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Sanitary Survey Review for Carlingford Lough

With Shoreline and Bacteriological Surveys

Produced by AQUAFACT part of the APEM group

On behalf of The Food Standards Agency in Northern Ireland

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Glossary

Acronym	Definition
AFBI	Agri-Food and Biosciences Institute
ANOVA	Analysis of Variance
ASP	Amnesic Shellfish Poisoning
Bathymetry	The measurement of water depth at various places of a water body
Benthic	Of , pertaining to, or occurring at the bottom of a body of water
Biogenic	Produced by living organisms or biological processes
Bioturbation	The stirring or mixing of sediment or soil by organisms
BOD	Biochemical Oxygen Demand
BTO	British Trust for Ornithology
Bysso-palegic drifting	Drifting or dispersal that is aided by long byssus threads produced by young post-larval mussels
Byssus Threads	Strong filaments by which mussels attach themselves to fixed surfaces
CD	Chart Datum; is the level of water that charted depths displayed on a nautical chart are measured from. Common chart datums are lowest astronomical tide and mean lower low water
CEFAS	Centre for Environmental, Fisheries and Aquaculture Science
CEH	Centre for Ecology and Hydrology
C-Mar	Centre for Marine Resources and Mariculture
CSO	Combined Sewer Overflow
DAERA	Department of Agriculture, Environment and Rural Affairs
Depuration	The process of puridication or removal or impurities
Detrital/Detritus	Non-living, particulate, organic fragments which have been separated from the body to which they belonged
DSP	Diarrhetic Shellfish Poisoning
DWF	Dry Weather flow

Acronym	**Definition**
EC	European Communities
E. coli	*Escherichia coli*
EMS	Environmental Monitoring Stations
Epifauna	Animals living on the surface of marine or freshwater substrates
Epiflora	Plants living on the surface of marine or freshwater substrates
Fetch	The distance a wave can travel towards land without being blocked
FFT	Flow to Full Treatment
Fouling	Accumulation of unwanted material on solid surfaces, most often in an aquatic environment.
FSA in NI	Food Standards Agency in Northern Ireland
FTU	Formazin Turbidy Unit
Geometric Mena	The nth root of the product of n numbers (The average of the logarithmic values of a data set, converted back to a base 10 number).
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine environmental Pollution
GIS	Geographical Information Systems
GPS	Global Positioning System
GSM	Global System for Mobile Communication
Hydrodynamic	Forces in or motions of liquids
Hydrography	The description and analysis of the physical conditions, boundaries, flows and related characteristics of water bodies
LAT	Lowest Astronomical Tide
Marpol 73/78	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978. Marpol is short for Marine Pollution, 73 for 1973 and 78 for 1978.
MPN	Most probable number
MSD	Marine Sanitation Devide
NAP	Nitrates Action Programme
ND	Not detectable

Acronym	Definition
NH_4	Ammonium
NI Water	Northern Ireland Water
NO_2	Nitrite
NO_3	Nitrate
NR	Nature Reserve
NRFA	National River Flow Archive
NRL	National Reference Laboratory
OD	Ordnance Datum
OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
P	Phosphorus
PAH	Polycyclic Aromatic Hydrocarbons
Pathogenic	Capable of causing disease
PCB	Polychlorionated Biphenyls
PCP	Pentachlorophenol
p.e.	Population Equivalent
Plankton/Planktonic	Pertaining to small, free=floating organisms of aquatic systems
Pseudofaeces	Materials rejected by suspension or deposit feeders as potential food before enterning the gut.
PSP	Paralytic Shellfish Poisoning
PSU	Practical Salinity Units
RAMSAR	A term adopted following an international conference, held in 1971 in Ramsar in Iran, to identify wetland sites of international importance, especially as waterfowl habitat.
Regulation (EU) 2017/625	Of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products.
RMP	Representative Monitoring Point
SAC	Special Area of Conservations
SMILE	Sustainable Mariculture in norther Irish Lough Ecosystems
SOA	Super Output Areas or ward

Acronym	**Definition**
SPA	Special Protection Area
SPS	Sewage Pumping Station
SS	Suspended Solids
Suspension feeders	Animals that feed on small particiles suspected in water
TBTO	Tributyl Tin Oxide
Telemetry	The measurement and transmission of data from remote sources to receiving stations for recording and analysis
TPP	Total Physical Product
UKAS	United Kingdom Accreditation Service
UKHO	United Kingdom Hydrographic Office
Vector	A carrier which transmits a disease from one party to another.
WeBS	Wetland Bird Survey
WWTW	Waste Water Treatment works

1. Executive Summary

Under Regulation (EU) 2017/625 and its subsequent Implementing Regulation (EU) 2019/627, there is a requirement for competent authorities intending to classify bivalve production and relaying areas to undertake a sanitary survey. The purpose of this is to determine the extent to which potential sources of pollution may impact on a production area and ultimately inform the sampling plan for the Official Control Microbiological Monitoring Programme, the results of which determine the annual classification for bivalve mollusc production areas. In accordance with the EURL Guide to Good Practice on the microbiological monitoring of bivalve mollusc harvesting areas, a re-evaluation of pollution sources and the sampling plan (primary sanitary survey) should be undertaken if a time trigger (6 years or > since last survey) or change in the environment has occurred. As the sanitary survey for Carlingford Lough was completed in 2011 a review of this sanitary survey is required. This report will review any changes to Carlingford Lough and assess whether or not the changes are likely to affect the microbiological concentration of the classified production area.

Carlingford Lough is a 51km² flooded river valley located along the eastern coast of Ireland between Co. Louth in the Republic of Ireland and counties Armagh and Down in Northern Ireland. Extensive expanses of intertidal flats (more sand than mud) occur along the southern shore, particularly between Greenore Point and Carlingford Harbour. The flats in the area are broken by outcropping reefs and some shingle deposits and saltmarsh on drier higher rocks. Intertidal mudflats are also present in Mill Bay, where dwarf eelgrass (*Zostera noltii*) is present. These flats are very important feeding grounds for wildfowl and waders. The shore around Rostrevor Bay is a sheltered boulder shore very rich in invertebrate species. The lough is generally shallow with water depths ranging from 2 to 5m, the narrow navigation channel can extend to depths of 25m with the deepest part of the lough reaching a depth of 36m. The lough supports populations of blue mussels (*Mytilus edulis*), Pacific oysters (*Crassostrea gigas*) and razor clams (*Ensis* spp.), all of which have designated fisheries within the lough.

This report attempts to document and quantify all known sources of pollution to the Lough. It was concluded that the main sources of pollution in Carlingford Lough come from direct sewage discharges into the Lough and into the Newry/Clanrye River, mainly from the Warrenpoint WWTW, Newry WWTW and the untreated discharges from Omeath and Greenore sewage schemes. The Carlingford sewage scheme is also over capacity. In addition, there is a large quantity of intermittent discharges, septic tanks and overflows draining into the Newry/Clanrye River which ultimately flow into the lough. Agriculture is the dominant Land use in the catchment and livestock are present throughout. There are also some seasonal contributions from wildfowl (birds), boats (shipping and recreational activity) and tourism.

The northwestern section of the Lough is more vulnerable to pollution due to the shallow depths (increased suspended sediment concentration) and weak currents compared with the outer part of the Lough. It was on the basis of hydrodynamic and spatial features (i.e. areas of similar depth, tidal currents, suspended sediment levels and freshwater influence) that resulted in the Lough being divided into 6 production areas. Each of these production areas contain one Representative Monitoring Point (RMP) for each of the species cultivated within it i.e. blue mussel, Pacific oyster and razor clam. In total there are 8 RMPs in the Lough to be sampled on a monthly basis.

2. Overview of the Fishery/Production Area

2.1 Location/Extent of Growing/Harvesting Area

The shellfish designated waters in Carlingford Lough cover an area of approximately 37km^2 and can be seen in Figure. Of this area, 25km^2 is in Northern Irish waters and approximately 12km^2 in Republic of Ireland waters. Pacific oyster and bottom mussel cultivation is predominant in Carlingford Lough.

Figure 2.1: Shellfish designated waters within Carlingford Lough.

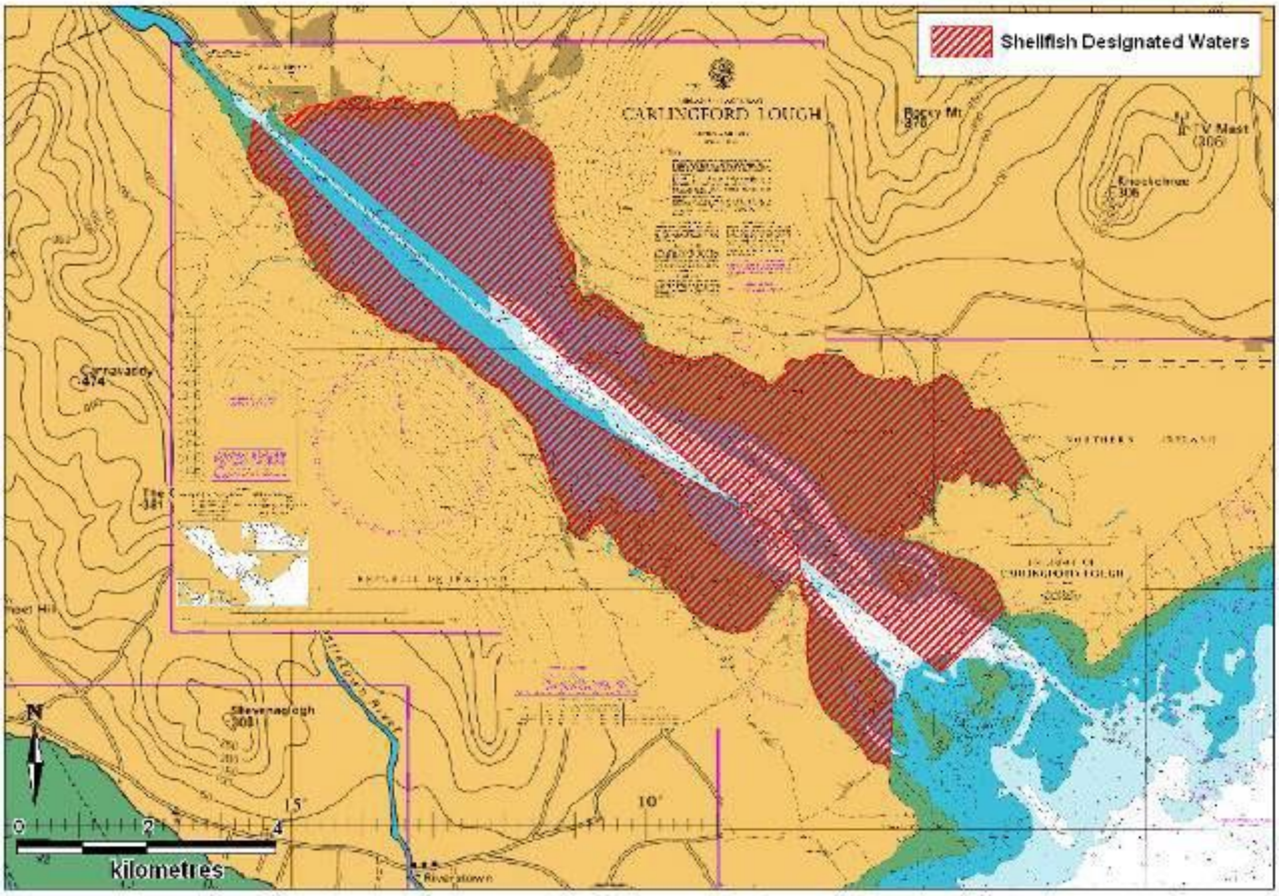
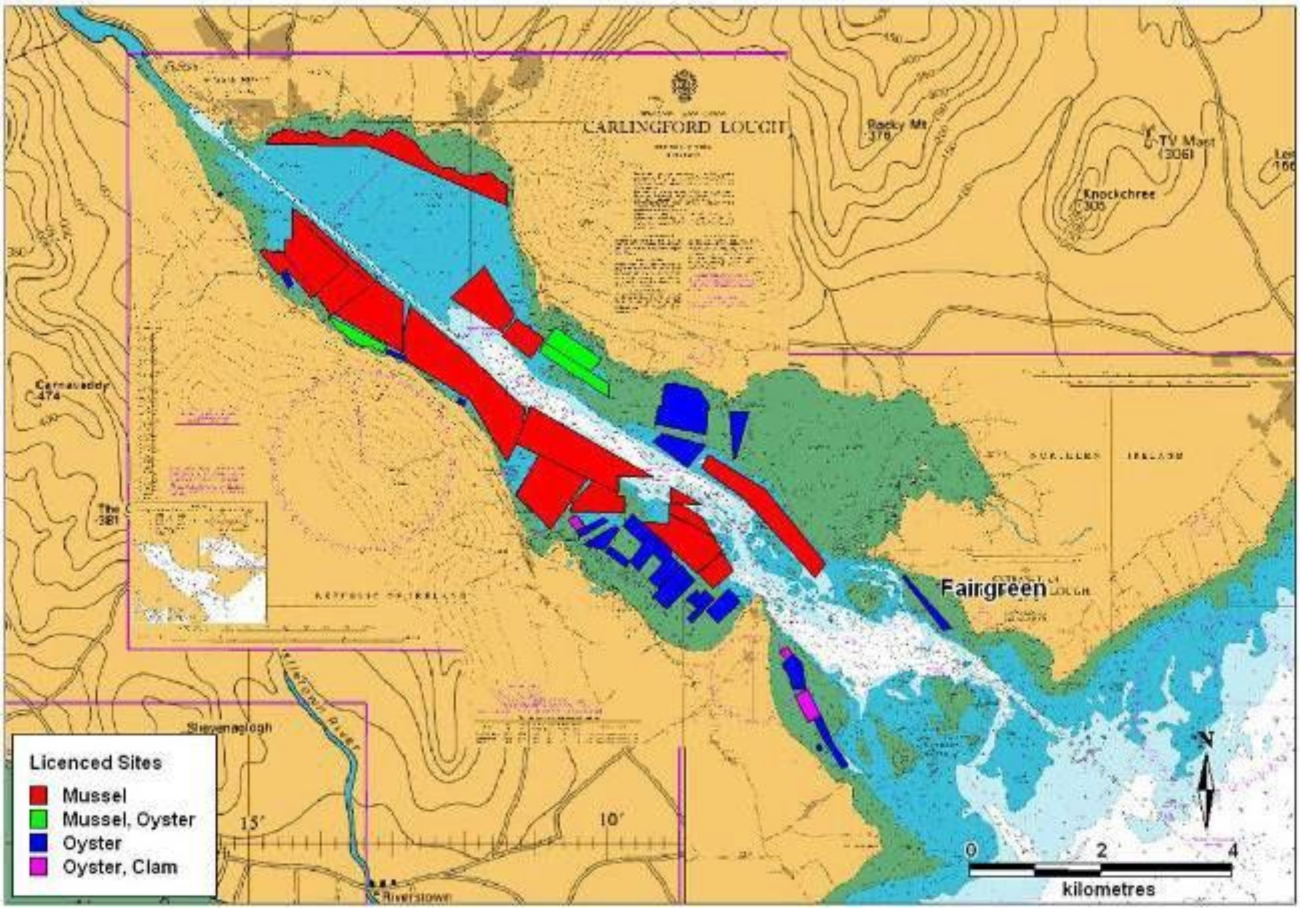


Figure 2.2 shows the current locations of licensed shellfish sites within Carlingford Lough. The northern shore is currently licensed for mussels and oysters in the locations shown in Figure 2.2. The southern shore is licensed for oysters, mussels and clams. Approximately 74% of the licensed area is occupied by mussels (8.26km^2), 2.17km^2 by oysters, 0.2km^2 by oysters and clams and 0.57km^2 by mussels and oysters.

Figure 2.2: Licensed harvesting areas located within Carlingford Lough (Source: DARD & Loughs Agency).



