford Lough are summarised within Table 3.

Table 3: Summary of the Conservation Objectives for Natura 2000 designated sites within the shared waters of Carlingford Lough. Taken from NPWS 2013a, NPWS 2013b, and NIEA 2015b.

Designated Site	Designated Features	Conservation Objectives	Target
Carlingford Shore SAC ROI (Site Code: 002306)	Annual vegetation of drift lines	To maintain the favourable conservation condition of Annual vegetation of drift lines in Carlingford Shore SAC	• The overall extent of this habitat is unknown, however the general target for annual drift line vegetation extent is that it should be stable or increasing. • There should be no decline or change in the distribution of this habitat, unless it is the result of natural processes. • Maintain the natural circulation of sediment and organic matter throughout the site, without any physical obstructions. • Maintain the range of coastal habitats, including transitional zones, subject to natural processes. • Maintain the presence of species-poor communities with typical species: sea rocket, sea sandwort. Prickly saltwort and orache. • Negative indicator species (including non-native species) should represent less than 5% of the vegetation cover.
	Perennial vegetation of stony banks	To maintain the favourable conservation condition of Perennial vegetation of stony banks in Carlingford Shore SAC	• The current extent of this habitat is unknown. The habitat area should be stable or increasing, subject to natural processes, including erosion and succession. • There should be no decline or change in the distribution of this habitat, subject to natural processes

Designated Site	Designated Features	Conservation Objectives	Target
			• Maintain the natural circulation of sediment and organic matter, without any physical obstructions. • Maintain the range of coastal habitats, including transitional zones, subject to natural processes. • Maintain the typical vegetated shingle flora including the range of sub-communities within the different zones. • Negative indicator species (including non-native species) should make up less than 5% of the vegetation cover.
Carlingford Shore SPA ROI (Site Code: 004078)	Brent Goose (*Branta bernicla hrota*)	To maintain the favourable conservation condition of the Light-Bellied Brent Goose in Carlingford Lough SPA.	• Long term population trend stable or increasing. • There should be no significant decrease in the range, timing or intensity of use of areas by light-bellied brent goose, other than that occurring from natural patterns of variation.
	Wetlands	To maintain the favourable conservation condition of the wetland habitat at Carlingford Lough SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.	• The permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 595 hectares, other than that occurring from natural patterns of variation.
Carlingford Lough SPA NI (Site Code: UK9020161)	Overwintering population of Light-bellied Brent Geese (*Branta bernicla hrota*)	To maintain each feature in favourable condition*	• To maintain or enhance the population of the qualifying species

Designated Site	Designated Features	Conservation Objectives	Target
	Breeding population of Common Tern (*Sterna hirundo*)		• Fledging success sufficient to maintain or enhance population • To maintain or enhance the range of habitats utilised by the qualifying species • To ensure that the integrity of the site is maintained • To ensure there is no significant disturbance of the species and • To ensure that the following are maintained in the long term: ▪ Population of the species as a viable component of the site ▪ Distribution of the species within site ▪ Distribution and extent of habitats supporting the species ▪ Structure, function and supporting processes of habitats supporting the species.
	Breeding population of Sandwich Tern (*Sterna sandvicensis*)		

4.1 Aquaculture activities within designated protected areas in Carlingford Lough

As outlined within section 2.1 aquaculture activities within Carlingford Lough occur on licensed sites within both the intertidal and subtidal areas of the Lough. Subtidal aquaculture involves the bottom culture of the blue mussel *Mytilus edulis*, whilst intertidal aquaculture occurs predominantly in the form of off-bottom (trestle) culture of the Pacific oyster (*Magallana gigas* formally known as *Crassostrea gigas*).

On the northern side of the dredged channel, using mapping software it is possible to ascertain the total area occupied by licensed aquaculture sites within the boundary of the proposed Carlingford Lough SPA extension. The total area of the extended SPA occupied by currently licensed aquaculture sites is approximately 260 hectares. This equates to approximately 2% of the total designated area of the extended SPA (see Figure 6).

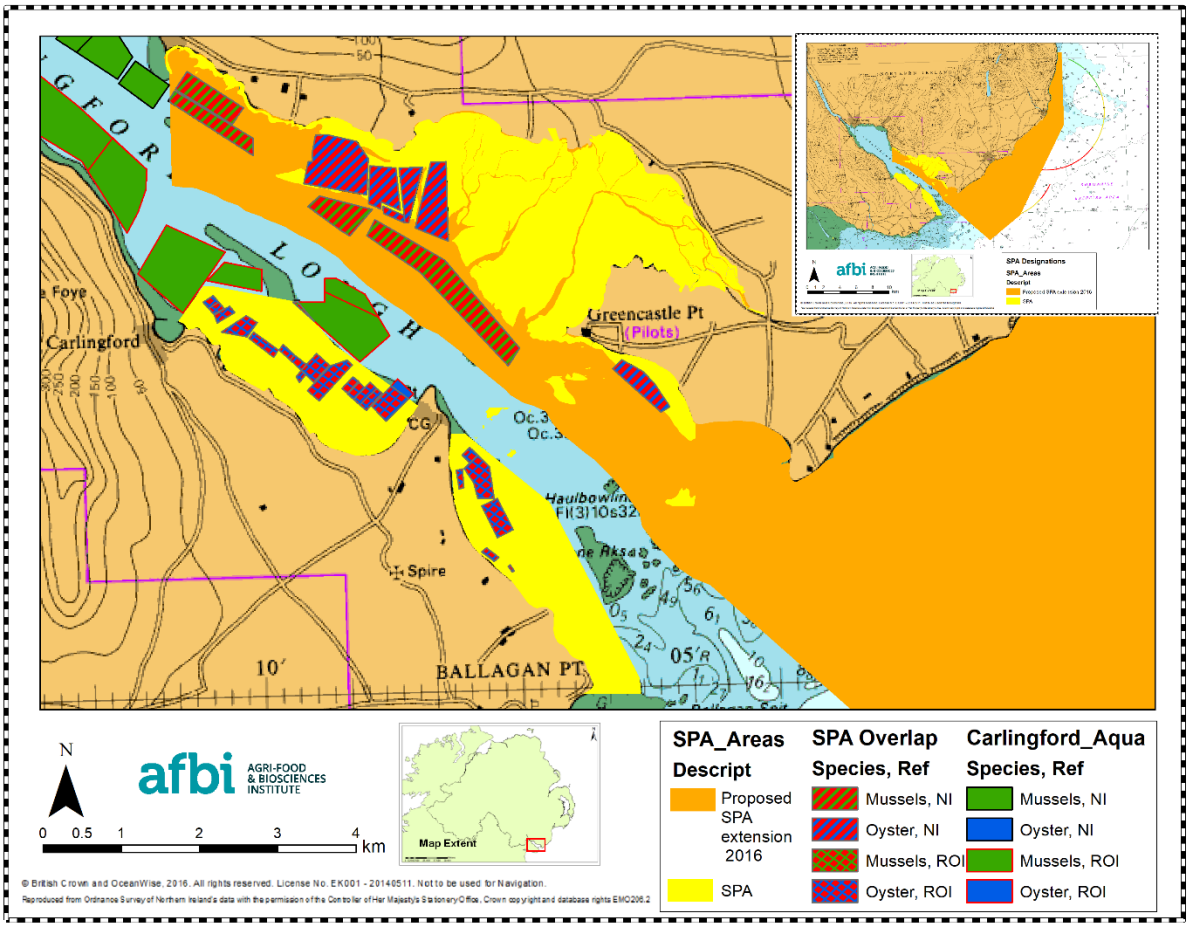


Figure 6: Map showing the areas within the boundaries of the Designated SPA sites within Carlingford Lough occupied by licensed aquaculture sites.

Similarly, on the southern side of the dredged channel, the total area of the Carlingford Shore SPA occupied by aquaculture is approximately 87 hectares. This equates to approximately 15% of the total designated area of the SPA. The total area of the SAC occupied by aquaculture is approximately 47 hectares. This equates to approximately 9% of the total designated area of the SAC (see Figure 7).