2.2 Description of the Area

Carlingford Lough is a 51km^2 flooded river valley located along the eastern coast of Ireland between Co. Louth in the Republic of Ireland and counties Armagh and Down in Northern Ireland (see Figure 2.3). It is approximately 15km in length and approximately 3.7km in width at its widest point. The Newry (or Clanrye) River flows into the Lough through Warrenpoint, Co. Down and the Lough has a catchment of approximately 474km^2. The Lough is generally shallow with water depths ranging from 2 to 5m, the narrow navigation channel can extend to depths of 25m with the deepest part of the Lough (36m) located approximately 2.3km north of Carlingford Harbour, Co. Louth and 1.3km south of Killowen Point, Co. Down.

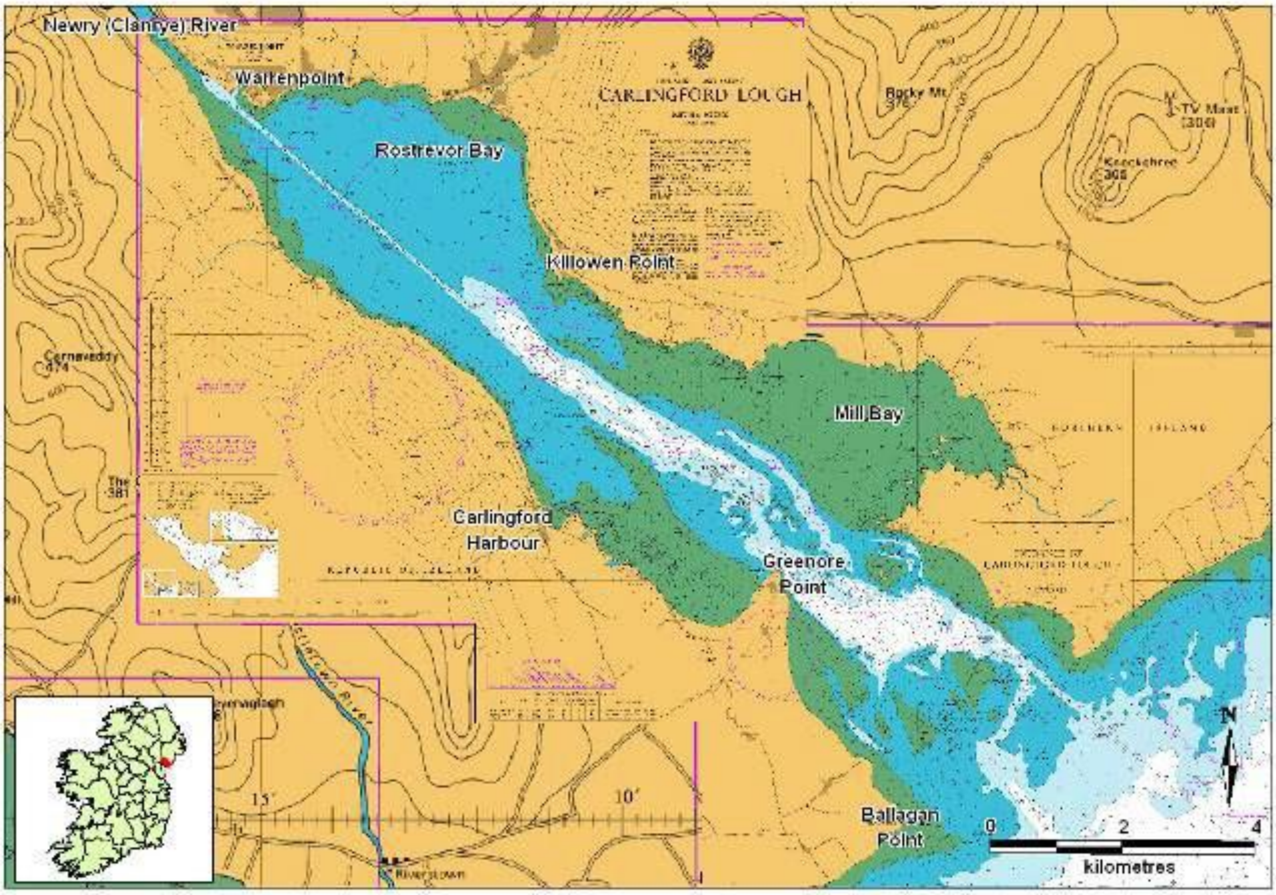


Figure 2.3: Location of Carlingford Lough.

Carlingford Lough is designated as a Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar Site. The southern shoreline is designated in the Republic of Ireland as an SAC due to the presence of two Annex I habitats of the EU Habitats Directive: stony banks and drift lines (Site Name: Carlingford Shore, Site Code: IE002306). Grey seals and harbour seals (Annex II species) are also present within the site. Part of the Co. Louth shoreline is designated as an SPA due to the presence of a nationally important population of wintering cormorants (Site Name: Carlingford Lough SPA, Site Code: IE004078). A range of other waterfowl species occur, notably Brent goose, oystercatcher, dunlin, bar-tailed godwit, redshank and turnstone. The bar-tailed godwit is an Annex I species of the EU Birds Directive. In addition, an SPA is present along the Co. Down coastline due to the presence of two Annex I species: the common tern and the sandwich tern (Site Name: Carlingford Lough, Site Code: UK9020161). The Ramsar Site (Site Code: UK12004) overlaps the

Co. Down SPA and is designated due to the populations of sandwich terns and light bellied Brent goose.

Carlingford Lough supports a wide diversity of species, especially shellfish. The designated shellfish area within the Lough is $37km^2$ and the licensed shellfish sites cover an area of $10.2km^2$. Pacific oysters and mussels are the dominant shellfish cultivation species in the Lough.

Land cover along the coastal regions of the catchment area is a mixture of forestry, pastures, agricultural land, natural vegetation, with small areas of arable land. The inland regions of the catchment are dominated by a mix of pastures, natural grassland and moors and heathland. The main freshwater input is the Newry (Clanrye) River. Other rivers on the northern side of the Lough include the Ryland, Moygannon, the Rostrevor, the White Water, the Ballincurry, the Cassey Water and the Ghann.

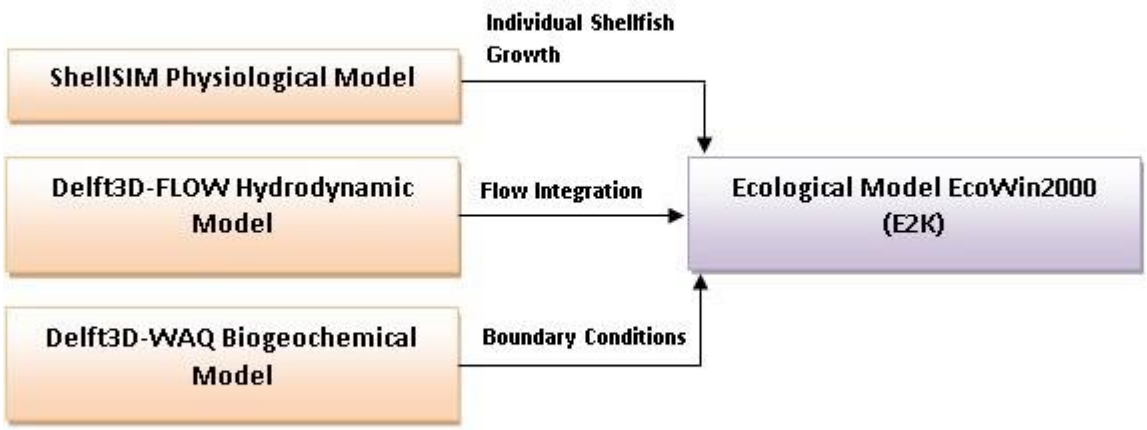
There are a number of shellfish fisheries within the Lough. European lobster and edible crab fishing is carried out within the lough (DAERA, 2016). There was no data available on the location of the fisheries within the lough, with data only available for the ICES rectangle (37E3) that covers the lough and a small area outside. The species landed for the rectangle for 2018 to 2020 include Velvet swimming crab, edible crab, green crab, lobster, mussels and whelks (Source: DAERA, 2021). The average tonnage for each species for the three years is as follows: velvet swimming crab 3.3t, edible crab 20.7t, Green crab 137.1t, lobster 1.6t and whelks 2.5t. Data for mussels was only available for 2018 when 284.8t was landed. The two fishing methods used are boat dredge and pots. The species caught by dredge include edible crab, green crab and mussels, while species caught by pot include velvet swimming crab, edible crab, green crab, lobster and whelk. There are sixteen registered boats operating in the area.

3. Hydrography/Hydrodynamics

3.1 Simple/Complex Models

The Sustainable Mariculture in northern Irish Sea Lough Ecosystems (SMILE) project was commissioned by the Department of Agriculture and Rural Development Northern Ireland (DARD) in 2004 to develop and apply a range of tools for decision-support in the sustainable development of shellfish aquaculture, within the context of integrated coastal zone management (Ferreira *et al.,* 2007). Carlingford Lough was one of 5 Northern Irish Loughs studied in the project. Figure 3.1 shows the general modelling framework used in SMILE (Ferreira *et al.,* 2007).

Figure 3.4: General modelling framework used in SMILE (Ferreira *et al.,* 2007).



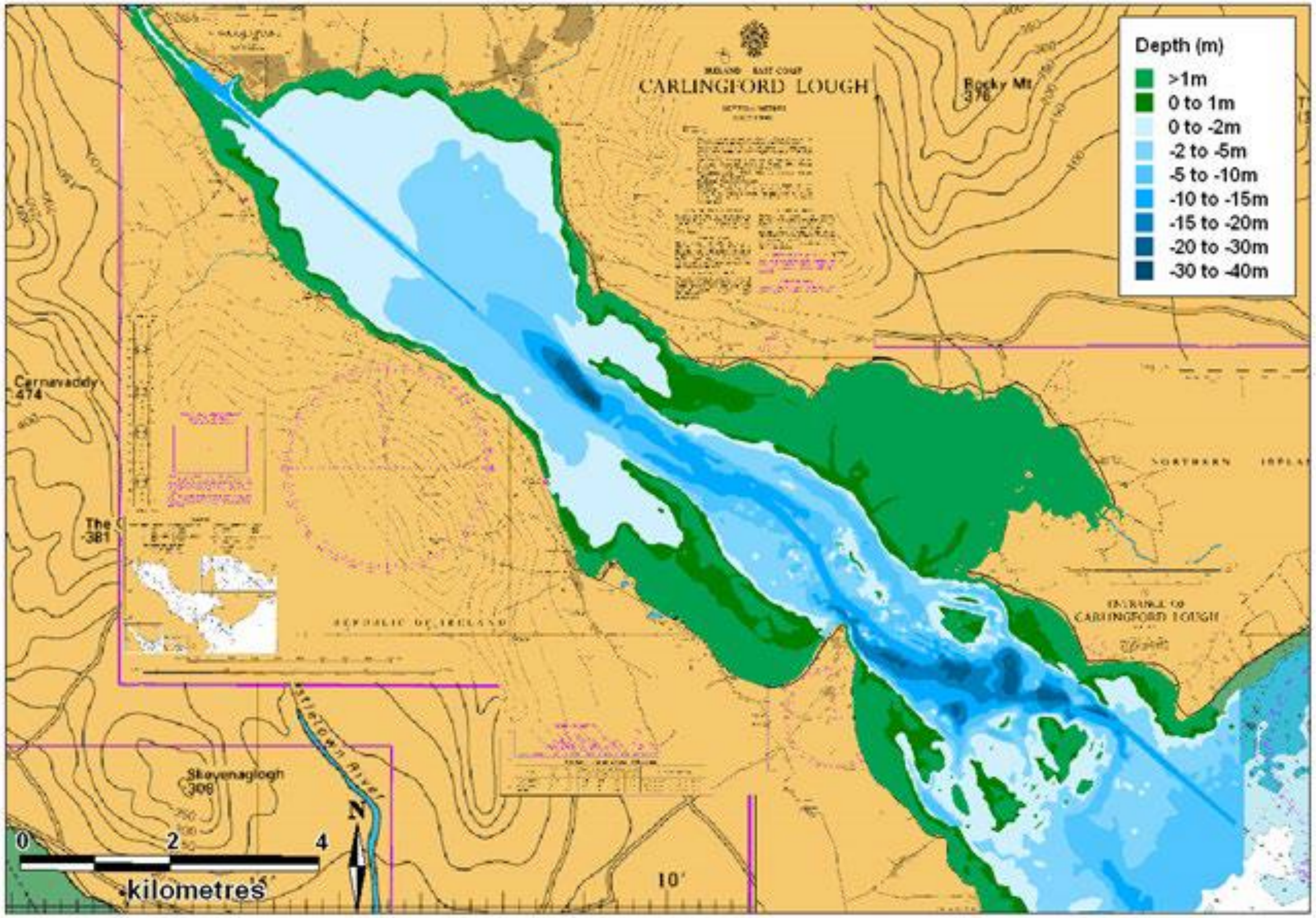
The Delft3D-FLOW hydrodynamic model was used to simulate the tidal, wind and ocean currents within the lough (Ferreira et al., 2008). This model was combined with the Delft3D-WAQ model to stimulate circulation and phytoplankton productivity for periods of up to 1 year and used to generate aggregated water exchange and boundary conditions for the lough. ShellSIM is a generic dynamic model structure which simulates feeding, metabolism and growth. EcoWin2000 (E2K) is an ecological model that provides a platform for integration of the various other models. It typically divides coastal systems into (<100) boxes, which can be structured in one, two or three dimensions and performs simulations at the system scale, using water exchange across box faces and system boundaries which are up-scaled from detailed hydrodynamic models.

In addition, Ferreira *et al.,* (1998) produced a one-dimensional ecosystem box model for carrying capacity assessment in Carlingford Lough and Taylor *et al.* (1999) applied a tidal box model to the Lough in order to model the residence times of water within the ‘boxes’ and gain a greater understanding of the dynamics and behaviour of physical, chemical and biological parameters within the lough.

3.2 Depth

Carlingford Lough is generally shallow with water depths ranging from 2 to 5m. The narrow navigation channel can extend to depths of 25m with the deepest part of the Lough (36m) located approximately 2.3km north of Carlingford Harbour, Co. Louth and 1.3km south of Killowen Point, Co. Down. The narrowest point of the Lough is at the Narrow Water site where the channel is only 40m wide at low tide (CLAMS, 2005). Intertidal sand/mud flats (approximately 15km2) are present along the southern shore, particularly between Greenore Point and Carlingford Harbour and in the Mill Bay area of the northern shore. In addition, a series of limestone rocks guard the shallow mouth of the Lough. Figure 3.2 shows a bathymetric map of Carlingford Lough.

Figure 3.5: Depths in Carlingford Lough (Source: The Loughs Agency).



3.3 Tides and Currents

The tidal cycle in Carlingford Lough ranges from a mean high water of 5.1m to a mean low water of 0.9m during spring tides (UKHO, 2004). The characteristic tidal levels in Carlingford Lough can be seen in Table 3.1. These are taken from the Admiralty Chart 2800 (UKHO, 2004). Levels are presented in metres Chart Datum, which is approximately equal to Lowest Astronomical Tide (LAT).

Table 3.1: Carlingford Lough tidal characteristics (Source: UKHO, 2004).