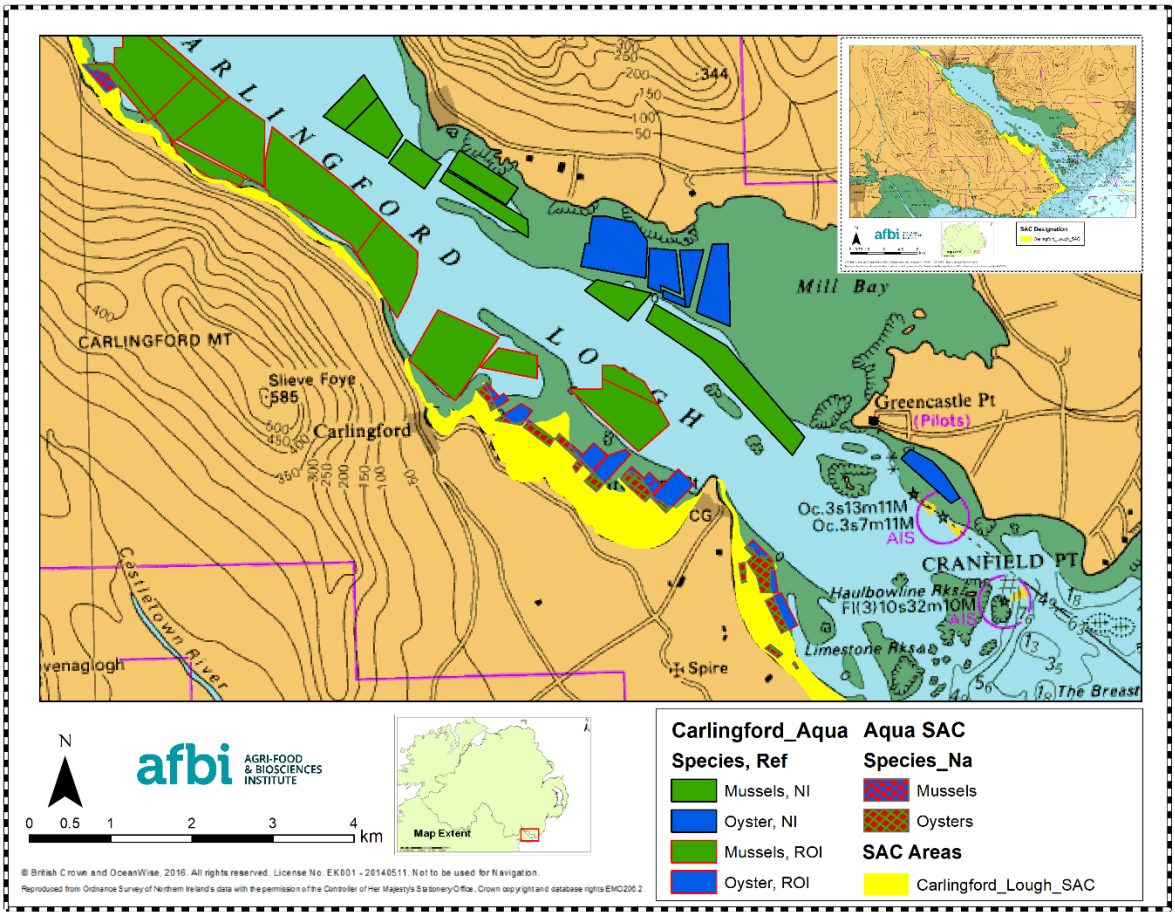


Figure 7: Map showing the areas within the boundaries of the Carlingford Lough SAC occupied by licensed aquaculture sites.

The Agri-Food and Biosciences Institute carried out a comprehensive cumulative impact assessment (AFBI, 2015), which investigated aquaculture activities within and adjacent to the Natura 2000 sites in Carlingford Lough. A summary of the potential pressures of aquaculture activities and their impacts on the designated features of the Natura 2000 sites outlined above can be viewed within Tables 4 and 5.

Tern populations within Carlingford Lough have fallen within recent years. This decline had been attributed to; wet weather, high tides, predation by Black backed gulls (Wolsey 2011 and 2012), disturbance, food availability, winter mortality and shifts in breeding populations outside of the site (Cook *et al*. 2013). There is no evidence to suggest that aquaculture activities within Carlingford Lough are negatively impacting the conservation objectives for this designated feature.

Light Bellied Brent Geese numbers within Carlingford Lough are relatively stable (NIEA pers comm.). There is no evidence to suggest that aquaculture activities within Carlingford Lough are negatively impacting the conservation objectives of this designated feature.

Intertidal shellfish aquaculture occurs on the lower intertidal zone and there therefore will not be any spatial overlap between aquaculture and annual vegetation of drift lines or perennial vegetation of stony banks. There is no evidence to suggest that aquaculture activities within Carlingford Lough are negatively impacting the conservation objectives of these designated features.

It is also worth noting that intertidal oyster culture is undertaken within the boundaries of all of the designated protected sites in Carlingford Lough. It has the potential therefore to impact the benthic habitats within these sites. Pseudofaeces and faeces bioaccumulation beneath intertidal oyster trestles has the potential to impact benthic community structures. These impacts are generally considered to

the small scale and localised (Nuges *et al*, 1996; Forrest and Creese 2006; Forrest *et al,* 2009 and the literature reviewed within).

Oyster trestles within Carlingford Lough are generally around 50 cm above the ground. This ensures adequate circulation and reduces sedimentation (Nuges *et al* 1996). In order to ensure that any changes in benthic sediments and communities remain small and localised, a programme of monitoring has been established (in agreement with the DAERA) for all new intertidal aquaculture sites within the Northern Irish region of Carlingford Lough granted in recent years. Baseline core samples and samples for Particle Size Analysis (PSA) are collected before the installation of trestles onsite (to be used as a baseline for future comparisons). PSA samples are collected monthly for analysis. If changes in sediments are detected, then further Infaunal samples are collected for baseline comparison and management options explored.

Table 4: Potential Impact of Aquaculture Activities on SPA Designated features

SPA designated feature	Potential impact of aquaculture activities on SPA designated features
Intertidal Oyster Culture	
Breeding Birds Common Tern (*Sterna hirundo*) and Sandwich Tern (*Sterna sandvicensis*)	**Disturbance at nesting sites** Tern species breed on three islands near the mouth of Carlingford Lough which are monitored annually by the Royal Society for the Protection of Birds (RSPB). Terns are colonial breeding waterbirds (Gonzalez-Solis *et al* 2001) and their high density nesting habits make them particularly sensitive to human disturbance (Rodgers and Smith, 1995). Using Flushing Distance ("the distance from the observer to the bird at the moment it actually began movement away from approaching disturbance" (Rodgers and Smith, 1997)) to determine protective buffer zones for bird species, several studies have recommended buffer or set back distances to minimise human disturbance to Tern species. These buffer zones range from 100m to 300 m (Rodgers and Smith 1995; Rodgers and Smith, 1997; Erwin 1989). There are no licensed aquaculture sites within 500 m of the Islands within Carlingford Lough on which Tern populations breed. A negative impact is not expected on this feature of the SPA.
	Damage to/disturbance within feeding areas Terns are surface feeding seabirds (Furness and Tasker, 2000; Einoder, 2009) feeding primarily on fish species (Comeau *et al* 2009; Burger and Gochfeld 2003 and Cramp and Simmons, 2004 (cited in Christel *et al* 2013)). Becker and Ludwigs, (2004) (cited in Dänhardt and Becker, 2011) state the maximum diving depth for Common Tern as 0.5 m. Sandeels are an important component in the diets of tern species (Dunn, 1972 and Tasker and Furness 1996). Sandeels have a preference for depths ranging between 30 to 70 m (Holland *et al*, 2005, Wright *et al* 2000) but have been found to occur as shallow as 15 m and up to depths of 120 m (Wright *et al* 1998 cited in Holland *et al*. 2005). The main food source for Common Tern populations in the Wadden Sea has been identified as juvenile herring (Greenstreet *et al* 1999). Common Tern breeding success in the Wadden Sea has been strongly linked to the annual stocks of juvenile herring (Greenstreet *et al* 1999). An area within the Irish Sea just outside the mouth of Carlingford Lough has been identified as potential herring spawning grounds (AFBI unpublished data). Breeding Common Terns

	have a foraging range of approximately 7km (Greenstreet *et al* 1999). They could therefore potentially be feeding on juvenile herring within this area. The main prey species of Tern populations within Carlingford Lough is not presently known. Intertidal aquaculture activities do therefore not impact upon the feeding and foraging areas of the Tern species for which the Carlingford Lough SPA is designated.
	Impacts on prey availability As Tern species feed mainly on fish, shellfish aquaculture will not impact on the availability of prey species for these birds. There are several factors that are impacting the Tern numbers and breeding success within Carlingford Lough. This includes; wet weather, high tides, predation by Black backed gulls (Wolsey 2011 and 2012), disturbance, food availability, winter mortality and shifts in breeding populations outside of the site (Cook *et al*. 2013).
Overwintering (non-breeding) Birds Light-bellied Brent Geese (*Branta bernicla hrota*)	**Human presence within their preferred habitat** Light Bellied Brent Geese numbers within Carlingford Lough are counted annually through the Wetland Bird Survey (WeBS) Wildfowl and Wader Counts. These counts are undertaken at high tide and may not be representative of the populations utilising the site at low tide (when intertidal aquaculture operators are onsite). Gittings and O'Donoghue (2012) investigated the effects of intertidal oyster aquaculture on the distribution of waterbirds within six sites in the Republic of Ireland. In their investigations Gittings and O'Donoghue (2012) found that Light Bellied Brent Geese showed a variable response to oyster trestles. During their investigations Gittings and O'Donoghue (2012) state that "detectable disturbance impacts to birds were only observed occasionally and were usually minor (birds which flushed but resettled nearby)" and at some sites Light bellied Brent Geese were observed feeding on top of the oyster trestles. The preferred food of Light bellied Brent Geese is intertidal eelgrass (*Zostera marina*) (Owen and Black 1990, Hassall and Lane 2005, Inger *et al.* 2006). There are currently no licensed aquaculture sites within the areas identified as intertidal eelgrass beds within Carlingford Lough.