Admiralty Chart 2800 Levels (m CD)	MHWS	MHWN	MLWN	MLWS
Cranfield Point	4.8	4.3	1.8	0.9
Warrenpoint	5.1	4.3	1.6	0.9

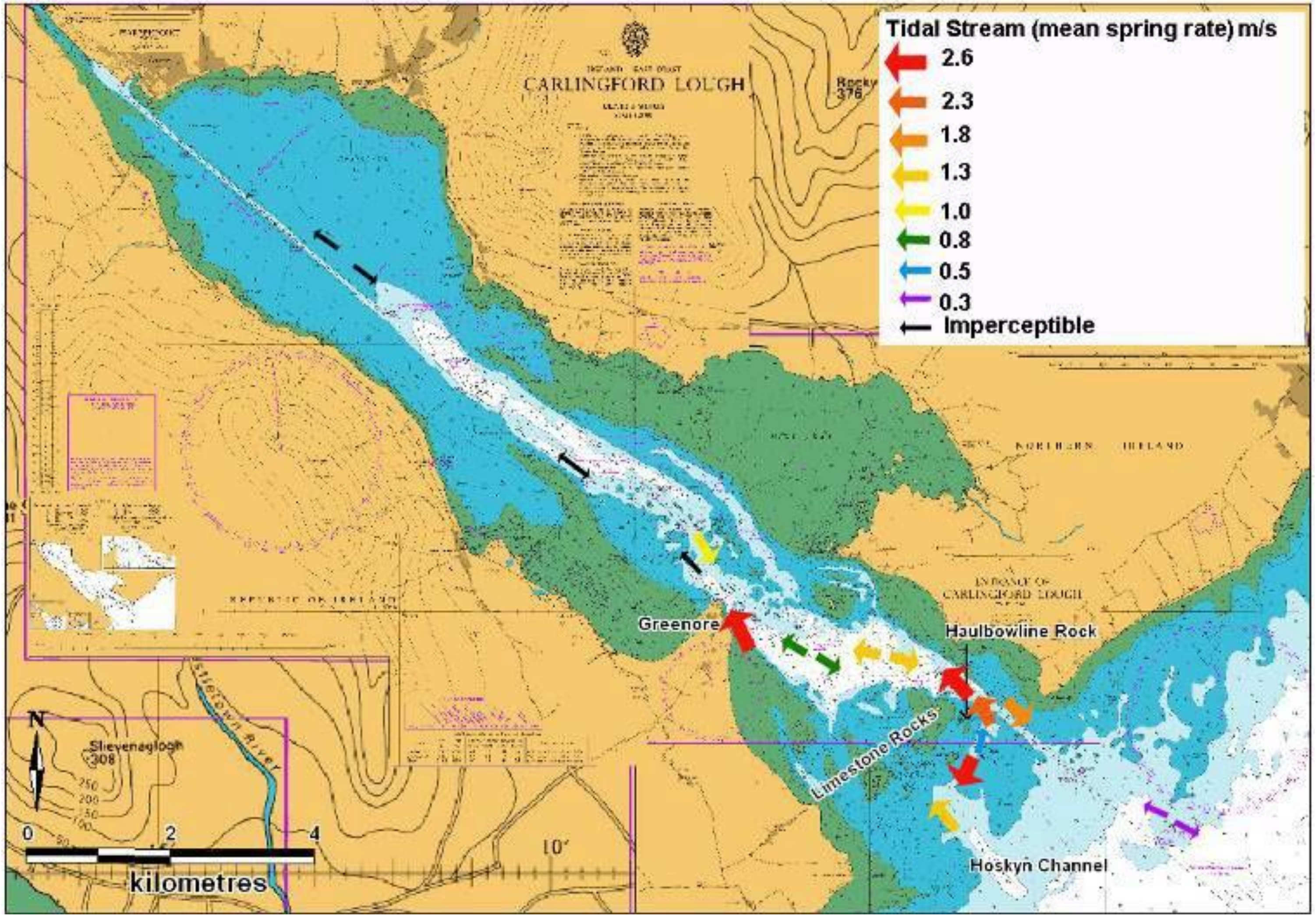
Ball *et al.* (1997) reported that maximum current speeds at the mouth of the Lough regularly exceed 0.87m/s, with speeds regularly exceeding 0.35m/s in the vicinity of the Rostrevor Narrows. The greatest tidal movements occur in the narrow channels that run along the centre of the Lough (Taylor *et al.,* 1999).

Tidal streams with the mean spring rate (m/s) can be seen in Figure 3.3 below and this information was taken from the most up-to-date admiralty charts for Carlingford Lough (UKHO, 2004). The flood and ebb flow rate outside the entrance to the Lough is 0.26m/s on a spring tide and imperceptible at all other times.

On a flooding spring tide, tidal flows increase to 1.3m/s northwest of the Hoskyn Channel at the mouth of the Lough. This flow decreases to 0.5m/s on approaches to Haulbowline Rock and rapidly increases to 2.3 and 2.6m/s as the tide enters the Lough through the channel northeast of the Limestone Rocks. The tidal flow decreases then to 1.3 and 0.8m/s on approach to Greenore where it increases to 2.6m/s as it flows around Greenore. Beyond this point the flow is imperceptible. On the ebbing spring tide, the flow is imperceptible to just north of Greenore where it reaches speeds of 1m/s within the channel. This flow decreases slightly to 0.8m/s east of Greenore and increases again to 1.3m/s as the tides moves into the channel and around Limestone Rocks. From here the tides increases to 1.8m/s as it exits along the channel and to 2.6m/s as it flows southwest towards the Hoskyn Channel.

A series of current meters were deployed in Carlingford Lough as part of the Greenore Port redevelopment project (Hydrographic Surveys Ltd., 2007). All of the meters were deployed within 1km from Greenore Port. Figure 3.4 shows tidal graphs for one of the current meter locations (approximately 420m southeast of Greenore Point) over a spring and neap tide. Lowest velocities were recorded generally around high water and low water and velocities peaked during mid-flood and mid-ebb. During the neap tide, surface velocities were generally faster during the ebbing tide in comparison with those recorded at mid-depth and the bottom. During the flood tide, surface velocities were generally lower than at the other two depths. During the spring tide, velocities were consistent throughout the water column during the flooding tide.

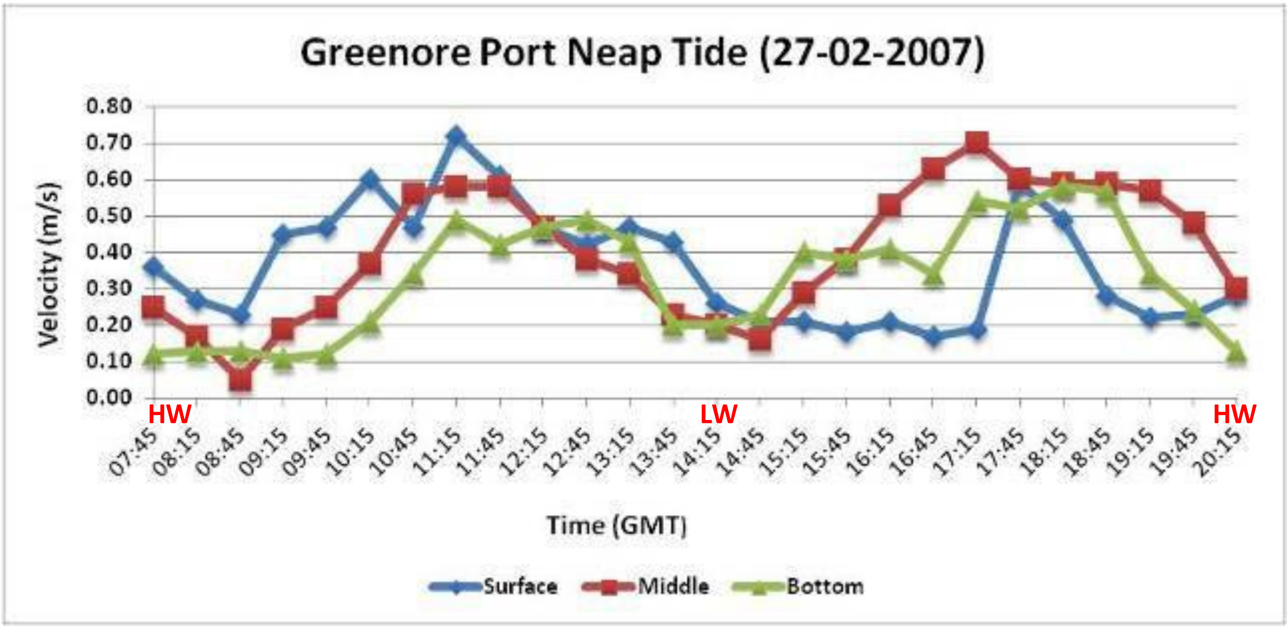
Figure 3.6: Tidal streams within Carlingford Lough (UKHO, 2004).



During the ebb tide, there is variation throughout the water column with the bottom velocities showing the lowest values. Table 3.2 shows the lowest and highest velocities recorded from this site.

The results also showed that the direction of flow is predominantly northerly during a flooding tide and southerly during the ebbing tide.

Figure 3.7: Tidal velocity (knots) over spring and neap tide at Greenore, Carlingford Lough (Source: Hydrographic Surveys Ltd., 2007).



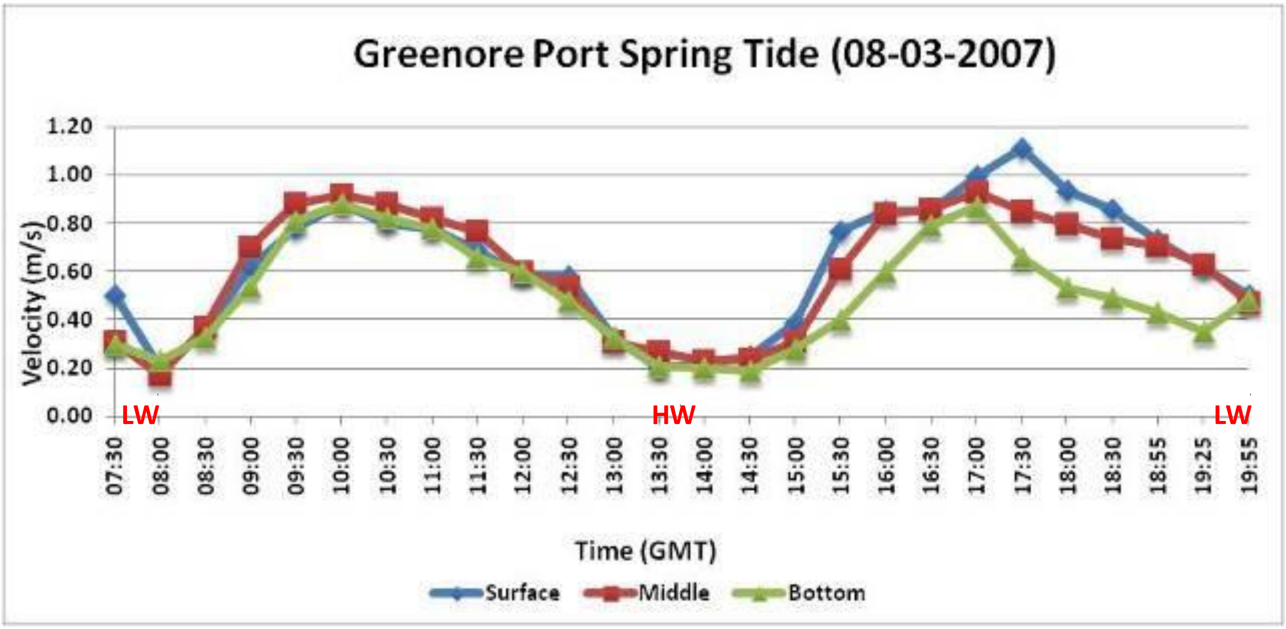


Table 3.2: Lowest and highest velocities recorded over a spring and neap tide at Greenore, Carlingford Lough (Source: Hydrographic Surveys Ltd., 2007).

Position	Spring	Spring	Neap	Neap
-	**Lowest Velocity**	**Highest Velocity**	**Lowest Velocity**	**Highest Velocity**
Surface	0.2m/s @LW & HW	1.11m/s @HW+4	0.17m/s @HW-4	0.72m/s @HW+3hr15min
Mid	0.17m/s @LW	0.92m/s @HW-3hr 30min	0.05m/s @HW+45min	0.7m/s @HW-3hr30min
Bottom	0.2m/s @HW+20min	0.88m/s @HW-3hr & HW+3hr	0.11m/s @HW+1hr 15min	0.58 @HW-2hr30min

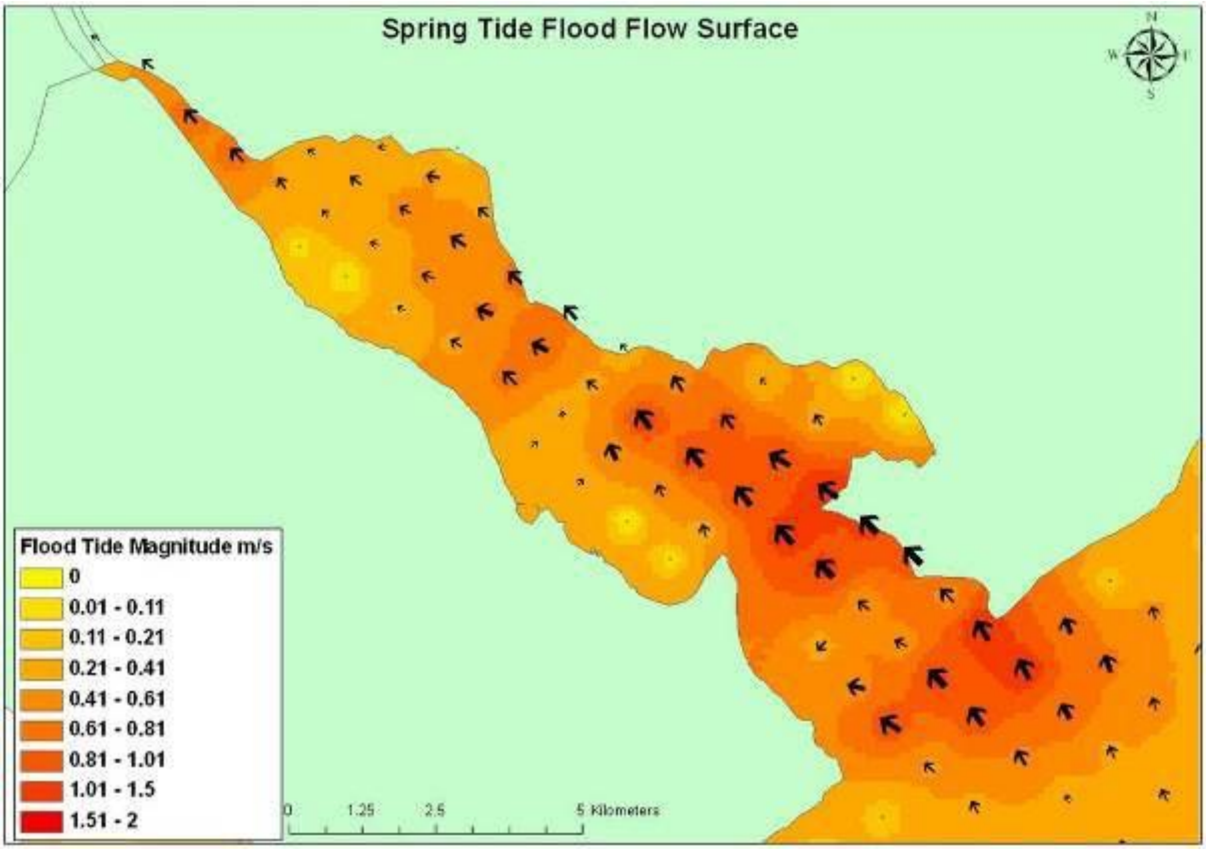
Outputs from the Delft3D-FLOW hydrodynamic model which was developed during the SMILE Project were provided by the Agri-Food and Biosciences Institute (AFBI). Figure 3.5 shows the direction and magnitude of spring tide surface and bottom flood flows. Figure 3.6 shows the direction and magnitude of spring tide surface and bottom ebb flows. Figure 3.7 shows the direction and magnitude of neap tide surface and bottom flood flows and Figure 3.8 shows the direction and magnitude of neap tide surface and bottom ebb flows.

Tidal movements in Carlingford Lough are relatively simple entering in the southeast and moving in a northwesterly direction up through the Lough. During a flooding spring tide, maximum velocities are seen around Cranfield Point and Greencastle Point (1.3 – 1.4m/s at the surface and 0.5-0.7m/s at the bottom). Surface flows remain in the region of 1m/s as they flow past Mill Bay, decreasing to approximately 0.4m/s beyond Mill Bay. Surface velocities increase slightly around Killowen Point (0.8m/s) and decrease to approximately 0.4m/s in Rostrevor Bay. Velocities increase to approximately 0.7m/s as the tide enters the Newry River. Surface flood flows within Mill Bay range from 0.01 – 0.33m/s and bottom flood flows range from 0.03 – 0.13m/s. On the ebbing tide, bottom flows are highest in the Newry River, approximately 0.9m/s and surface flows are highest around Greencastle and Cranfield Point (1.1 -1.2m/s). Ebb flows in Mill Bay range from 0.02 – 0.3m/s at the surface and between 0.06 – 0.4m/s at the bottom.

On a flooding neap tide, maximum bottom speeds are found around Cranfield Point and maximum surface speeds around Cranfield Point range from 0.8 – 0.9m/s, around

Greencastle Point range from 0.8 – 0.95m/s and within the Newry River velocities are in the region of 0.8m/s. Ebb surface flows in the Newry river are also in the region of 0.8m/s and flows around Greencastle Point and Cranfield are in the region of 0.9m/s with bottom flows approximately 3m/s slower in these regions. Surface flood flows in Mill Bay range from 0.05 – 0.26m/s with bottom flows ranging from 0.04 – 0.18m/s. Surface ebb flows range from 0.03 – 0.26m/s and bottom ebb flows range from 0.03 – 0.19m/s.

Figure 3.20: Surface and bottom current velocities and direction during a spring flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).



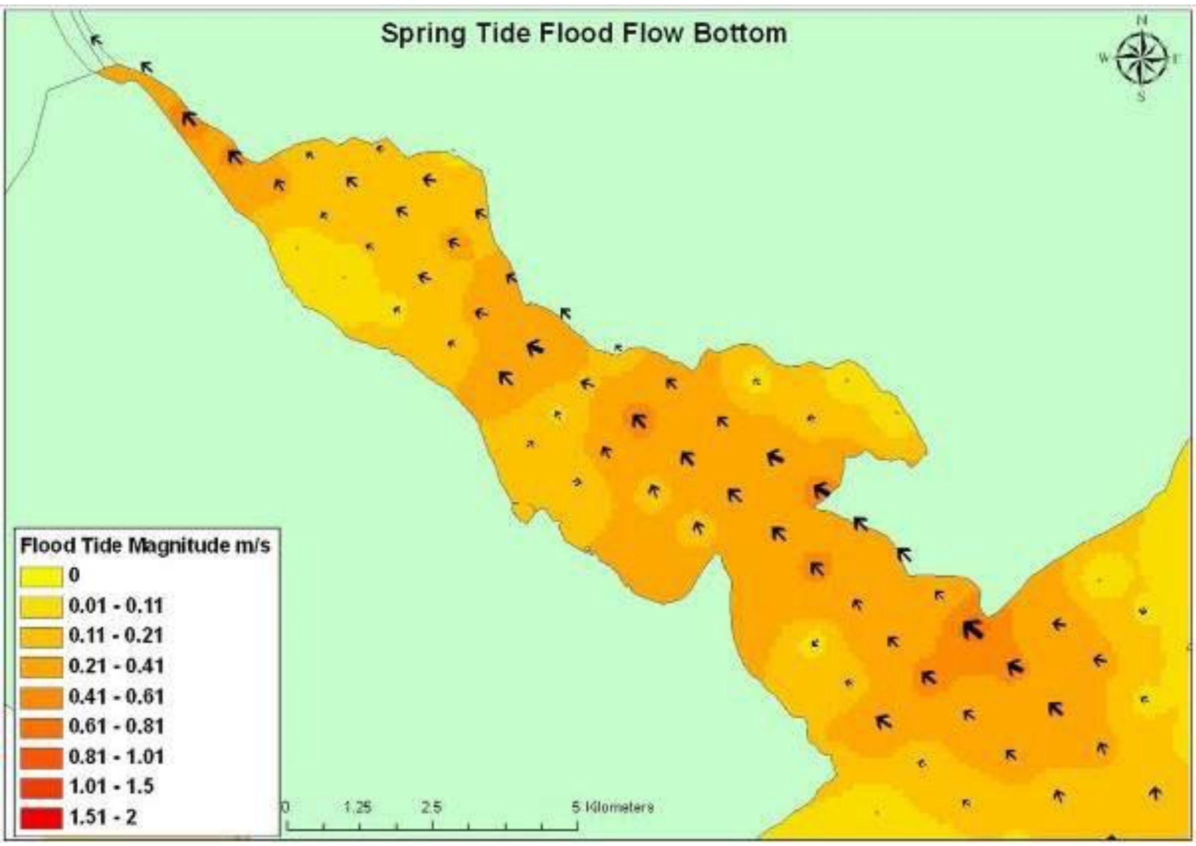
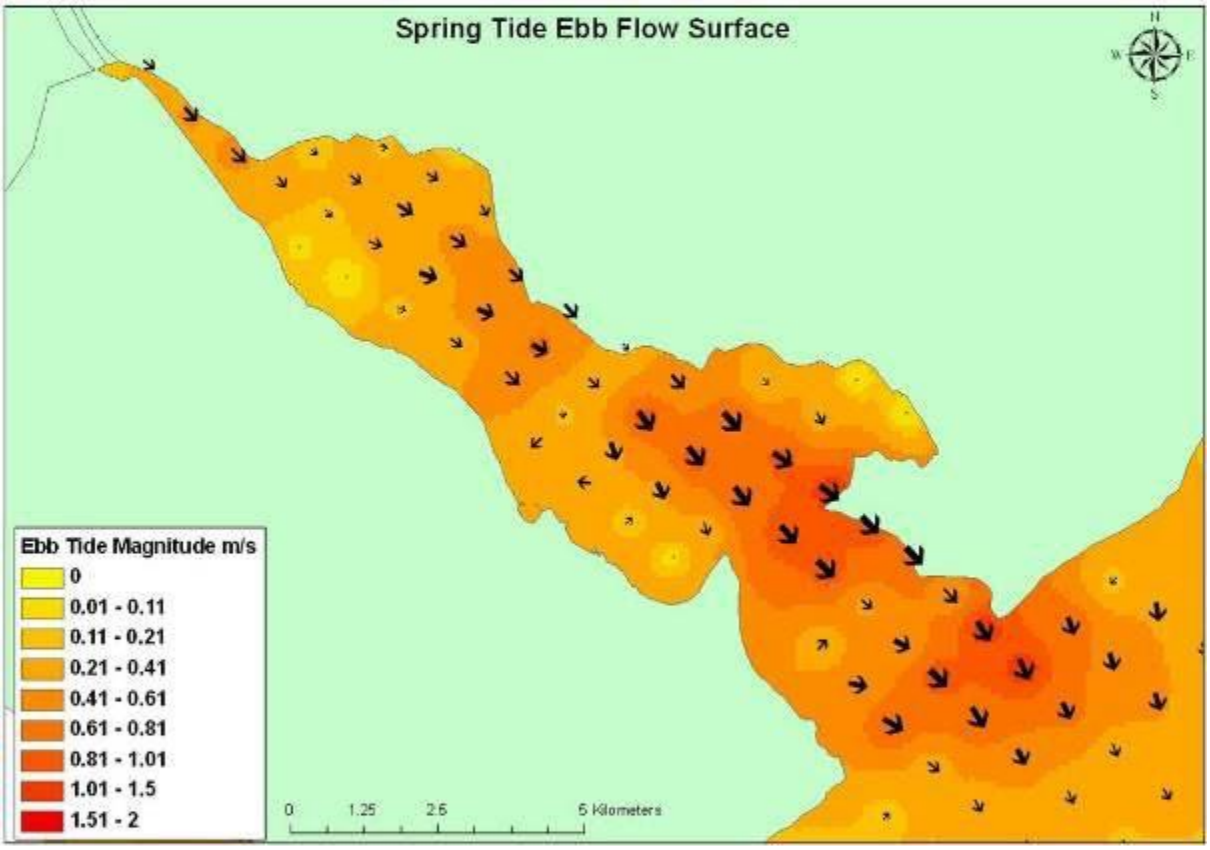


Figure 3.21: Surface and bottom current velocities and direction during a spring ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).



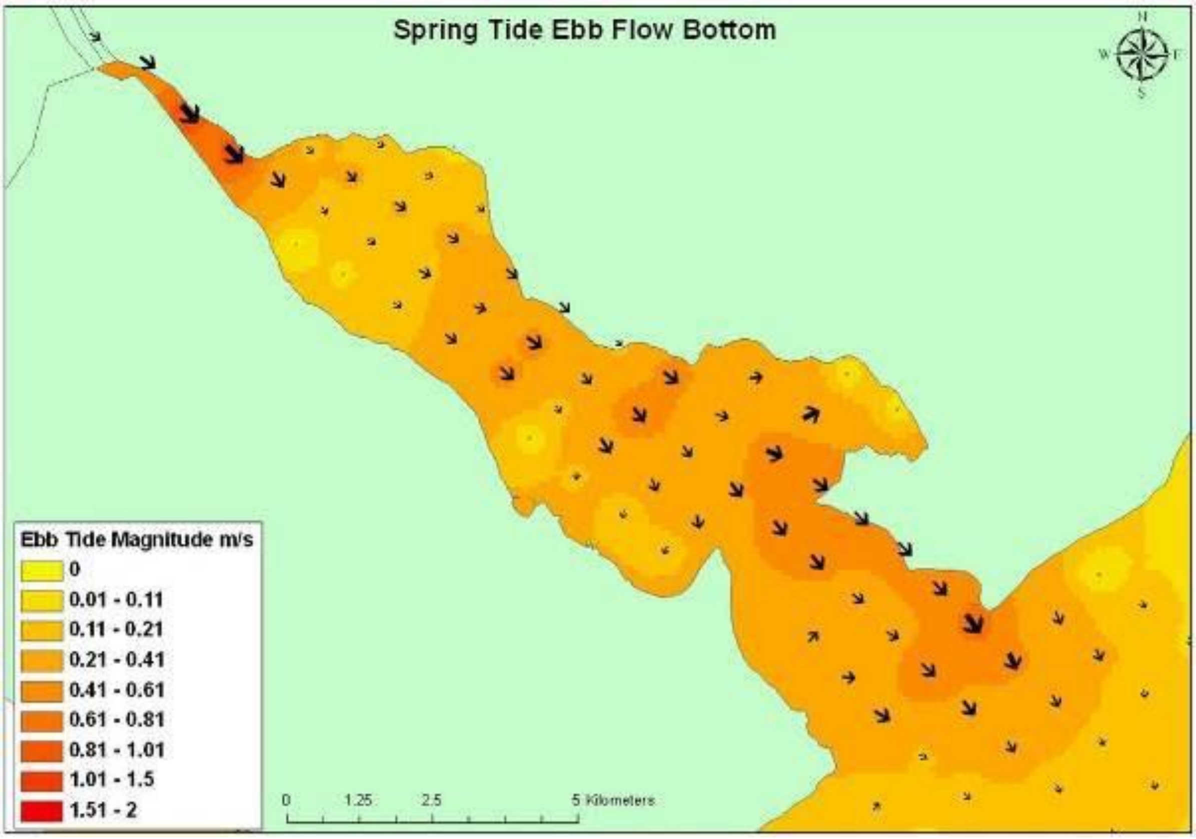
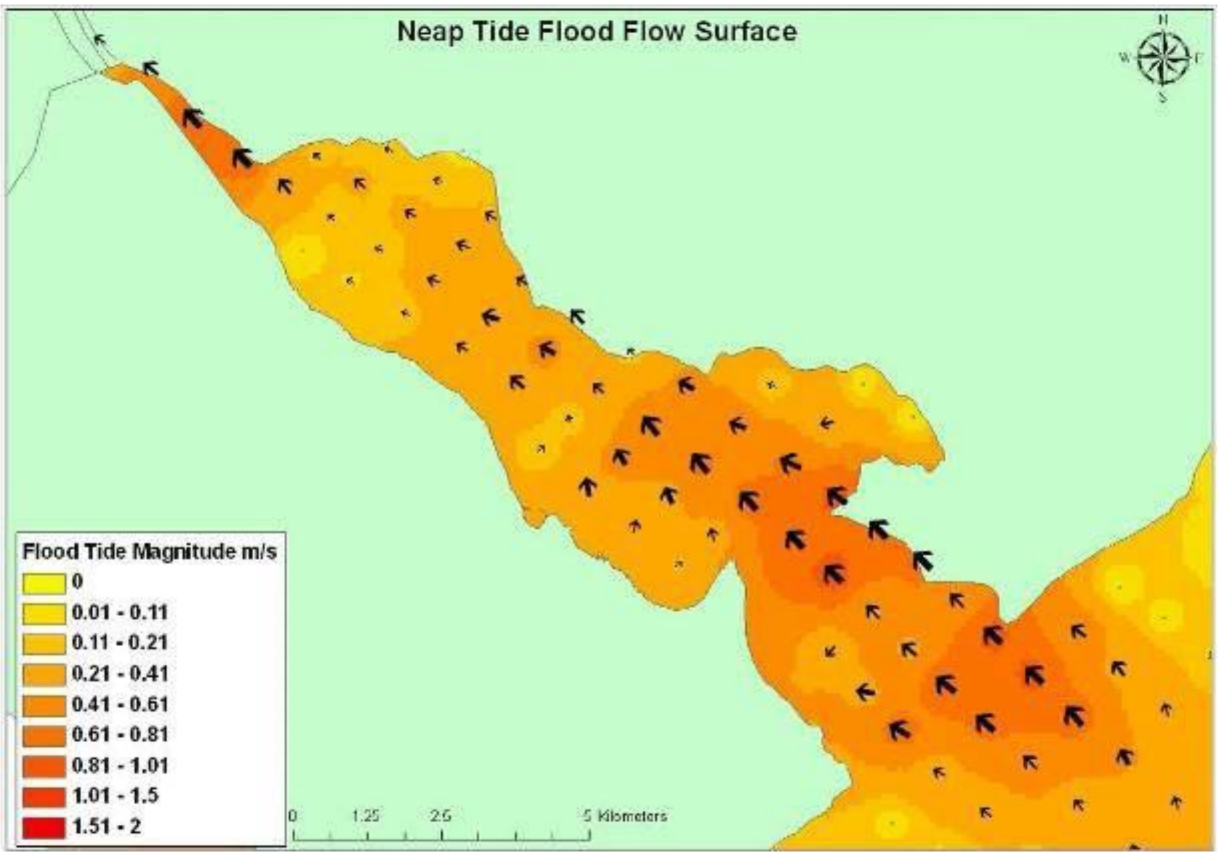


Figure 3.10: Surface and bottom current velocities and direction during a neap tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).