	Damage/disturbance to feeding areas/species As mentioned above, the preferred food of Light bellied Brent Geese is intertidal eelgrass (*zostera marina*) (Owen and Black 1990, Hassall and Lane 2005, Inger *et al.* 2006). Alternative food sources that can be exploited by Light Bellied Brent Geese include green algae, saltmarsh plants and terrestrial grassland (Owen and Black 1990, Inger *et al.* 2006). Preliminary studies on the effects of oyster trestles on bird feeding behaviour found that the percentage of birds observed feeding did not differ between the reference areas (areas free of aquaculture) and the trestle areas (Hilgerloh *et al* 2001). For some species of bird the trestles provided an additional food source. The intertidal oyster culture sites within Carlingford Lough have the potential to cause disturbance to Light Bellied Brent Geese populations through human presence in intertidal areas within which they feed on eelgrass. Areas currently licensed for intertidal aquaculture do not overlap with identified eelgrass beds.
SPA designated feature	**Potential impact of aquaculture activities on SPA designated features**
Subtidal Mussel culture	
Breeding Birds Common Tern (*Sterna hirundo*) and Sandwich Tern (*Sterna sandvicensis*)	**Disturbance at nesting sites** Tern species breed on three islands near the mouth of Carlingford Lough which are monitored annually by the Royal Society for the Protection of Birds (RSPB). Terns are colonial breeding waterbirds (Gonzalez-Solis *et al* 2001) and their high density nesting habits make them particularly sensitive to human disturbance (Rodgers and Smith, 1995). Using Flushing Distance ("the distance from the observer to the bird at the moment it actually began movement away from approaching disturbance" (Rodgers and Smith, 1997)) to determine protective buffer zones for bird species, several studies have recommended buffer or set back distances to minimise human disturbance to Tern species. These buffer zones range from 100m to 300 m (Rodgers and Smith 1995; Rodgers and Smith, 1997; Erwin 1989). There are no licensed aquaculture sites within 500 m of the Islands within Carlingford Lough on which Tern populations breed. A negative impact is not expected on this feature of the SPA.

	Damage to/disturbance within feeding areas Terns are surface feeding seabirds (Furness and Tasker, 2000; Einoder, 2009) who feed primarily on fish species (Comeau *et al* 2009; Burger and Gochfeld 2003 and Cramp and Simmons, 2004 (cited in Christel *et al* 2013)). Becker and Ludwigs, (2004) (cited in Dänhardt and Becker, 2011) state the maximum diving depth for Common Tern as 0.5 m. Sandeels are an important component in the diets of tern species (Dunn, 1972 and Tasker and Furness 1996). Sandeels have a preference for depths ranging between 30 to 70 m (Holland *et al*, 2005, Wright *et al* 2000) but have been found to occur as shallow as 15 m and up to depths of 120 m (Wright *et al* 1998 cited in Holland *et al*. 2005). The main food source for Common Tern populations in the Wadden Sea has been identified as juvenile herring (Greenstreet *et al* 1999). Common Tern breeding success in the Wadden Sea has been strongly linked to the annual stocks of juvenile herring (Greenstreet *et al* 1999). An area within the Irish Sea just outside the mouth of Carlingford Lough has been identified as potential herring spawning grounds (AFBI unpublished data). Breeding Common Terns have a foraging range of approximately 7km (Greenstreet *et al* 1999). They could therefore potentially be feeding on juvenile herring within this area. Mussel beds are not the preferred habitat for herring or sandeel therefore it can be inferred that Tern species within Carlingford Lough are not feeding within the areas where bottom culture of mussels is undertaken. Resultantly vessel activity within bottom mussel cultivation areas will not disturb feeding terns.
	Impacts on prey availability As Tern species feed mainly on fish, shellfish aquaculture will not impact on the availability of prey species for these birds. There are several factors that are impacting the Tern numbers and breeding success within Carlingford Lough. This includes; wet weather, high tides, predation by Black backed gulls (Wolsey 2011 and 2012), disturbance, food availability, winter mortality and shifts in breeding populations outside of the site (Cook *et al*. 2013).

Overwintering (non-breeding) Birds Light-bellied Brent Geese (*Branta bernicla hrota*)	**Human presence within their preferred habitat** The preferred food of Light bellied Brent Geese is intertidal eelgrass (*zostera marina*) (Owen and Black 1990, Hassall and Lane 2005, Inger *et al.* 2006). Alternative food sources that can be exploited by Light Bellied Brent Geese include green algae, saltmarsh plants and terrestrial grassland (Owen and Black 1990, Inger *et al.* 2006). Waters with depths exceeding 0.5m are outside the feeding range for this species (Clausen, 2000, cited in MI 2019). Subtidal mussel culture areas are therefore not used by Brent geese for foraging. MI, 2019 noted that whilst birds may occasionally roost on the waters over licenced subtidal aquaculture sites during daylight hours, the Light-bellied Brent geese that utilise Carlingford Lough roost overnight ion Dundalk Bay.
	Damage/disturbance to feeding areas/species As mentioned above, the preferred food of Light bellied Brent Geese is intertidal eelgrass (*zostera marina*) (Owen and Black 1990, Hassall and Lane 2005, Inger *et al.* 2006). Alternative food sources that can be exploited by Light Bellied Brent Geese include green algae, saltmarsh plants and terrestrial grassland (Owen and Black 1990, Inger *et al.* 2006). Subtidal mussel culture will therefore not impact the preferred feeding areas/species of Light bellied Brent goose.

Table 5. Potential Impact of Aquaculture Activities on SAC Designated features

SAC designated feature	**Potential impact of aquaculture activities on SAC designated features**
Intertidal Oyster culture	
Annual vegetation of drift lines	This Annex I habitat occurs primarily on deposits of shingle found lying at or above mean high-water spring tides (JNCC, 2007). Intertidal shellfish aquaculture occurs on the lower intertidal zone and there therefore will not be any spatial overlap between aquaculture and this feature of the SAC. Whilst aquaculture activities overlap with the SAC area, they do not intersect with the SAC designated features.

Perennial vegetation of stony banks	This Annex I habitat is found at the limit of high tide (JNCC 2007). Intertidal shellfish aquaculture occurs on the lower intertidal zone and there therefore will not be any spatial overlap between aquaculture and this feature of the SAC.
SAC designated feature	**Potential impact of aquaculture activities on SAC designated features**
Subtidal Mussel culture	
Annual vegetation of drift lines	This Annex I habitat occurs primarily on deposits of shingle found lying at or above mean high-water spring tides (JNCC, 2007). Mussel culture within Carlingford Lough is subtidal, therefore there will not be any spatial overlap between aquaculture and this feature of the SAC.
Perennial vegetation of stony banks	This Annex I habitat is found at the limit of high tide (JNCC 2007). Mussel culture within Carlingford Lough is subtidal, therefore there will not be any spatial overlap between aquaculture and this feature of the SAC.

4.2 Identification of the mitigation measures for potential impacts of aquaculture activities on designated protected areas

Assessments have been undertaken on the potential impacts of aquaculture activities on the designated features of the SPA and SAC sites within Carlingford Lough in both jurisdictions (AFBI 2015, MI 2019). These reports concluded that the current licensed aquaculture activity within Carlingford Lough does not negatively impact on Brent geese use of the SPA nor are there any current impacts on the breeding Tern population within the SPA. However, in order to ensure that no negative impacts arise from aquaculture activities on the bird species for which the SPA sites within Carlingford Lough are designated several mitigation measures have been recommended (AFBI, 2015).

Assessments have also been undertaken on the potential impacts of aquaculture activities on the SAC designated features within Carlingford Lough (AFBI 20154, ATKINS 2019). Both reports concluded that there is currently no spatial overlap between licensed aquaculture sites and the Annex I habitats for which the Carlingford Shore SAC is designated.

The mitigation measures outlined above are summarised within Tables 6 and 7.

In order to assess the ecological carrying capacity of aquaculture activities within Carlingford Lough, to ensure the preservation of the habitats utilised by the species for which the SPAs within Carlingford Lough are designated, the Sustainable Mariculture in northern Irish Lough Ecosystems (SMILE) model is currently being utilised by AFBI (https://www.afbini.gov.uk/articles/sustainable-mariculture-smile). The SMILE model is used for the collation and processing of scientific information, and is discussed further within Section 6.

Table 6: Potential mitigation measures for licensed aquaculture activities within the designated SPAs within Carlingford Lough.