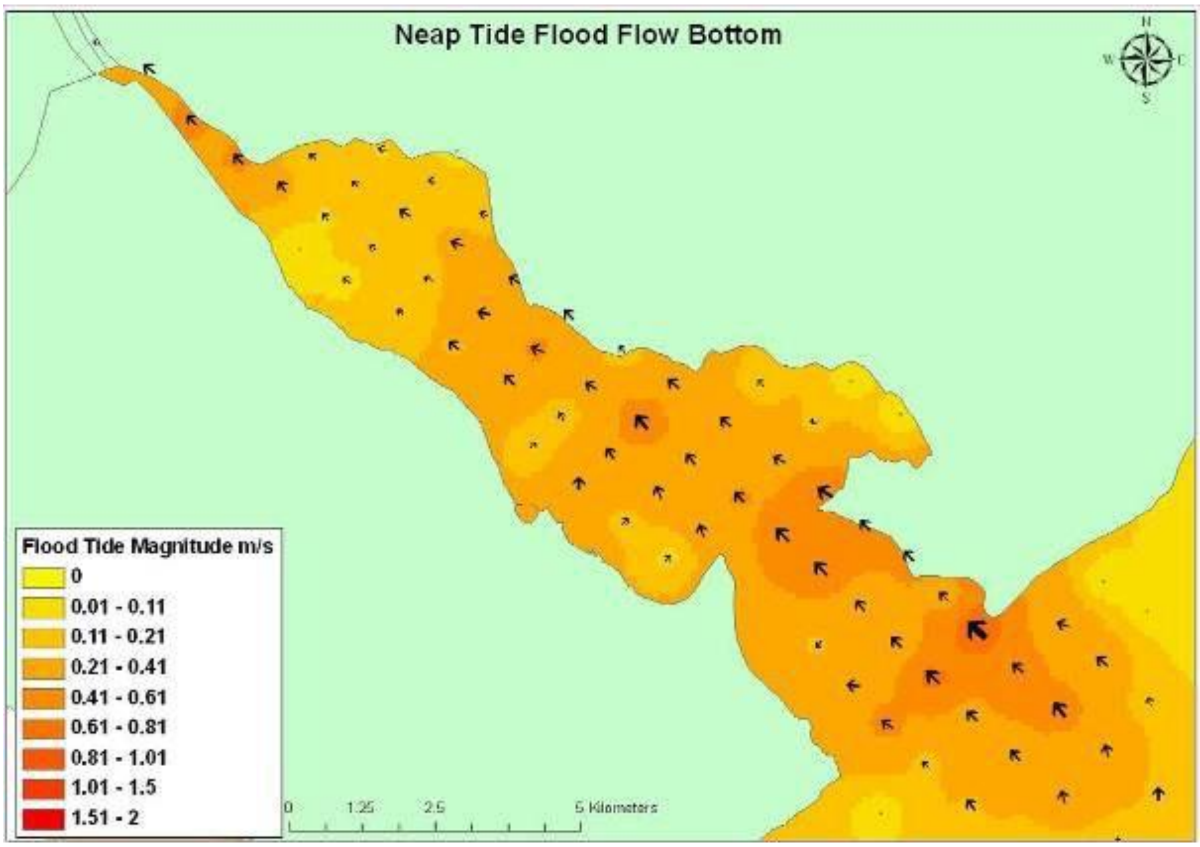
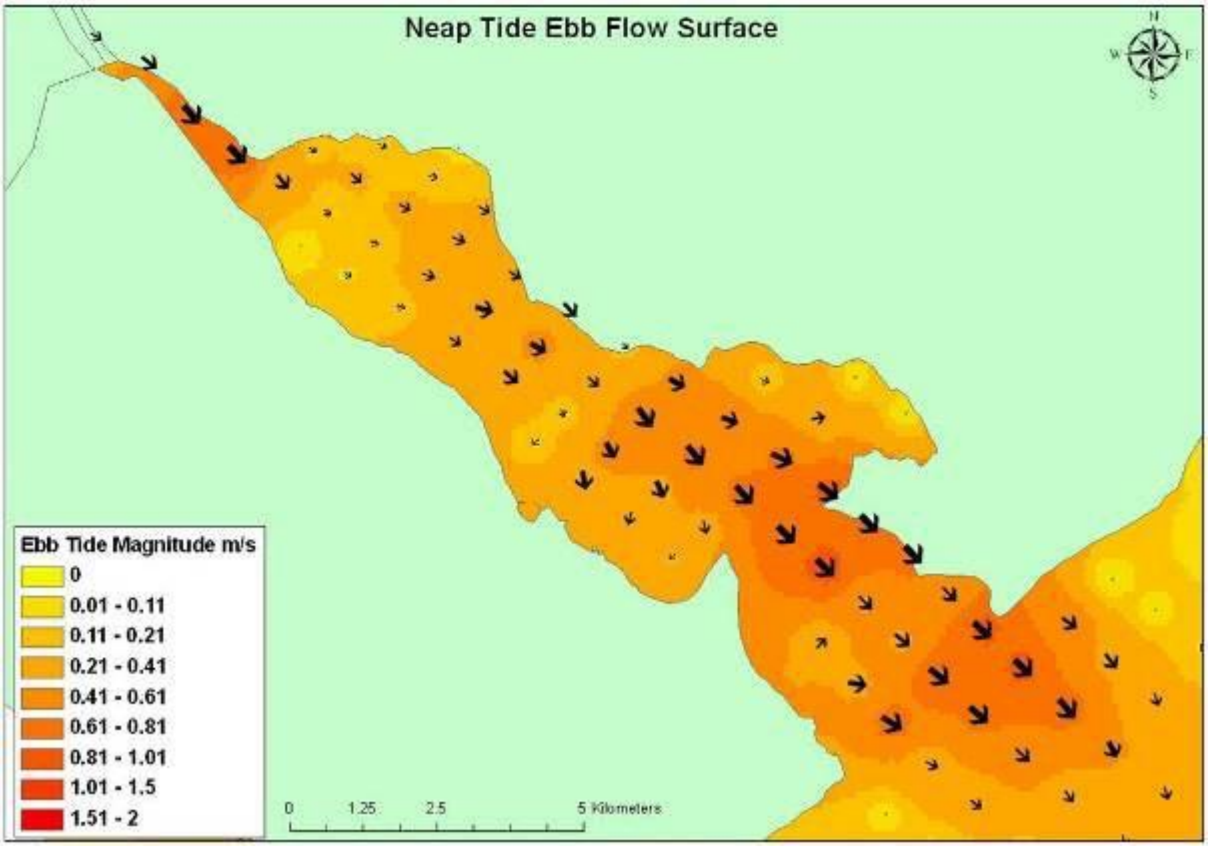
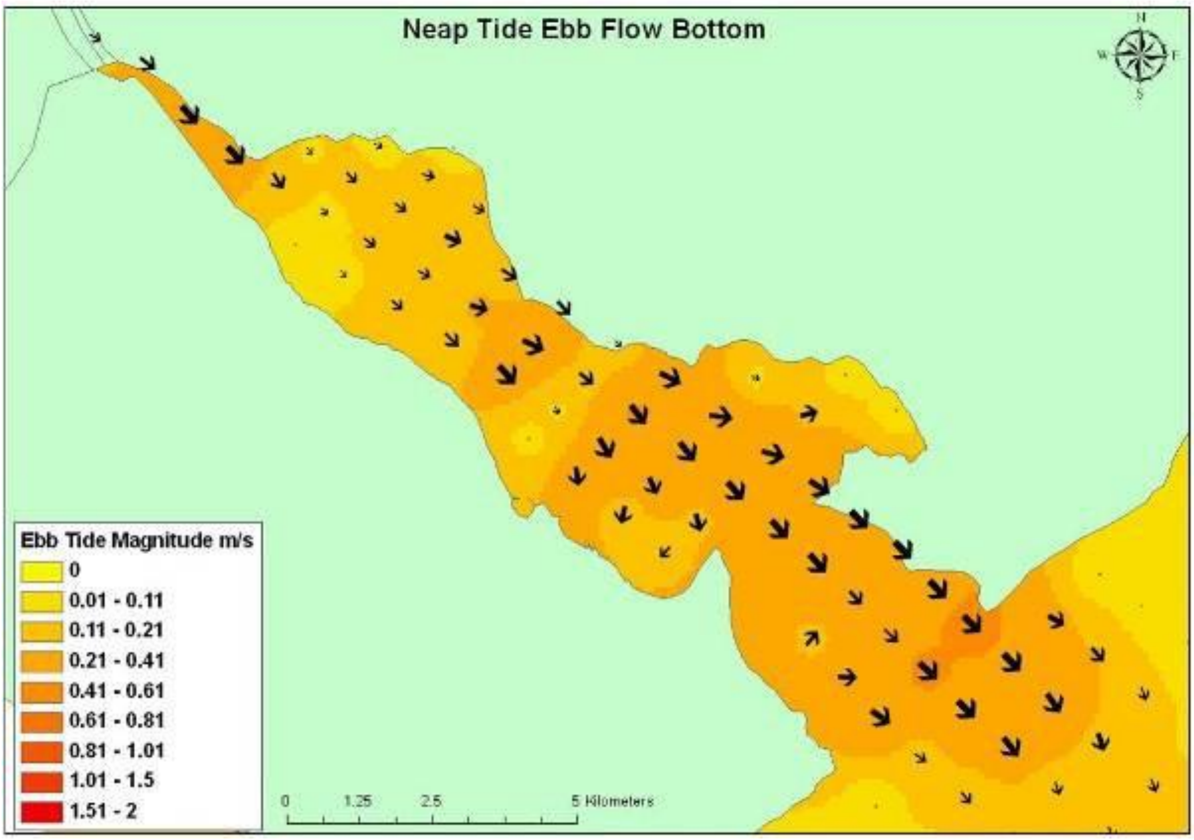


Figure 3.11: Surface and bottom current velocities and direction during a neap tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).





3.4 Wind and Waves

Wind data from 2005 to 2010 for Dublin Airport are displayed in Table 3.3 below and wind roses for the period can be seen in Figure 3.9 below. In 2005, 26% of the wind came from the west, 21.5% from the southwest and 11.3% from the southeast. The strongest winds came from the west direction (15.86kn). In 2006, 27.9% of the wind came from the west, 21.9% from the southwest and 15% from the southeast. The strongest winds (13.15kn) came from the southwest. In 2007, 30.9% of the wind came from the west, 22.3% came from the southwest and 11.8% came from the southeast. The strongest winds (16.2kn) came from the southwest. In 2008, 27.6% of the wind came from the west, 26.5% came from the southwest and 11.4% came from the southeast. The strongest winds (14.59kn) came from the southwest. In 2009, 27.8% of the wind came from the west, 24.3% came from the southwest and 14.7% came from the southeast. The strongest winds (15.04kn) came from the southwest. In 2010, 29.1% of the wind came from the west, 15.9% came from the southwest and 13.6% came from the southeast. The strongest winds (11.57kn) came from the south southwest. It can be seen from these data that the prevailing wind direction does not vary much and is mainly from the southwest.

Table 3.5 shows the seasonal averages from 2005 to 2010. Seasons were selected by grouping the results from the following periods: spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). Seasonal averages over the past 6 years indicate that winds are typically strongest in the winter months (11.71kn), followed very closely by spring (11.04kn), decreasing to 10.99kn in autumn and decreasing further to 9.61kn during the summer months.

Wind data from 2015 to 2020 for Dublin Airport are displayed in Table 3.4 below and wind roses for each year can be seen in Figure 3.9 below. In 2015, 27.4% of wind recorded came from the southwest, 26.4 came from the west and 13.1% came from the southeast. The strongest winds came from the southwest direction (15.09kn). In 2016, 26.8% of the wind came from the west, 23.1% came from the southwest and 11.6% came from the southeast. The strongest winds (13.21kn) came from the southwest. In 2017, 34% of the wind came from the west, 25.2% came from the southwest and 11.8% came from the southeast. The strongest winds (13.43kn) came from the southwest. In 2018, 24.6% of the wind came from the west, 20.2% came from the southwest and 14.7% came from the southeast. The strongest winds (14.78kn) came from the southwest. In 2019, 29.3% of the wind came from the west, 19.8% came from the southwest and 14.6% came from the southeast. The strongest winds (11.27kn) came from the southwest. In 2020, 28.4% of the wind came from the west, 22.1% came from the southwest and 10.3% came from the south. The strongest winds (13.1kn) came from the north. It can be seen from these data that the wind speed and prevailing wind direction does not vary much from the data for 2005 to 2010 and is mainly comes from the southwest.

Table 3.6 shows the seasonal averages from 2015 to 2020. Seasons were selected by grouping the results from the following periods: spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). Seasonal averages over the past 6 years indicate that winds are typically strongest in the winter months (11.90kn), followed very closely by spring (10.21kn), decreasing to 9.97kn in autumn and decreasing further to 9.17kn during the summer months. This data follow the same patterns as the 2005-2010 data with similar wind speeds.

Table 3.3: Wind speed and direction data for Dublin Airport from 2005-2010 (Source: Met Eireann, 2010a).

Year	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	2010	2010
Month	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Directio n (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**
January	15.86	244.18	10.10	186.33	16.20	241.81	14.59	214.22	12.00	197.88	10.98	211.69
February	11.53	223.83	10.65	190.65	10.35	205.62	12.20	183.82	12.20	228.69	8.44	200.86
March	10.53	198.61	12.66	169.78	12.35	216.19	15.04	233.49	15.04	231.66	9.32	209.66
April	11.19	195.06	10.90	240.76	8.91	172.76	11.69	205.09	9.62	165.62	8.32	188.30
May	10.81	193.89	10.83	204.48	11.35	209.12	9.70	114.69	12.18	194.50	8.21	194.50
June	9.33	197.66	8.76	181.5	9.25	171.97	9.95	228.72	8.95	148.06	7.8	185.91
July	8.89	202.16	8.46	183.01	10.13	223.10	10.79	199.79	9.96	220.17	10.57	222.67
August	9.55	238.53	10.28	248.50	9.69	255.06	10.37	225.09	11.13	219.20	9.14	235.92
September	10.82	200.44	10.47	192.59	10.35	234.22	9.49	209.80	10.11	218.20	9.54	209.94
October	10.68	196.62	10.60	199.67	8.21	198.25	12.63	233.70	10.15	217.84	11.57	206.58
November	11.03	236.47	12.48	227.81	11.66	239.08	12.42	240.58	14.27	226.19	11.31	222.43
December	9.82	221.51	13.15	223.83	12.91	201.23	10.19	215.13	11.28	200.41	8.38	225.80

Table 3.4: Wind speed and direction data for Dublin Airport from 2015-2020 (Source: Met Eireann, 2010a).

Year	2015	2015	2016	2016	2017	2017	2018	2018	2019	2019	2020	2020
Month	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Mean Direction (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**
January	15.09	237.06	13.16	207.45	10.35	215.28	14.78	210.24	9.32	241.03	9.66	228.37
February	10.73	240.08	13.21	209.97	13.43	197.15	11.85	215.93	10.26	197.05	13.10	13.10
March	12.93	210.69	10.57	212.51	11.76	186.29	12.25	168.13	11.27	234.08	10.26	193.87
April	9.37	182.19	10.63	204.69	9.48	245.25	10.84	170.31	9.25	143.62	8.43	148.30
May	12.55	218.42	9.50	146.65	9.54	158.57	8.78	171.02	7.85	207.23	8.59	182.15
June	10.55	211.75	7.70	195.97	11.00	215.02	8.69	168.31	8.23	187.11	9.21	195.27
July	10.50	212.08	10.25	239.67	9.76	215.59	6.90	197.13	7.98	224.55	8.86	230.59
August	9.18	207.08	10.80	214.95	9.97	227.59	8.12	235.22	8.77	214.65	8.53	181.59
September	8.98	211.68	10.32	210.69	10.86	229.52	9.01	241.04	8.77	218.22	8.51	207.80
October	8.98	183.92	9.40	210.69	12.22	230.14	9.18	237.78	8.80	213.73	10.42	210.83
November	13.62	226.08	10.59	235.83	10.84	252.75	10.08	159.59	9.36	200.083	9.51	208.75
December	14.85	196.59	12.77	202	12.40	246.59	9.47	204.46	9.23	216.19	10.50	237.08