SPA designated feature	Mitigation of potential Impacts arising from Aquaculture activities
Intertidal oyster culture	
Breeding Birds Common Tern (*Sterna hirundo*) and Sandwich Tern (*Sterna sandvicensis*)	**Disturbance at nesting sites** In the absence of empirical data on the recommended protective buffer distance for Tern species in Carlingford Lough, a highly precautionary figure of 500 m was utilised by AFBI 2015 to highlight the proximity of licensed aquaculture sites to the islands utilised by breeding Tern species. Until field investigations have been undertaken within Carlingford Lough to determine the flushing distance for Tern species in relation to intertidal aquaculture activities any future aquaculture developments should maintain a precautionary distance of up to 500m from nesting Terns.
	Damage to/disturbance within feeding areas To prevent any potential impacts future aquaculture developments should avoid areas where Tern prey species congregate, such has herring spawning grounds or sandy substrates preferred by sandeels (*Ammodytes sp*). Within Northern Ireland surveys are undertaken within any potential new aquaculture areas and sediment samples collected for Particle Size analysis (PSA) to determine if the proposed area contains suitable sandeel habitat.
	Impacts on prey availability As stated before, as long as aquaculture does not encroach upon Tern feeding areas turn prey species should be unaffected.
Overwintering (non-breeding) Birds Light-bellied Brent Geese (*Branta bernicla hrota*)	**Human presence within their preferred habitat** Any future aquaculture developments should avoid areas of eelgrass habitat.
	Damage/disturbance to feeding areas/species Any future aquaculture developments should avoid areas of eelgrass habitat.

Subtidal mussel culture	
Breeding Birds **Common Tern (*Sterna hirundo*) and Sandwich Tern (*Sterna sandvicensis*)**	**Disturbance at nesting sites** In the absence of empirical data on the recommended protective buffer distance for Tern species in Carlingford Lough, a highly precautionary figure of 500 m was utilised by AFBI 2015 to highlight the proximity of licensed aquaculture sites to the islands utilised by breeding Tern species. Until field investigations have been undertaken within Carlingford Lough to determine the flushing distance for Tern species in relation to intertidal aquaculture activities any future aquaculture developments should maintain a precautionary distance of up to 500m from nesting Terns.
	Damage to/disturbance within feeding areas To prevent any potential impacts future aquaculture developments should avoid areas where Tern prey species congregate, such has herring spawning grounds or sandy substrates preferred by sandeels (*Ammodytes sp*). Within Northern Ireland surveys are undertaken within any potential new aquaculture areas and sediment samples collected for Particle Size analysis (PSA) to determine if the proposed area contains suitable sandeel habitat.
	Impacts on prey availability As stated before, as long as aquaculture does not encroach upon Tern feeding areas turn prey species should be unaffected.
Overwintering (non-breeding) Birds Light-bellied Brent Geese (*Branta bernicla hrota*)	**Human presence within their preferred habitat** Not applicable to subtidal aquaculture.
	Damage/disturbance to feeding areas/species Not applicable to subtidal aquaculture.

Table 7: Potential mitigation measures for licensed aquaculture activities within the Carlingford Lough SAC.

SAC designated feature	Mitigation of Potential impacts of aquaculture activities
Intertidal oyster aquaculture	
Annual vegetation of drift lines	Intertidal shellfish aquaculture occurs on the lower intertidal zone therefore there is not any spatial overlap between aquaculture and this feature of the SAC. There is however, the potential for aquaculture operations to indirectly impact upon this feature through vehicle/pedestrian access to the licensed aquaculture areas. The access routes for the main areas of aquaculture activity on the southern shores of Carlingford Lough were surveyed by AFBI in early 2013 (AFBI 2013, Annex IV and Annex V). As can be seen from these reports, at this time operators accessed the shore solely via existing slipways or manmade paths and therefore do not impact upon this feature of the SAC. As long as aquaculture site operatives limit their site access to pre-existing manmade paths and slipways, then damage or disturbances to SAC designated features should be minimal.
Perennial vegetation of stony banks	Intertidal shellfish aquaculture occurs on the lower intertidal zone therefore there is not any spatial overlap between aquaculture and this feature of the SAC. There is however, the potential for aquaculture operations to indirectly impact upon this feature through vehicle/pedestrian access to the licensed aquaculture areas. The access routes for the main areas of aquaculture activity on the southern shores of Carlingford Lough were surveyed by AFBI in early 2013 (AFBI 2013, Annex IV and Annex V). As can be seen from these reports, at this time operators accessed the shore solely via existing slipways or manmade paths and therefore do not impact upon this feature of the SAC. As long as aquaculture site operatives limit their site access to pre-existing manmade paths and slipways, then damage or disturbances to SAC designated features should be minimal.

Subtidal mussel Aquaculture	
Annual vegetation of drift lines	There is no spatial overlap between subtidal mussel culture and this feature of the SAC.
Perennial vegetation of stony banks	There is no spatial overlap between subtidal mussel culture and this feature of the SAC.

5 Spatial interactions between aquaculture practices and other sectors

Section 2 outlines some of the maritime uses and activities that are currently undertaken within Carlingford Lough. Of the activities outlined within section 2, only anchorages and the south Eastern Canoe trail overlap with currently licensed aquaculture sites within Carlingford Lough (Figure 8). As is shown within Figure 8 the South Eastern Canoe trail passes over several licensed intertidal oyster sites as well as licensed subtidal mussel aquaculture sites on the Northern shores of Carlingford Lough. There is also one area identified as an anchorage area that overlaps with a licensed subtidal mussel sites to the south of the dredged channel. Potential impacts and mitigation measures are outlined within Table 8, however these activities should be able to coexist within Carlingford Lough.

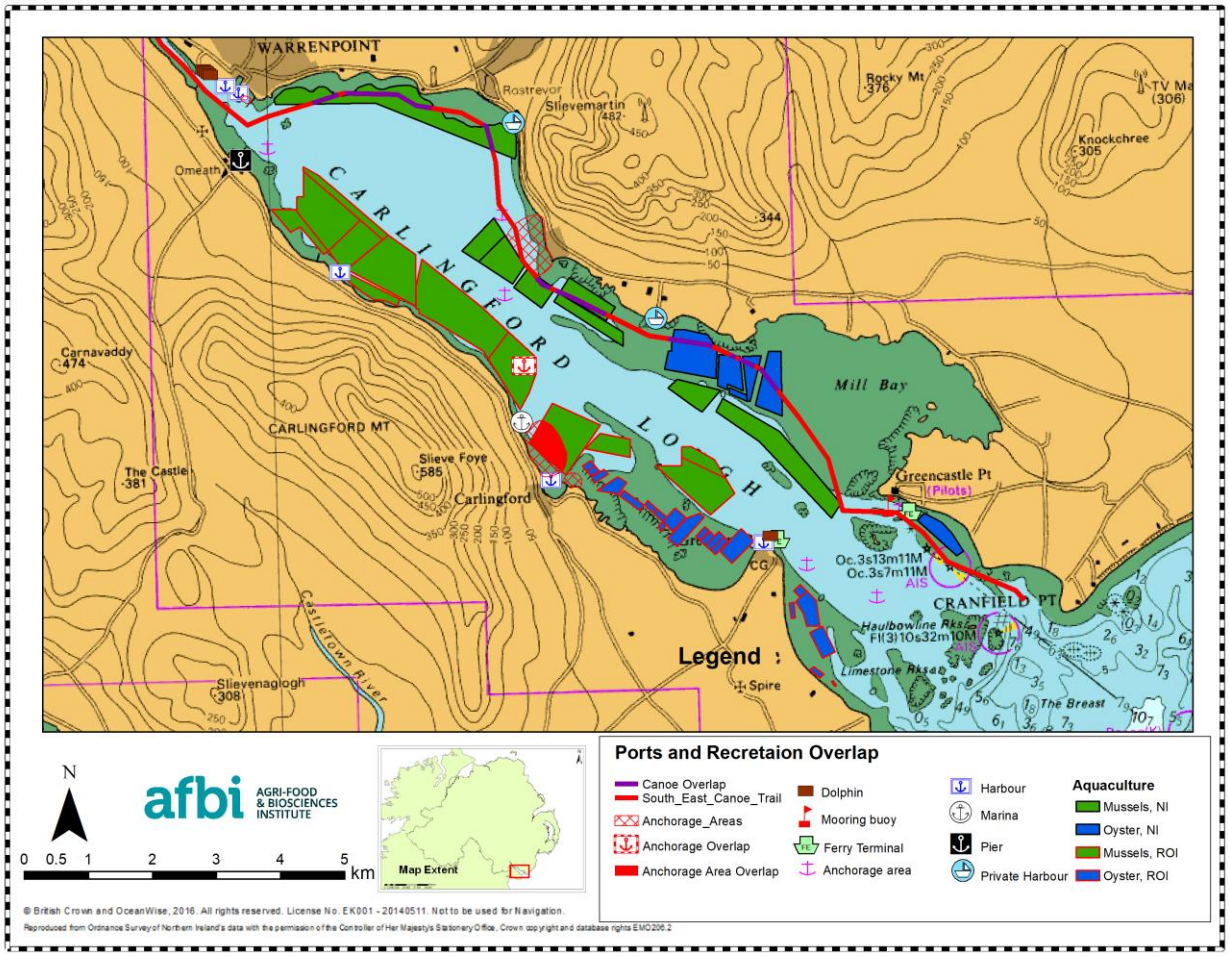


Figure 8: Map showing the spatial interactions between aquaculture activities and the other uses/activities occurring within Carlingford Lough as outlined within Section 2.

Table 8: Potential impacts and suggested mitigation for marine activities and users within Carlingford Lough that have a spatial overlap with licensed aquaculture sites.

Sector	Feature	Aquaculture Overlap	Potential impacts	Mitigation of impacts
Ports and harbour facilities	Anchorage Areas	Subtidal Mussel beds	Potential risk for disturbances to mussel bottom culture as a result of boats dropping anchor above beds. Risk of contamination from fuel spills.	Where possible small craft users should avoid mooring or dropping anchor within anchorage areas which overlap with licensed subtidal mussel aquaculture sites. Where anchorage areas are identified in aquaculture applications, provision to accommodate anchorage activity should be made.
Tourism and recreation	South East Canoe Trail	Intertidal Oyster trestles	Risk to oyster trestles at high tide is negligible. Trestles could pose an obstacle for kayaks/canoes at low /mid tide.	Canoes and kayaks should avoid oyster trestles or navigate the area at high tide. The Commissioner of Irish Lights have marked aquaculture areas with yellow 'X' top-marks to aid in navigation with yellow lights for low light navigation.
		Subtidal Mussel beds	Risk to mussel bottom cultures is negligible. Potential for disruption to kayaks/canoes as a result of aquaculture vessels operating within the area, (dredging and harvesting).	Canoes and kayaks should avoid entering aquaculture areas when vessels are operating within the areas. The Commissioner of Irish Lights marker buoys can be used to assist in navigation around aquaculture sites.

6 Ecosystem-based management

In ecological terms, the carrying capacity of an ecosystem is the size of the population or community that can be supported indefinitely upon the available resources and services of that ecosystem. An ecosystem approach to marine management is legally required under the EU Marine Strategy Framework Directive and the EU's Maritime Spatial Planning Directive. The rivers and lakes of the island of Ireland are designated as being within a single eco-region (eco-region 17), meaning a high degree of coordination between the authorities in both jurisdictions is necessary to ensure coherent management of the entire aquatic environment.

Catchment or ecosystem modelling is concerned with the use of mathematical models and systems analysis for the description of ecological, biogeochemical and socio-ecological processes and for the sustainable management of resources (Ferreira *et al*., 2007). Integrating existing models (e.g. SWAT, DELFT 3, SimCat) which have been developed for various terrestrial and estuarine environments is critical to dealing with EU Directives such as the Water Framework Directive. The purpose of modelling is to assist in the assessment and monitoring of water quality as required by the WFD, and further refine source apportionment of nutrient loads from terrestrial to estuarine and marine environments for purposes of minimising eutrophication.

6.1 SMILE Model

The Sustainable Mariculture in northern Irish Lough ecosystems (SMILE) model is a model used for the collation and processing of scientific information. Developed in 2007, it enables the application of an integrated framework for the determination of sustainable carrying capacity in the shellfish production areas for which it was developed (namely; Carlingford Lough, Strangford Lough, Belfast Lough, Larne Lough and Lough Foyle).

The SMILE model is currently being utilised by AFBI on behalf of local government departments to determine the ecological carrying capacity, the production carrying capacity and the cumulative impact of aquaculture activities within Carlingford Lough.

Using Chlorophyll a (Chl a) as a proxy for phytoplankton biomass the SMILE ecosystem model can determine the degree to which aquaculture species reduce the overall ecosystem phytoplankton biomass and hence food availability for other organisms within Carlingford Lough. This can therefore be utilised by government departments when considering applications for new aquaculture sites within the Lough as the model can simulate the impact on the ecosystem of increasing the abundance of filter-feeding organisms in Carlingford Lough.

For further information on the SMILE model see Ferreira *et al* (2007).

6.2 SWELL project

The Shared Waters Enhancement and Loughs Agency (SWELL) project represents a cross-border partnership comprising NI Water, Irish Water, Agri-Food & Biosciences Institute (AFBI), Loughs Agency and East Border Region, working collaboratively to improve water quality within the shared waters of Carlingford Lough and Lough Foyle. This €35m EU-funded project aims to improve the quality of water through the upgrade of wastewater assets on both sides of the border. The SWELL project is due for completion in 2023 and aims to deliver sustainable upgrades to wastewater assets on both sides of the border and make a positive contribution towards 'Good Ecological Status' under the EU Water Framework Directive.

Since environmental pressures do not recognise international boundaries and borders, the only mechanism for delivering improved water quality in the shared waters is to consider each lough catchment as a single ecosystem, impacted by polluters on both sides of the border. A number of key activities including catchment studies, ecosystem modelling and capital upgrades (or construction

packages) to deliver improvements to wastewater assets in Ireland and Northern Ireland are being carried out.

The project's legacy will be the development of a unique ecosystem model that will support further improvements in these shared waters. Work undertaken through the SWELL project will extend the prior modelling frameworks developed through the SMILE and EASE (Enhanced Application of the SMILE Ecosystem model to Lough Foyle) projects. The project is modelling from "Source to Sea" taking into account all inputs within the catchments (Figure 9). The SWELL project will utilise water and sediment quality models coupled with hydrodynamic models (Delft-WAQ) to determine the temporal and spatial impact of individual bacterial sources on existing and planned aquaculture areas. The SWELL modelling chain will interface with Sewerage Network Models (DAPs), developed by the water utilities on both sides of the border, at all key points, i.e. in the catchment, lough areas, and adjacent marine system.

For more information on SWELL, please see the project website. (The SWELL Project | Swell Project)

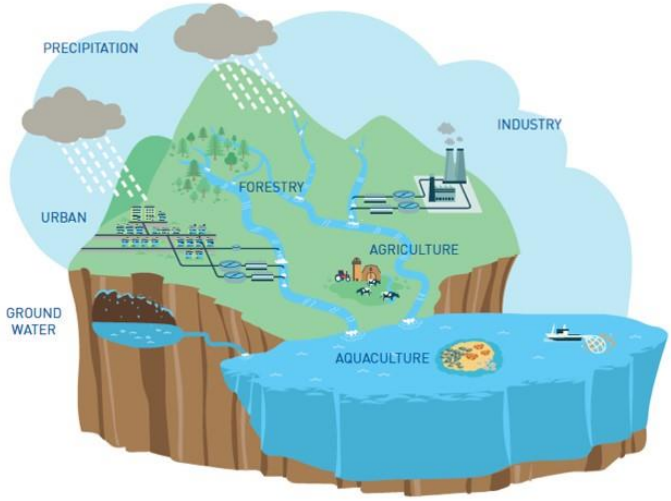


Figure 9. Illustration showing the coverage of the SWELL Project Legacy Models

7 Operational guidance for users of Carlingford Lough

As outlined within Section 1 of this document, activities and regulations within the shared waters of Carlingford Lough are managed, licensed and enforced by numerous governing bodies within both jurisdictions. One of the objectives of this guidance document is to provide information on activities within the Lough, their governing legislation and policy, and their responsible bodies in each jurisdiction. It should be kept in mind that the picture is an evolving one e.g. in the ROI the MAP Bill (https://www.oireachtas.ie/en/bills/bill/2021/104/) will change how the maritime area is managed, separately work is underway to establish new legislation related to MPAs (https://www.gov.ie/en/publication/e00ec-marine-protected-areas/).

Figures 10 to 15 provide information as to responsibilities within each jurisdiction for each of the areas highlighted within Section 2, and Table 9 below show the acronyms utilised within the flow charts within Figures 10 to 15.

Table 9: Acronyms used within Figures 10 to 15.