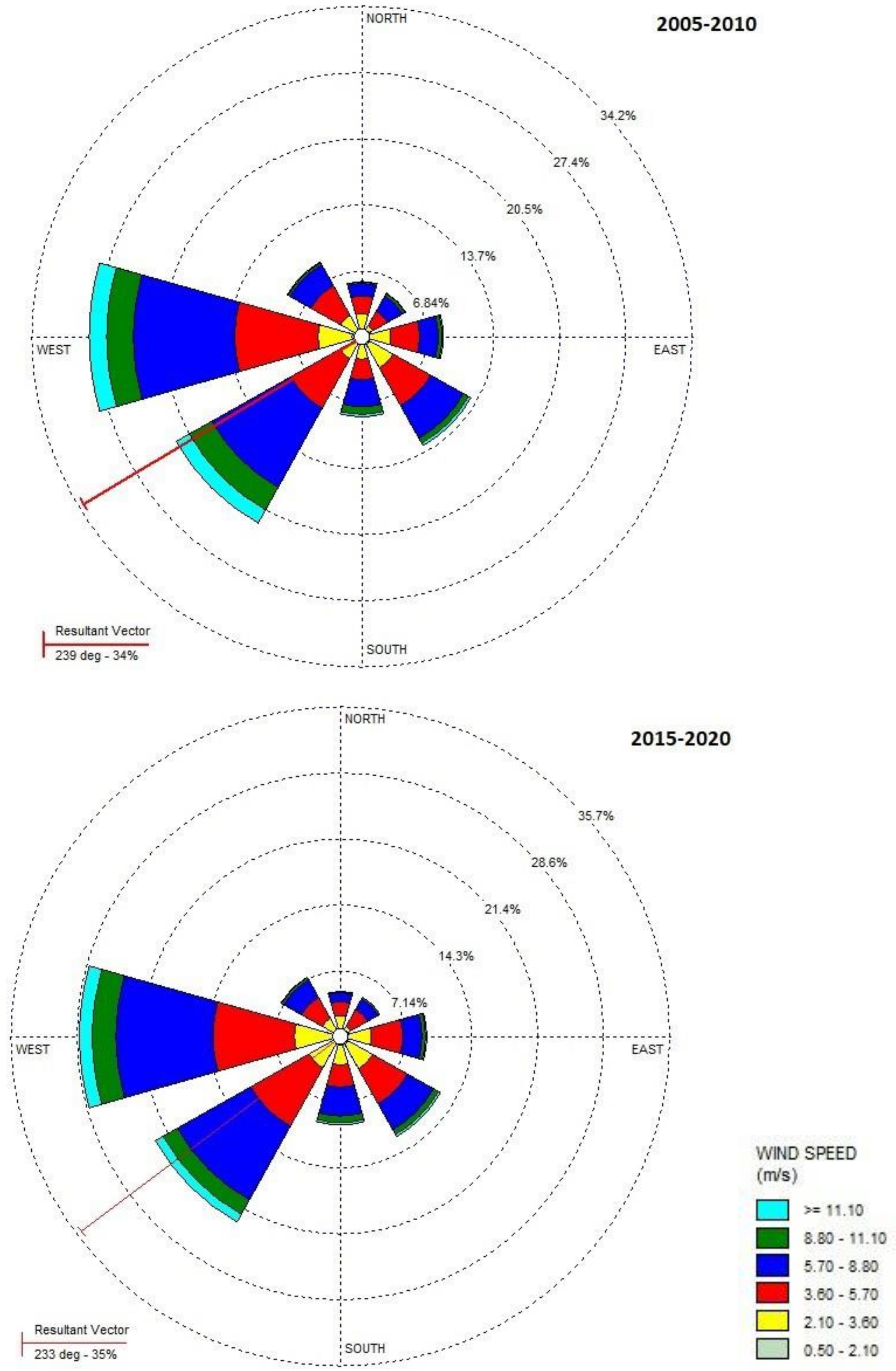
Table 3.5: Seasonal averages (knots) for Dublin Airport wind data 2005 - 2010 (Source: Met Eireann, 2010a).

Season	2005	2006	2007	2008	2009	2010	6-year Average
Winter	12.40	11.30	13.15	12.33	11.83	9.27	11.71
Spring	10.84	11.46	10.87	12.14	12.28	8.62	11.04
Summer	9.26	9.17	9.69	10.37	10.01	9.17	9.61
Autumn	10.84	11.18	10.07	11.51	11.51	10.81	10.99

Table 3.6: Seasonal averages (knots) for Dublin Airport wind data 2015 – 2020 (Source: Met Eireann, 2021a).

Season	2015	2016	2017	2018	2019	2020	6-year Average
Winter	13.56	13.05	12.06	12.03	9.60	11.09	11.90
Spring	11.62	10.23	10.26	10.62	9.46	9.09	10.21
Summer	10.08	9.58	10.24	7.90	8.33	8.87	9.17
Autumn	10.53	10.10	11.31	9.42	8.98	9.48	9.97

Figure 3.12: Wind roses for Dublin Airport from 2005 to 2010 and 2015 to 2020. (Source: Met Eireann, 2021).



Wind conditions affect the hydrodynamic conditions in Carlingford Lough by generating wind-induced currents and waves. Of these phenomena, wind-induced waves are an important factor in the process of sediment resuspension and transport. Wind waves are produced by the local prevailing wind. They travel in the direction of the prevailing wind, i.e. a southwesterly wind will produce northeasterly moving waves. The height of wind waves depends on:

- the strength of the wind;
- the time the wind has been blowing; and
- the fetch.

In Carlingford Lough the prevailing wind direction has the effect of directing water towards the northern coastline of the lough. Especially over the shallow areas of Carlingford Lough, wave-induced bottom friction may lead to resuspension of material and entrainment of sediments in the water column, with resulting higher turbidity levels in these areas.

3.5 River Discharges

The Newry (Clanrye) River is Carlingford Lough's major freshwater source. The quantities of freshwater from this source are relatively small with a small flow rate that can vary from 1m3/s in summer to 9m3/s in winter (Ferreira et al., 2007). Other freshwater discharges include the Ryland, Moygannon, Rostrevor, Whitewater, Ballincurry, Cassey Water and Ghann Rivers (CLAMS, 2005). The majority of these are spate rivers which feed off the mountains. These low levels generally do not affect the salinity of the Lough (Loughs Agency, 2010). Figure 3.10 below shows the 474km^2 catchment area of Carlingford Lough with seven measuring stations, operated by the Rivers Agency. Of these 7 stations, data are available for 2 of them; Clanrye at Mountmill Bridge and at Jerretspass. The mean flow of the Clanrye River at Mountmill Bridge is 2.04m3/s and the mean flow at Jerretspass is 0.82m^3/s in 2010 (NRFA [National River Flow Archive], 2010a). Figure 3.11 shows the averaged flow of the Clanrye River at Mountmill Bridge from 2005 to 2008. Over the 4 years, June and July have had the least flow with flow levels increasing towards and into the winter months. One notable exception to this is the relatively high flow levels seen in August 2008, which corresponds with the relatively high rainfall levels seen during this period. The mean flow of the Clanrye River at Mountmill Bridge is 1.71m3/s and the mean flow at Jerretspass is $0.78m^3/s$ in 2018 (NRFA [National River Flow Archive], 2019a). These average flow rates were lower than figures recorded in 2010 at both stations. Figure 3.12 shows the averaged flow of the Clanrye River at Mountmill Bridge from 2015 to 2019. Over the past 4 years, June and July have had the least flow with flow levels increasing towards and into the winter months, which is similar to the data recorded from 2005 to 2008.

Figure 3.13: Rivers and river monitoring stations (Source: NRFA, 2020).

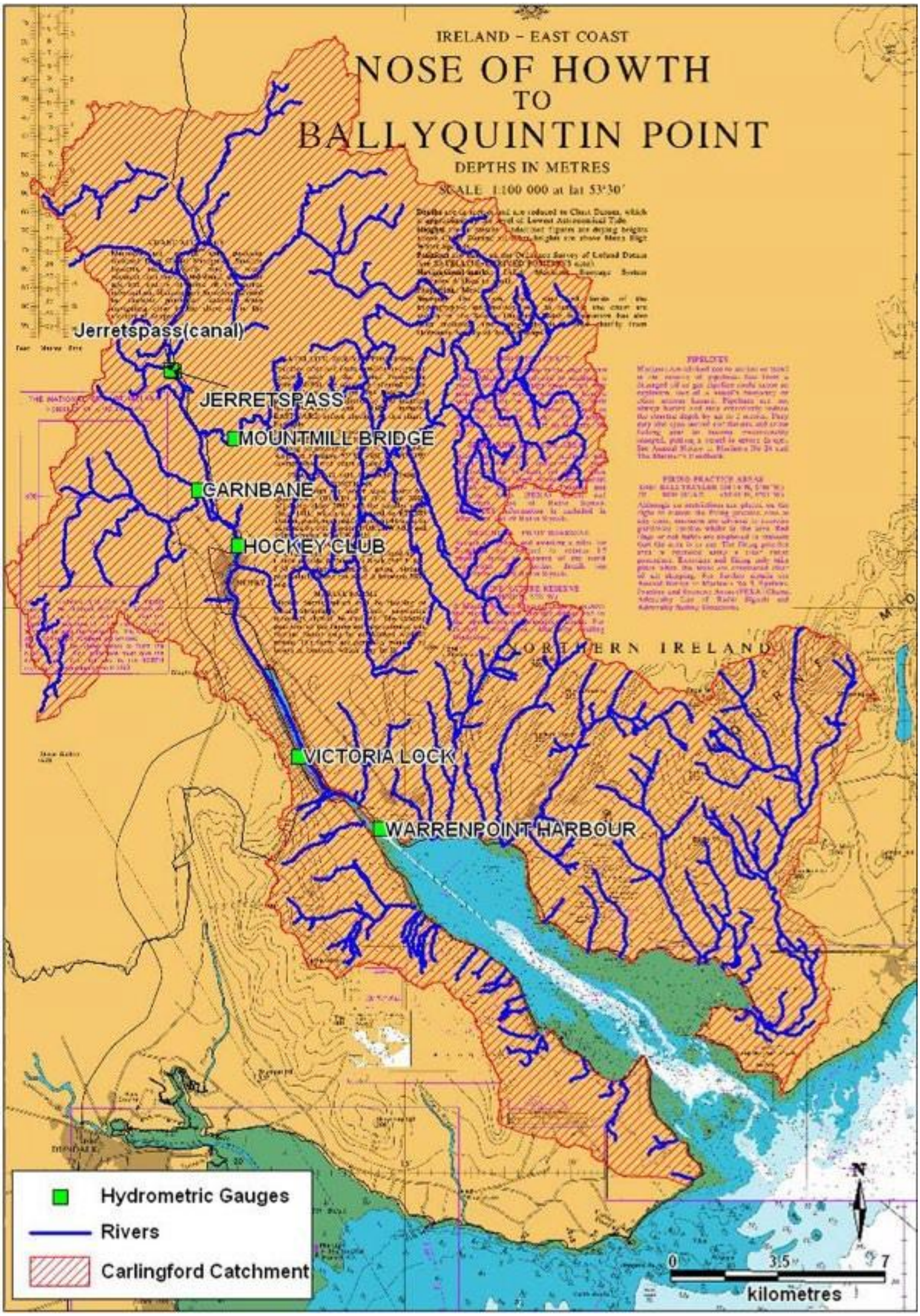


Figure 3.14: Average flow data from the Clanrye River at Mountmill Bridge from 2005 to 2008 (Source: NRFA, 2010b)

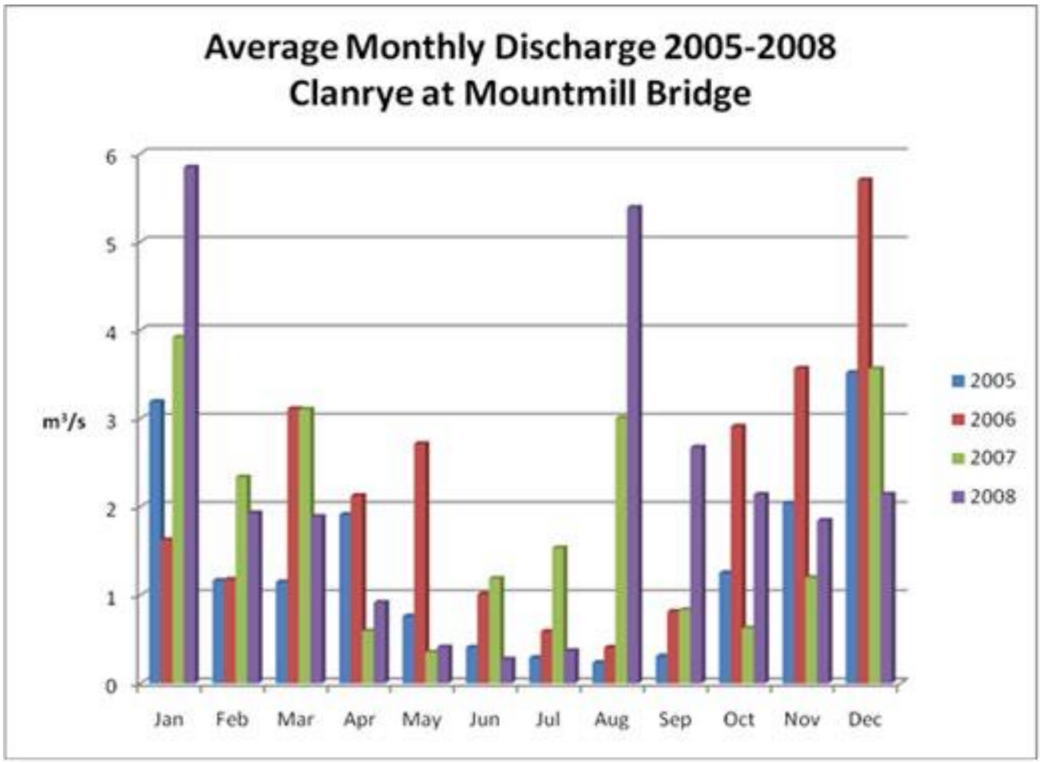
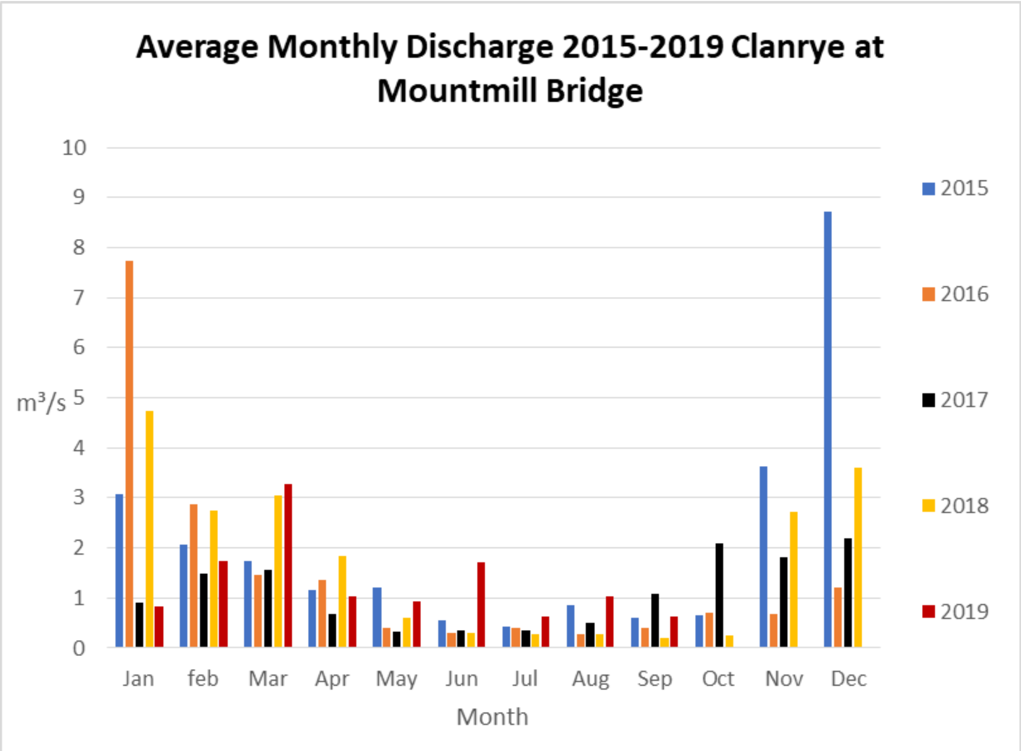


Figure 3.15: Average flow data from the Clanrye River at Mountmill Bridge from 2015 to 2019 (Source: NRFA, 2021)



3.6 Rainfall Data

3.6.1 **Amount** and **Time of Year**

Table 3.7 and Figure 3.14 show the average monthly rainfall data for Northern Ireland (Met Office, 2021) from 1978 to 2007. Table 3.7 shows the average rainfall range and median value along the Carlingford Lough coastline. During the period 1978 to 2007, the average rainfall along the Northern Ireland coastline of Carlingford Lough ranged from 61.6mm to 98.4mm. The lowest median value was 61.6 mm in April and the highest was 98.4mm in December. Figure 3.13 shows the seasonal averages for Northern Ireland from 1978 to 2007. Table 3.8 shows the median seasonal rainfall values. Seasonally, spring was the driest season (209mm) and autumn was the wettest season (264mm).

Table 3.7: **Rainfall range and median monthly rainfall (mm) data along the Carlingford Lough coastline from 1978-2007 (Source: Met Office, 2021).**

Month	**Median Value (mm)**
January	87.6
February	71.0
March	84.0
April	61.6
May	63.4
June	70.9
July	70.8
August	88.7
September	76.2
October	102.7
November	85.1
December	98.4

Table 3.8: Median seasonal rainfall values (mm) from 1978-2007 (Source: Met Office, 2021).

Season	**Median**
Spring	209
Summer	230.4
Autumn	264
Winter	257

Figure 3.16: Average seasonal rainfall (mm) data for spring to winter from 1981 to 2010 for Northern Ireland (Source: Met Office, 2011).

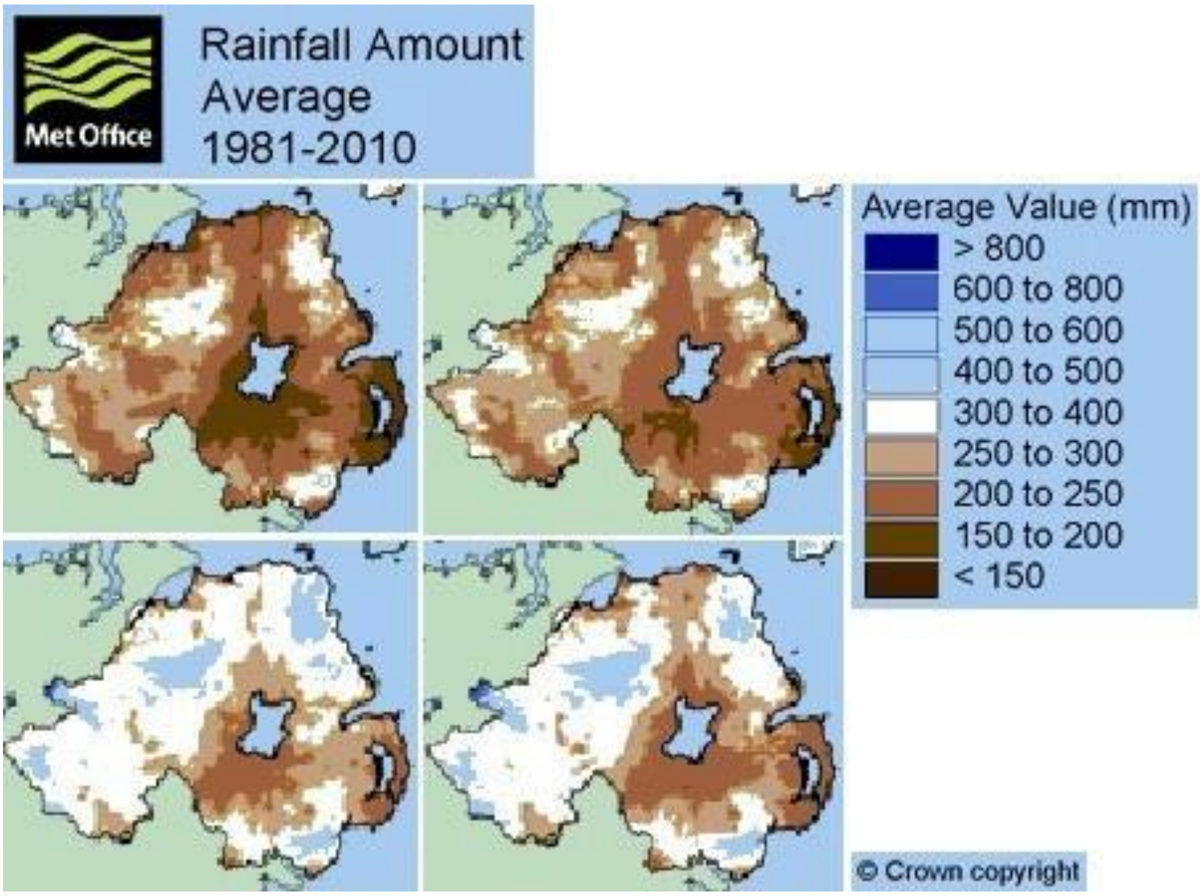
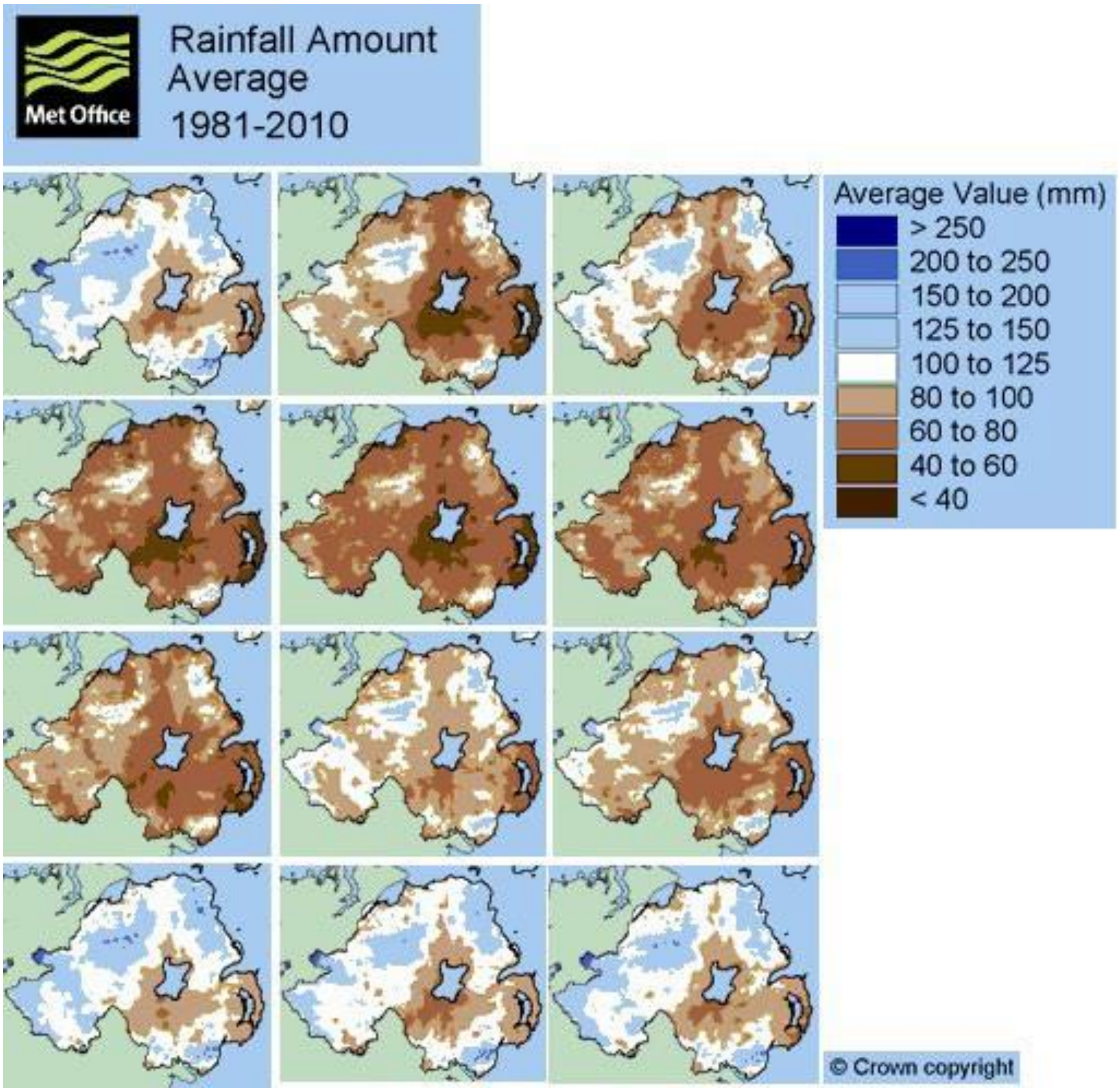


Figure 3.17: Average monthly rainfall (mm) data for January to December from 1981 to 2010 for Northern Ireland (Source: Met Office, 2011).



3.6.2 Frequency of Significant Rainfalls

Figure 3.15, Figure 3.16 and Figure 3.17 show the average monthly rainfall for the Carlingford Lough area from 1978-2007 and 2007-2019 respectively. Figure 3.16 shows the average monthly rainfall data at the Carlingford Lough coast. Over the past 5 years, July and August have on average been the wettest months, followed by October and November and of these 5 years, 2008 and 2009 were the wettest on average. During these months there may be an increased risk of contamination from land run-off and rainfall associated sewer overflows.

Figure 3.18: Average monthly rainfall (mm) data along the Carlingford Lough coast from 1978-2007 (Source: Met Office, 2021).

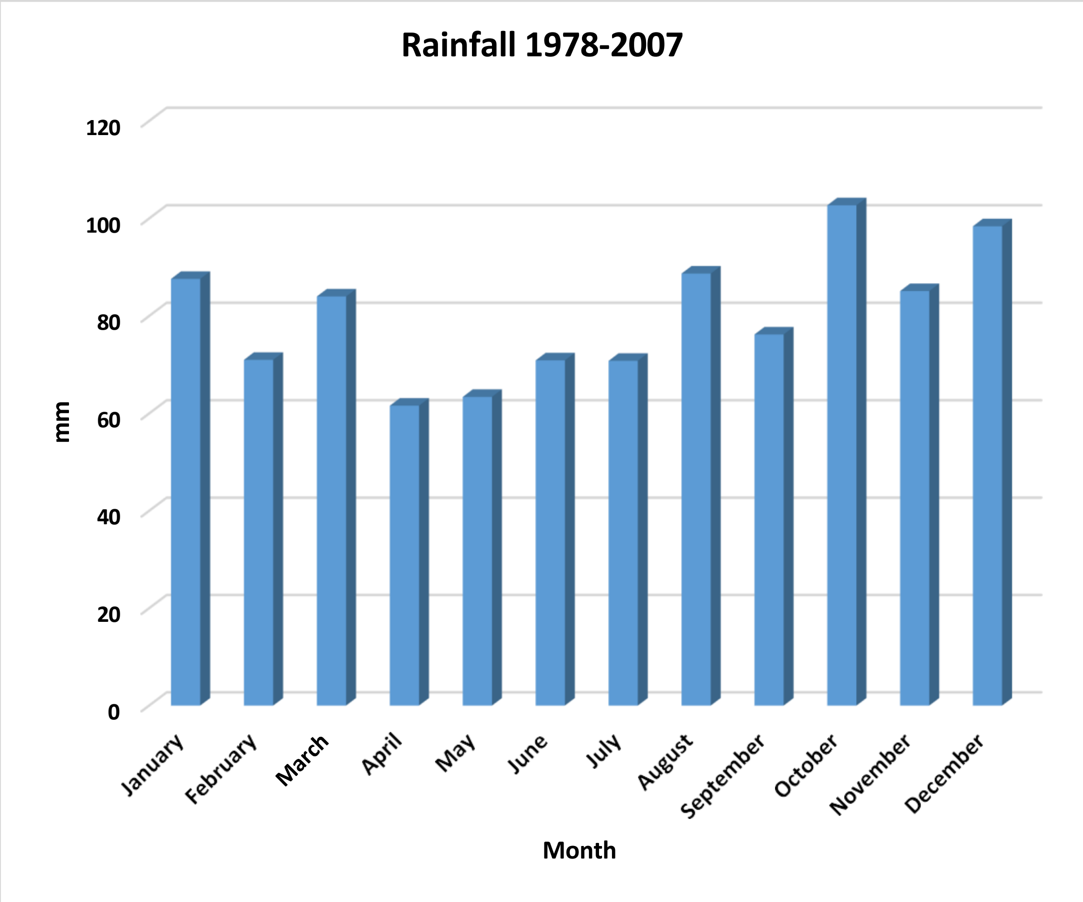


Figure 3.19: Average monthly rainfall (mm) data along the Carlingford Lough coast from 2007-2019 (Source: Met Eireann, 2021).

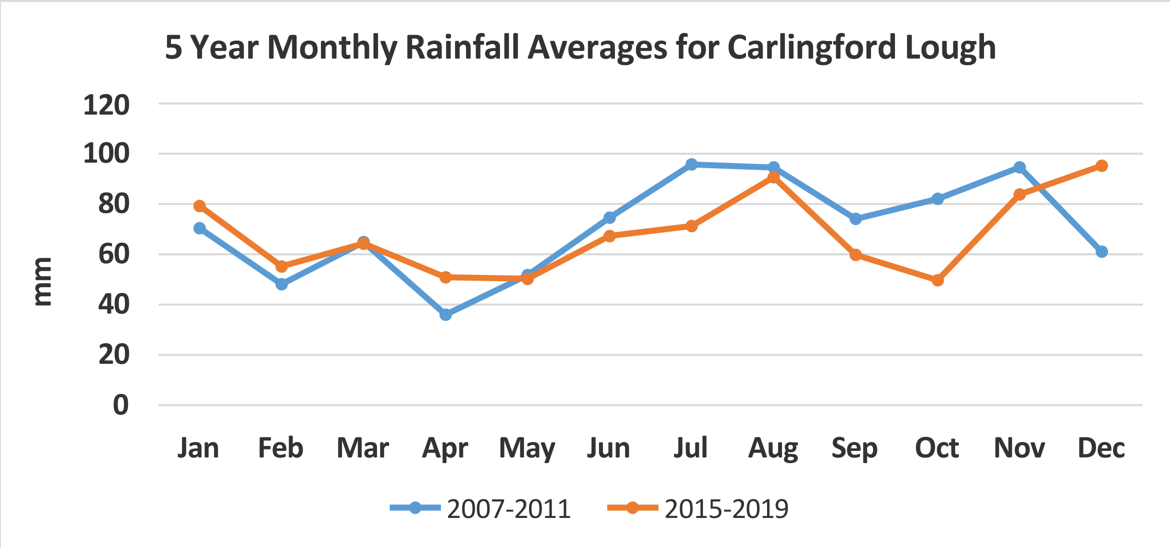
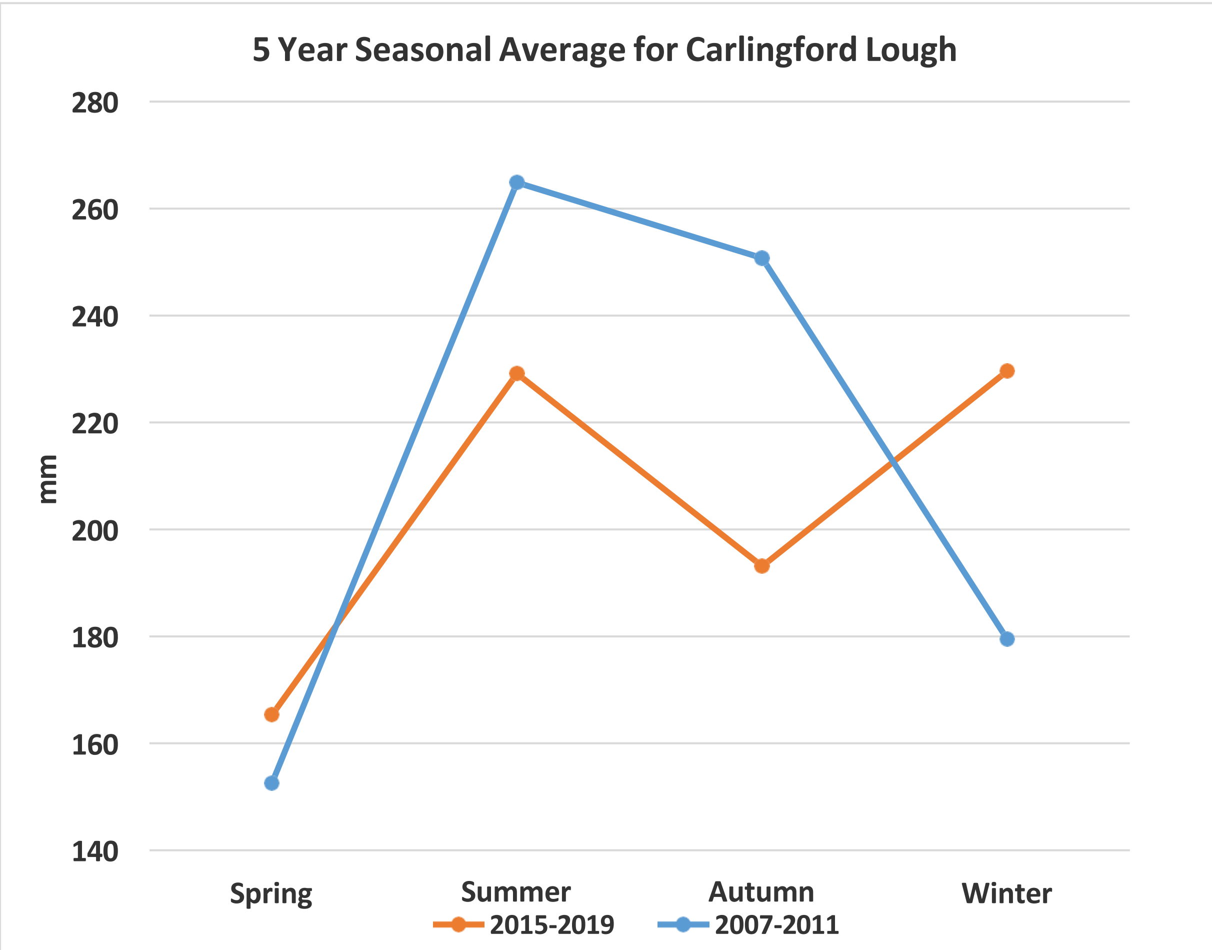


Figure 3.20: Average monthly rainfall (mm) data along the Carlingford Lough coast from 2007-2019 (Source: Met Eireann, 2021).