AFBI	Agri-Food and Biosciences Institute
DAERA	Department of Agriculture, Environment and Rural Affairs
DAFM	Department of Agriculture, Food and the Marine
DHLGH	Department of Housing, Local Government and Heritage
EPA	Environmental protection Agency
LA	Lough's Agency
MI	Marine Institute
NIEA	Northern Ireland Environment Agency
NPWS	National Parks and Wildlife Service
NRL	National Reference Laboratory

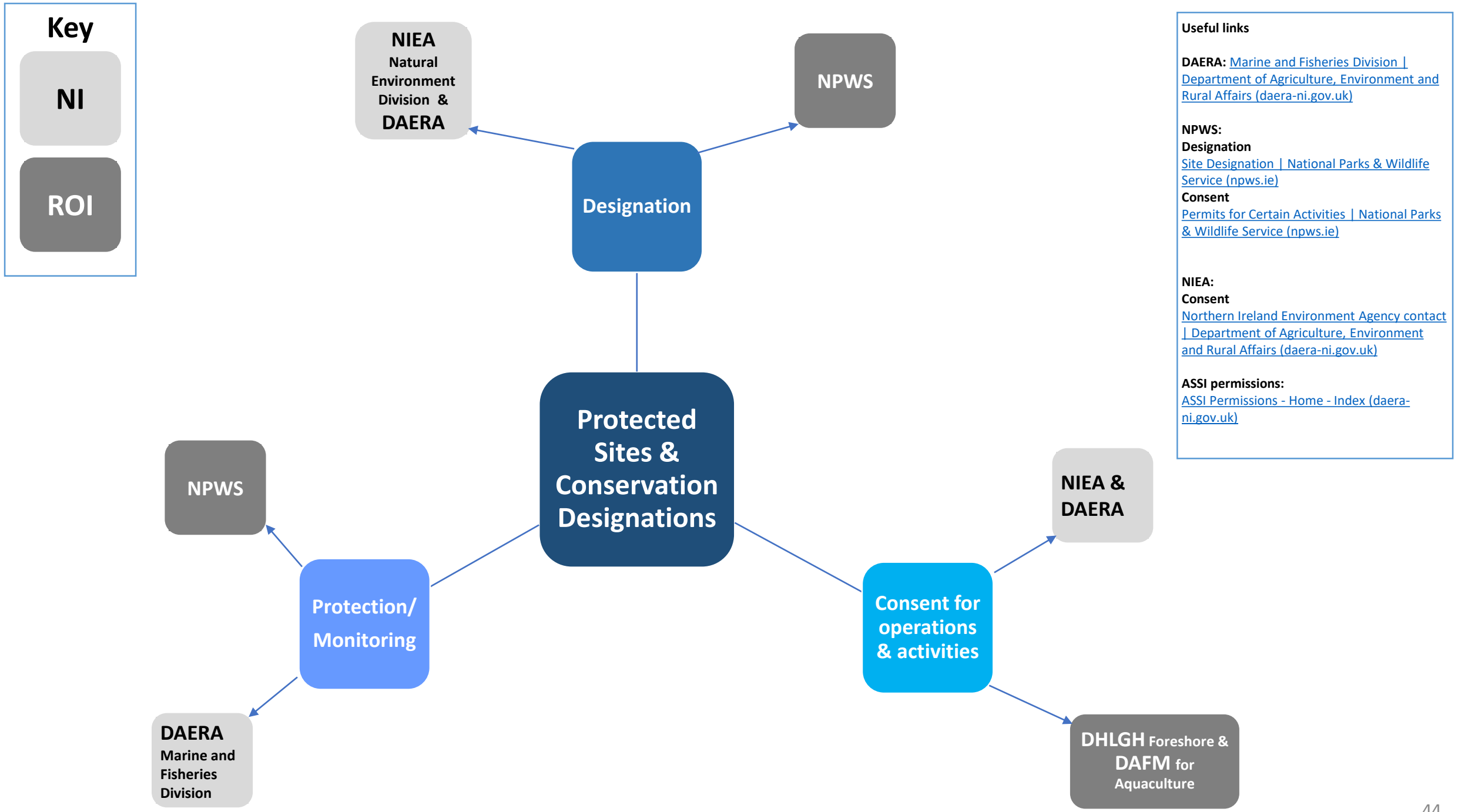
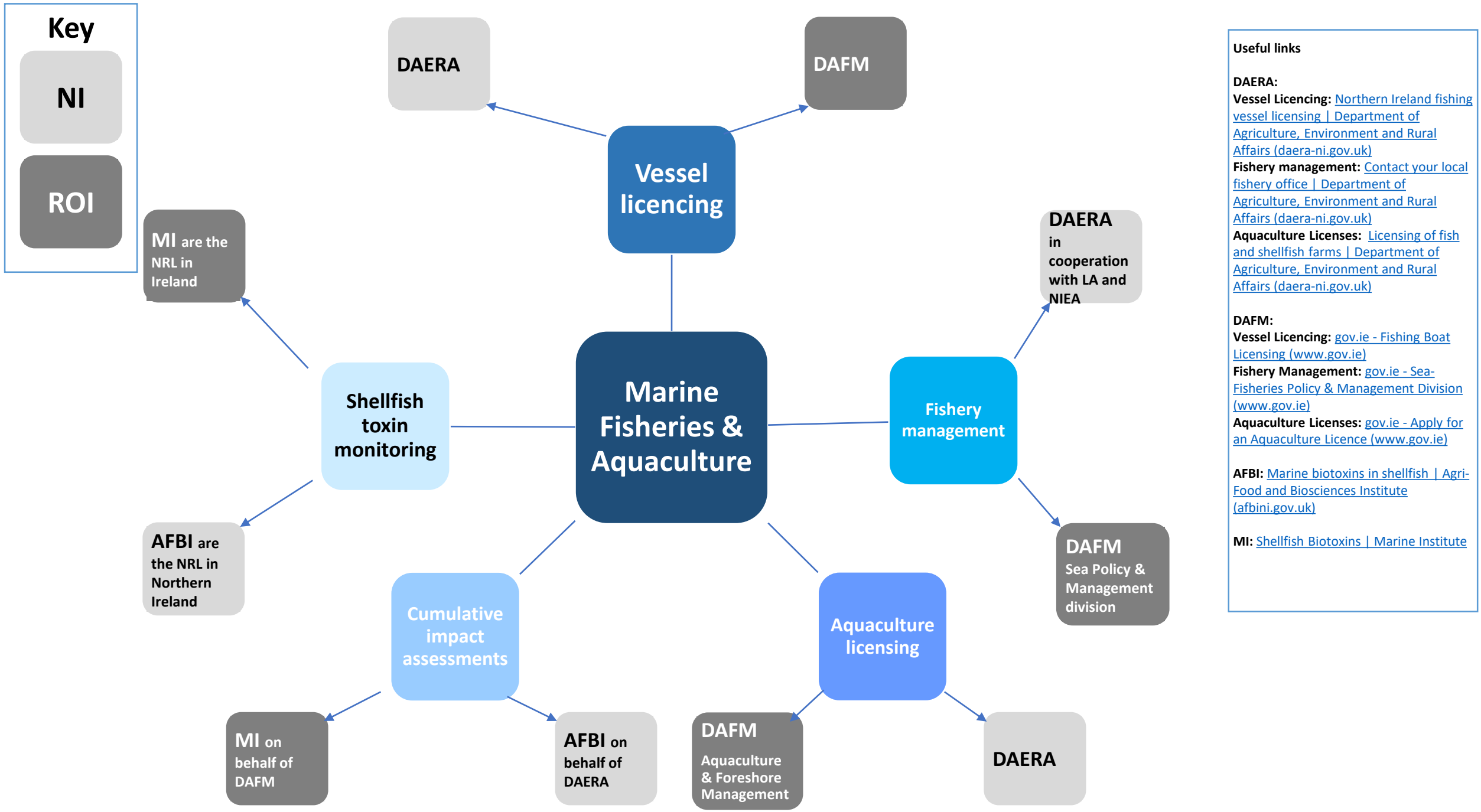


Figure 10: Flow chart highlighting management responsibilities for protected sites and Conservation Designations within Carlingford Lough.



Useful links

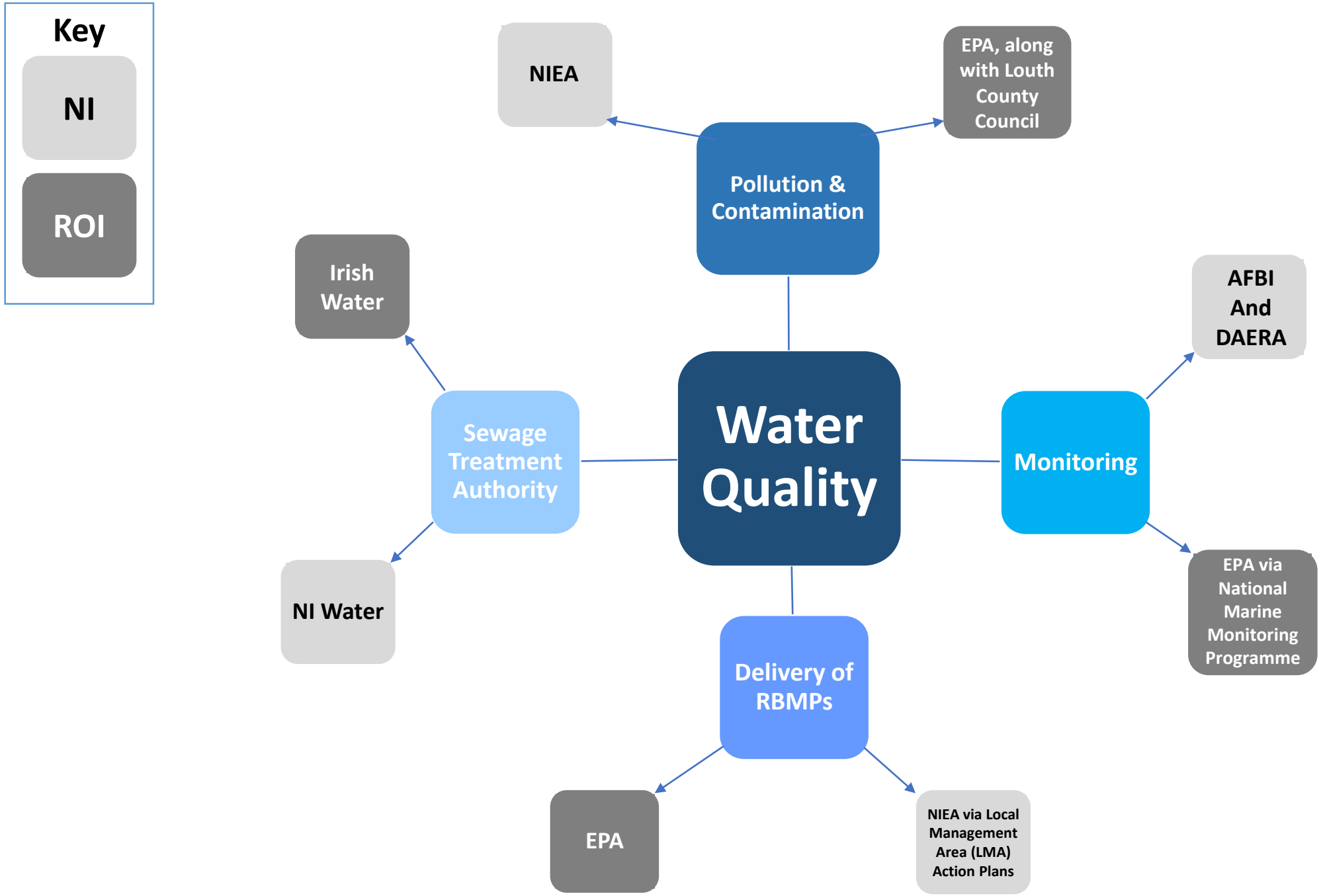
DAERA:
Vessel Licencing: Northern Ireland fishing vessel licensing | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
Fishery management: Contact your local fishery office | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
Aquaculture Licenses: Licensing of fish and shellfish farms | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)

DAFM:
Vessel Licencing: gov.ie - Fishing Boat Licensing (www.gov.ie)
Fishery Management: gov.ie - Sea-Fisheries Policy & Management Division (www.gov.ie)
Aquaculture Licenses: gov.ie - Apply for an Aquaculture Licence (www.gov.ie)

AFBI: Marine biotoxins in shellfish | Agri-Food and Biosciences Institute (afbini.gov.uk)

MI: Shellfish Biotoxins | Marine Institute

Figure 11: Flow chart highlighting management responsibilities for Marine Fisheries and Aquaculture within Carlingford Lough.



Useful links

NIEA:
Emergency Pollution Hotline:
emergency-pollution@daera-ni.gov.uk

LMA Action Plans:

NIEA: Carlingford and Newry Local Management Area Action Plan 2009 to 2015 | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)

EPA: Monitoring & assessment: Freshwater and Marine | Environmental Protection Agency (epa.ie)

DAERA: Water | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)

AFBI: Coastal monitoring | Agri-Food and Biosciences Institute (afbini.gov.uk)

NI Water: Home - Northern Ireland Water (niwater.com)

Irish Water: Irish Water | Uisce Éireann | Water Utility | Irish Water

Figure 12: Flow chart highlighting management responsibilities for Water Quality within Carlingford Lough.

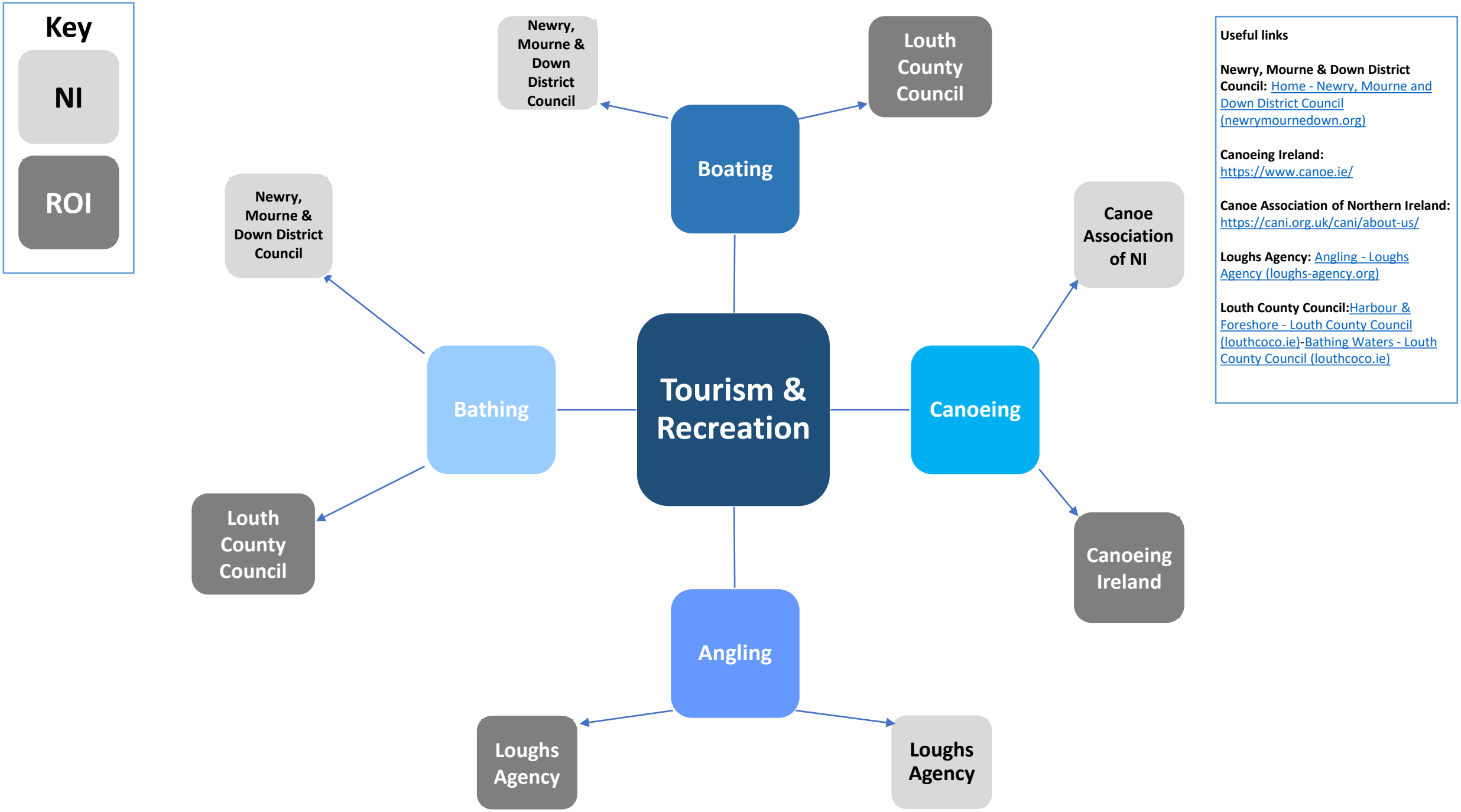


Figure 13: Flow chart highlighting management responsibilities for Tourism and Recreation within Carlingford Lough.

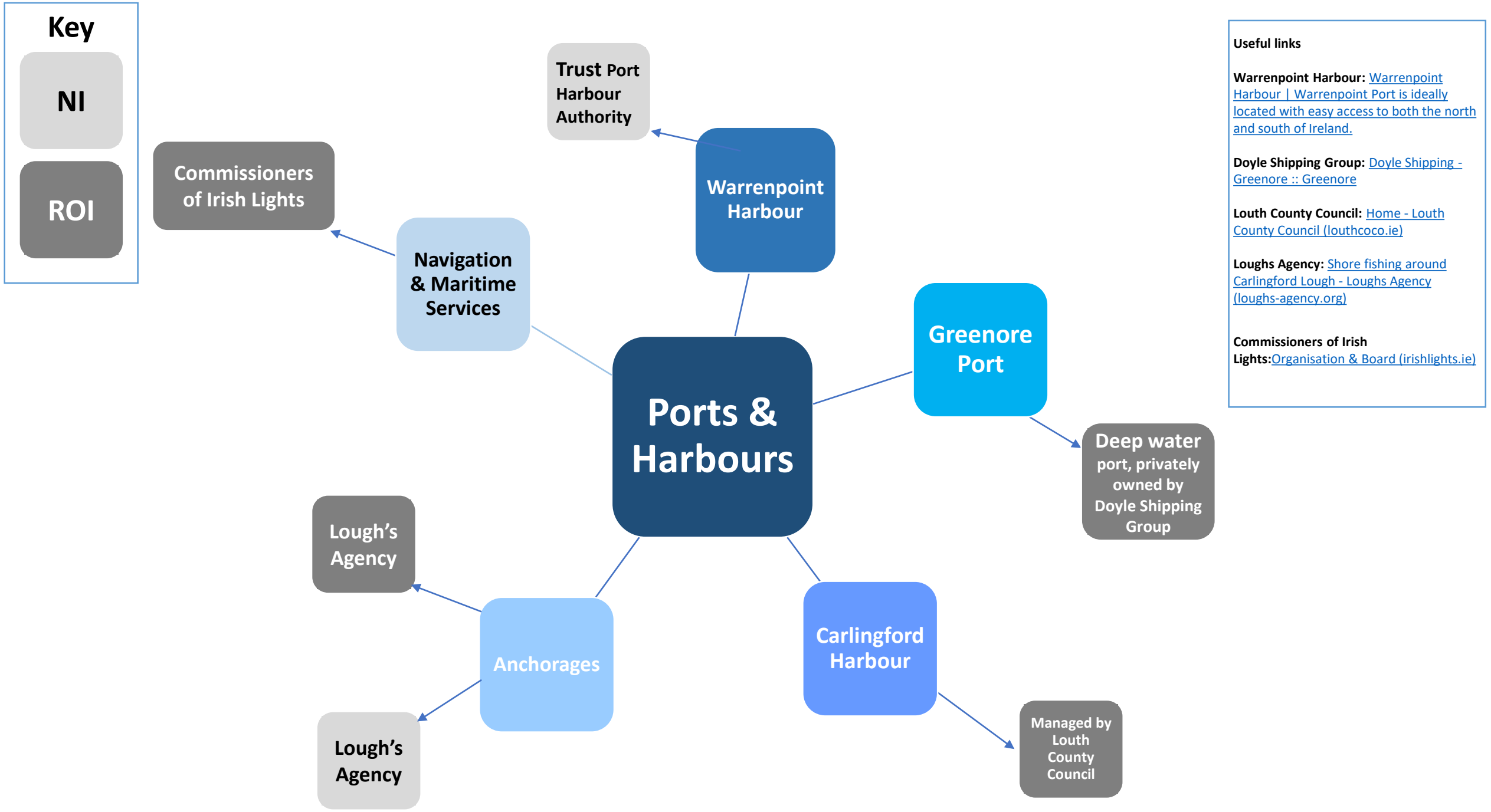


Figure 14: Flow chart highlighting management responsibilities for Ports and Harbours within Carlingford Lough.

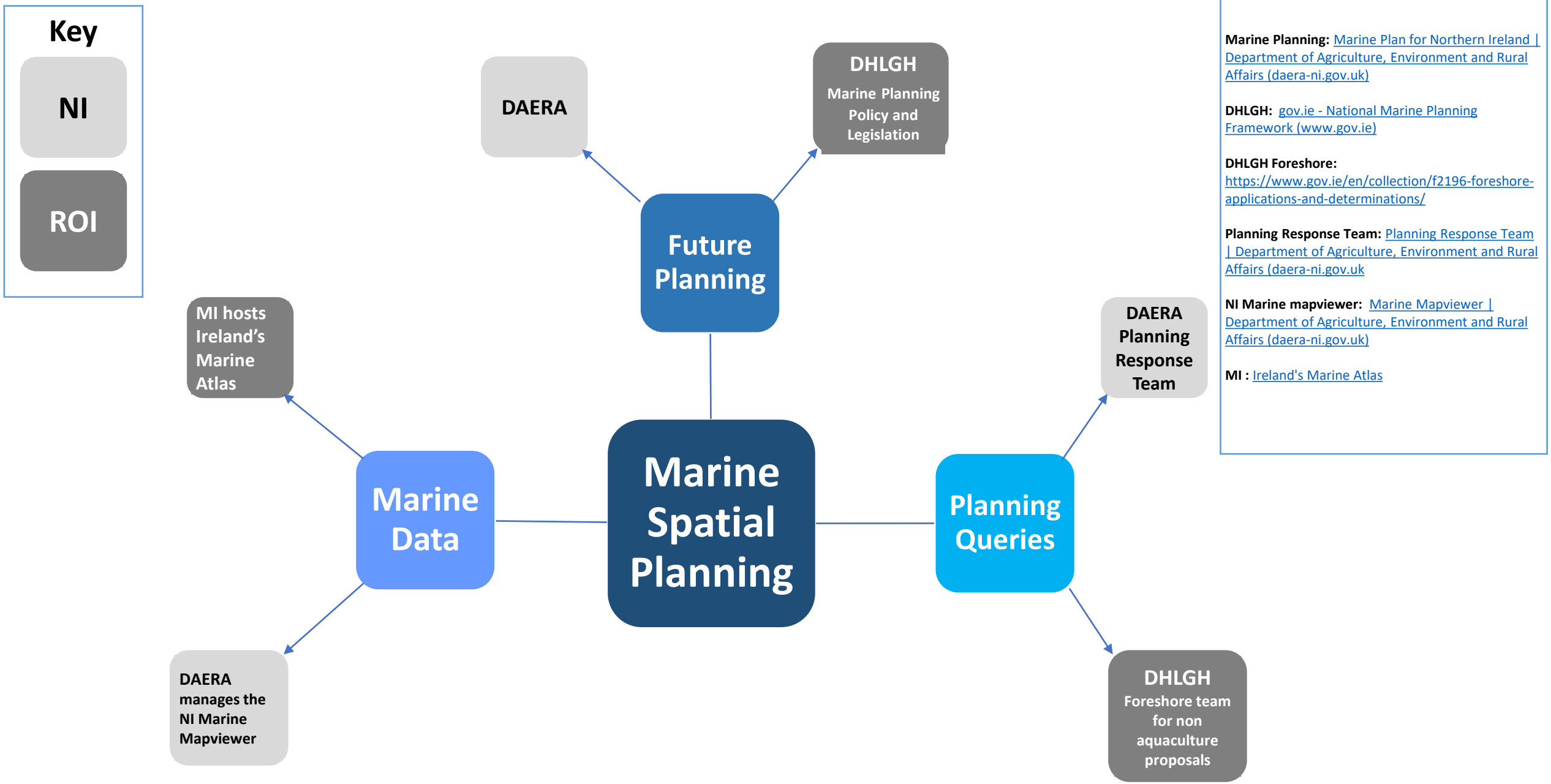


Figure 15: Flow chart highlighting management responsibilities for Marine Spatial Planning within Carlingford Lough.

8 Recommendations of further development of MSP tools

Human activities within the marine environment are increasing in their number, intensity and distance from the shore (Collie *et al* 2013). Increased usage can result in increased competition for marine space. Difficulties can then arise in determining priorities for usage, particularly in areas where there are already well established culturally or economically significant activities, such as tourism or fishing (Galparsoro *et al.* 2020). Such conflicting usages can lead to displacement of some activities at the expense of others. It is the spatial nature of these effects that gives rise to the requirement for "geo-spatial analytical" tools to facilitate the assessment of the relationships and risks (Gimpel *et al.* 2013). Such tools are required to make the processes involved in MSP more "efficient, effective and sustainable" (Gangnery *et al.* 2021).

In terms of aquaculture development, the requirement for decision support tools for the identification of suitable sites for "off-the-coast" and offshore development has been highlighted (Galparsoro *et al.* 2020). One such tool was developed as part of the Horizon 2020 funded AquaSpace project (Gimpel *et al* 2018). The AquaSpace tool provides a spatial representation of opportunities and risks and delivers detailed reports and graphics which permit key stakeholders to make informed decisions (Gimpel *et al.* 2018). The AquaSpace tool utilises open source data at a European Scale (Gimpel *et al.* 2018). For small, localised areas such as Carlingford Lough the data is not of a high enough resolution to produce meaningful outputs (AFBI pers com.).

Gangnery *et al.* 2021 developed a web based decision support tool to facilitate stakeholder access to information regarding environmental interactions, site selection and management for aquaculture. The AkvaVis tool originally designed for aquaculture management in Norway, was adapted and expanded to facilitate its application within different environments and national management frameworks (Gangnery *et al.* 2021). This GIS based tool performs suitability analysis on proposed aquaculture areas through the utilisation of a series of predefined indicators (Gangnery *et al.* 2021). Work undertaken as part of the Horizon H2020 funded AquaSpace project enabled an AkvaVis demonstrator model for Carlingford Lough to be developed. The AkvaVis demonstrator model for Carlingford Lough was developed as a risk analysis tool and highlights the importance of MSP tools in supporting decision making within the aquaculture licensing process (Gangnery *et al.* 2021). At present the AkvaVis tool for Carlingford focuses on aquaculture. Further development of this tool, (or similar tools) to include information from other sectors and also to include input from (or be linked to) other existing models (such as the SMILE and SWELL models), would help facilitate evidence based decision making within MSP in Carlingford Lough.

Some of the issues identified above have been recognised in ROI and a project, funded by DG REFORM under Technical Support Instrument (TSI) 2021, will be examining how to improve marine management in the context of the change being brought about through the MAP Bill in Ireland (https://ec.europa.eu/info/sites/default/files/tsi_2021_country_factsheet_ireland.pdf).

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