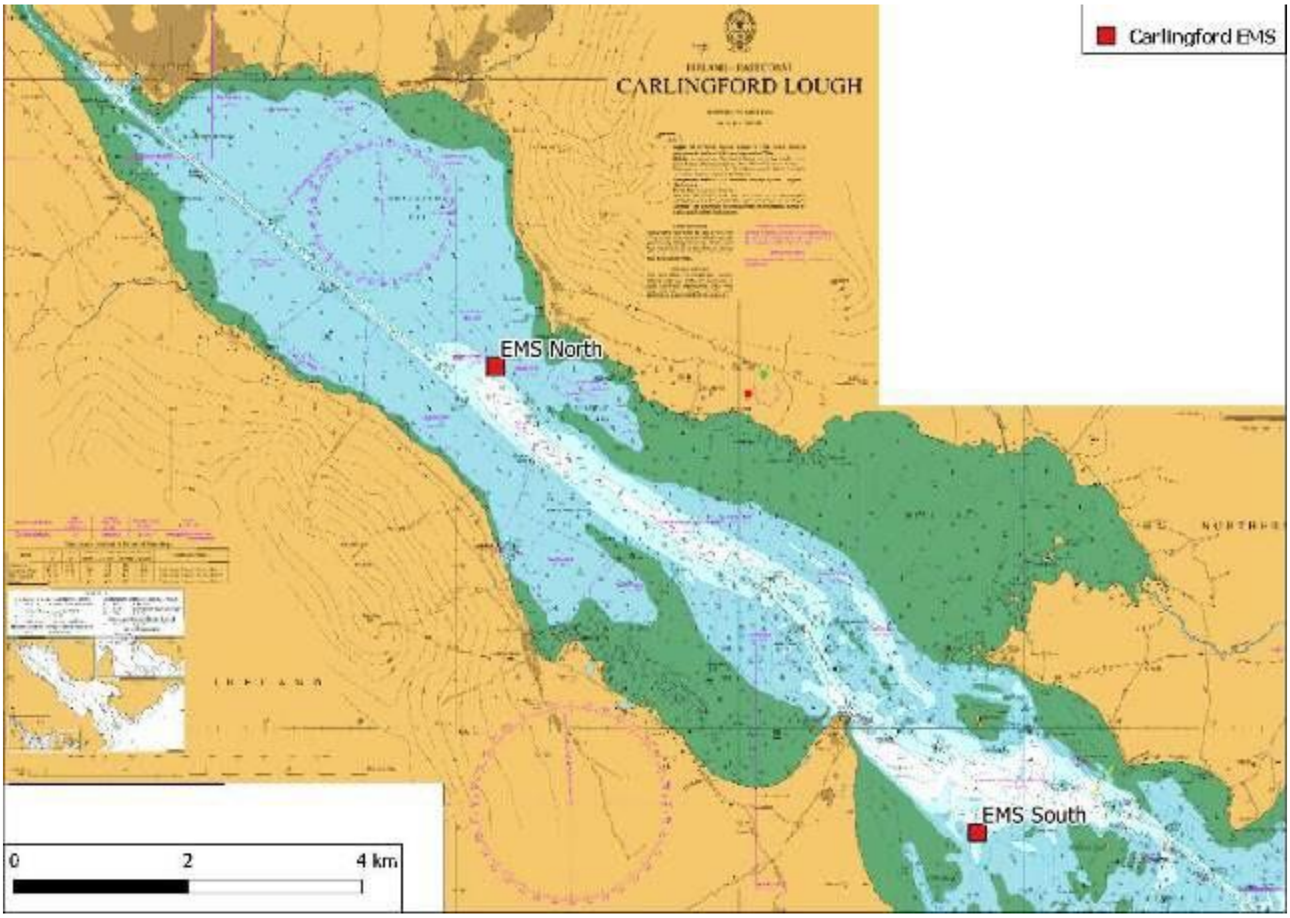
3.7 Salinity

The Loughs Agency collects data on coastal water quality including salinity via a network of remotely moored Environmental Monitoring Stations (EMS) in Carlingford Lough. AFBI manage and process these data. The EMS consists of an electronic unit which houses the data storage devices for capturing real time data and the GSM (Global System for Mobile Communication) telemetry system for communication of these data with a base station on-land. There are two EMS stations located within Carlingford Lough, North and South (See Figure 3.18). The Carlingford Lough North EMS is located approximately 650m southwest of Killowen Point and the Carlingford Lough South EMS is located approximately 2.1km southeast of Greenore. Salinity data are collected daily.

The salinity at the North EMS site ranged from 26.44 to 33.43 PSU and from 29.5 to 33.55 PSU at the south EMS site. The 2020 salinity data follows the same trends as the 2007 – 2009 data which was used in the 2011 sanitary survey. The salinity in both cases was higher at the south EMS site at the mouth of the lough as would be expected. The average salinity for both sites was slightly higher for the 2020 data. The north EMS site had an average salinity of 30.38 PSU in 2007-2009 as opposed to 31.71 PSU in 2020 and at the south EMS site it was 31.91 PSU in 2007-2009 and 32.62 PSU in 2020. Taylor *et al.* (1999) reported similar results and trends within the Lough and noted that the range within stations was greater at the inner sites, reflecting the influence of freshwater inputs. Douglas (1992) also reported similar results.

The flow from the Newry River (which represents 70% of the total riverine flow into the lough) is small in comparison to the tidal prism of Carlingford Lough: the average recorded daily flow of the Newry River is 470,707m^3, compared with a tidal prism volume of approximately 146 x 106m3 (Taylor *et al*., 1999). In addition, Wilson (1974) carried out an analysis of salinity variation over the tidal cycle and his results indicated that even in the inner lough the influence of rivers on salinity was only significant at low tide.

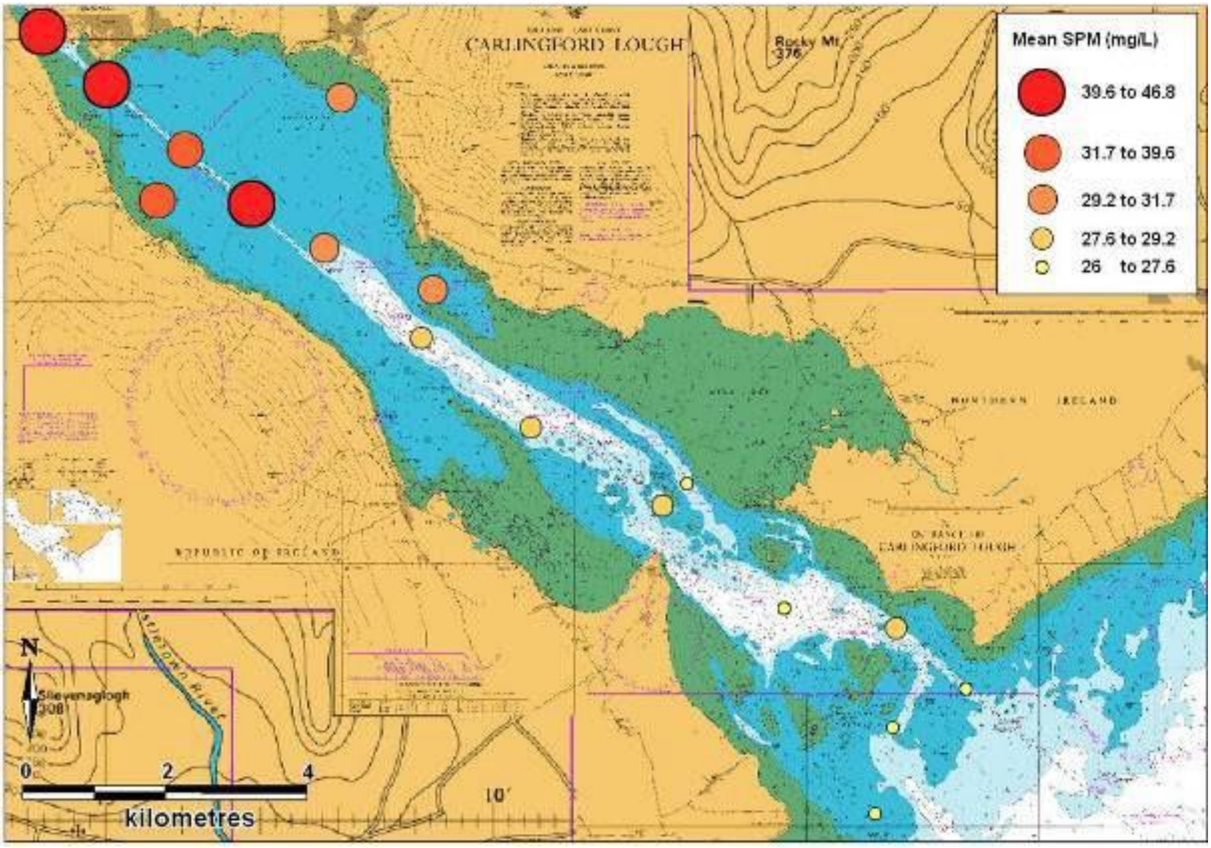
Figure 3.21: Location of the salinity and turbidity monitoring sites in Carlingford Lough.



3.8 Turbidity

Turbidity is a measure of the degree to which water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. Turbidity levels are expected to be highest in shallow disturbed waters compared to deeper well flushed areas. The 2011 sanitary survey found that turbidity levels increased with increasing distance from the mouth of the bay (Figure 3.19). The turbidity data from the EMS stations for 2020 agree with these findings. The average turbidity at the North EMS site was 24.1NTU while the south EMS site had an average turbidity of 2.5NTU.

Figure 3.22: SPM levels in Carlingford Lough from January 1997 to June 1998 (Source: Taylor et al., 1999).

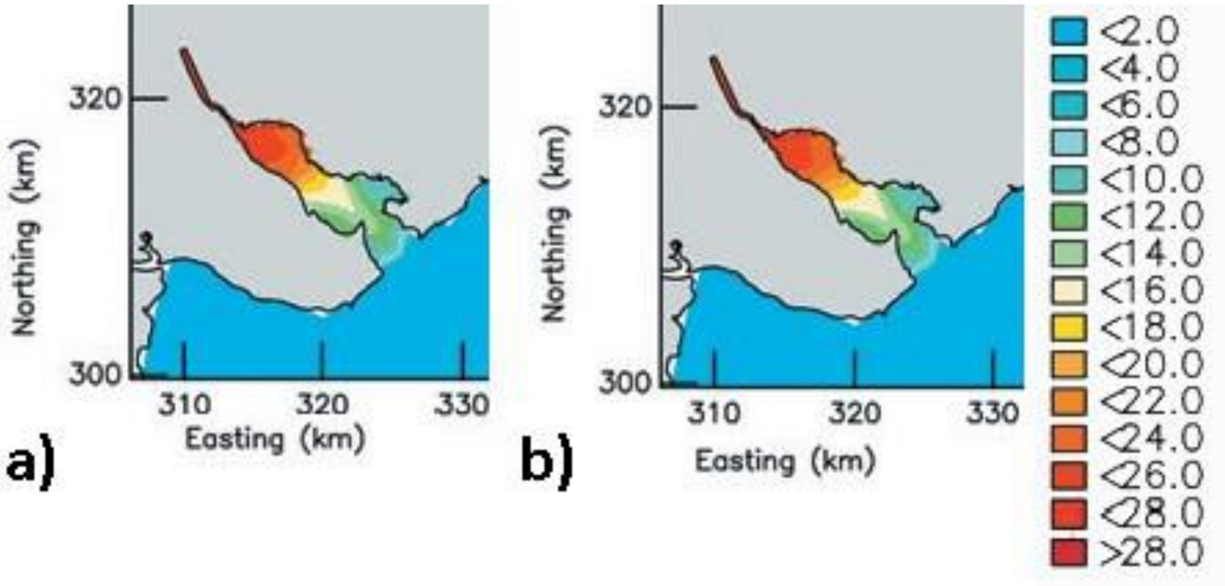


3.9 Residence Times

Residence time can be defined as the average amount of time that a molecule of water of a particle spends in a particular system (in this case Carlingford Lough). Residence times are important because of the way they govern productivity rates as well as the vulnerability to water quality degradation. The residence times within the Lough during the summer can be seen in Figure 3.22 (Source: Ferreira *et al.,* 2007). These values are calculated from the SMILE Delft3D Model. Carlingford Lough can be divided into three zones of long (> 20 days), mid (8–20 days) and short (< 8 days) residence times.

These residence time gradients have important ecological implications because they modulate the dynamical relationship between nutrient dispersion/transport and its utilisation by phytoplankton. Domains with long residence times are vulnerable to both nutrient depletion and low production if the main supply flux is from the coast and to eutrophication if the land based flux is much larger than the advection/dispersion rates. Ecologically the upper reaches are likely to be predominantly regeneration production driven in contrast to the short residence time areas near the mouth which will be largely new production driven.

Figure 3.23: Residence times (days) within Carlingford Lough a) near surface and b) near bottom (Source: Ferreira *et al.,* 2007).



3.10 Discussion

The inner section of Carlingford Lough (inside Killowen Point) is shallow (<5m depth), has relatively weak tidal currents and receives approximately 70% of the Loughs freshwater input from the Newry/Clanrye River. These three factors combine to result in a turbid slow moving sink with a long residence time (>20 days). In contrast the outer part of the Lough experiences strong tidal currents, deeper depths and shorter residence times (<8 days), which all results in a faster moving well flushed area. Any contamination in the outer section of the Lough will be diluted and dispersed rapidly, whereas the inner part of the Lough can act as a sink for contaminants. In addition, the prevailing wind direction in the area has the effect of pushing water towards the northern shoreline, into Rostrevor Bay and Mill Bay and given their shallow nature these areas may also act as sinks for contaminants.

There has been no significant change in the hydrodynamics of Carlingford Lough since the 2011 sanitary survey. A slight decrease was noted in the flow in Clanrye River at both Mountmill Bridge and Jerretspass. There was also a corresponding decrease in rainfall with an average annual rainfall of 847mm from 2007-2009 and 817mm from 2015-2019. There has been no change in wind patterns.

4. Identification of Pollution Sources

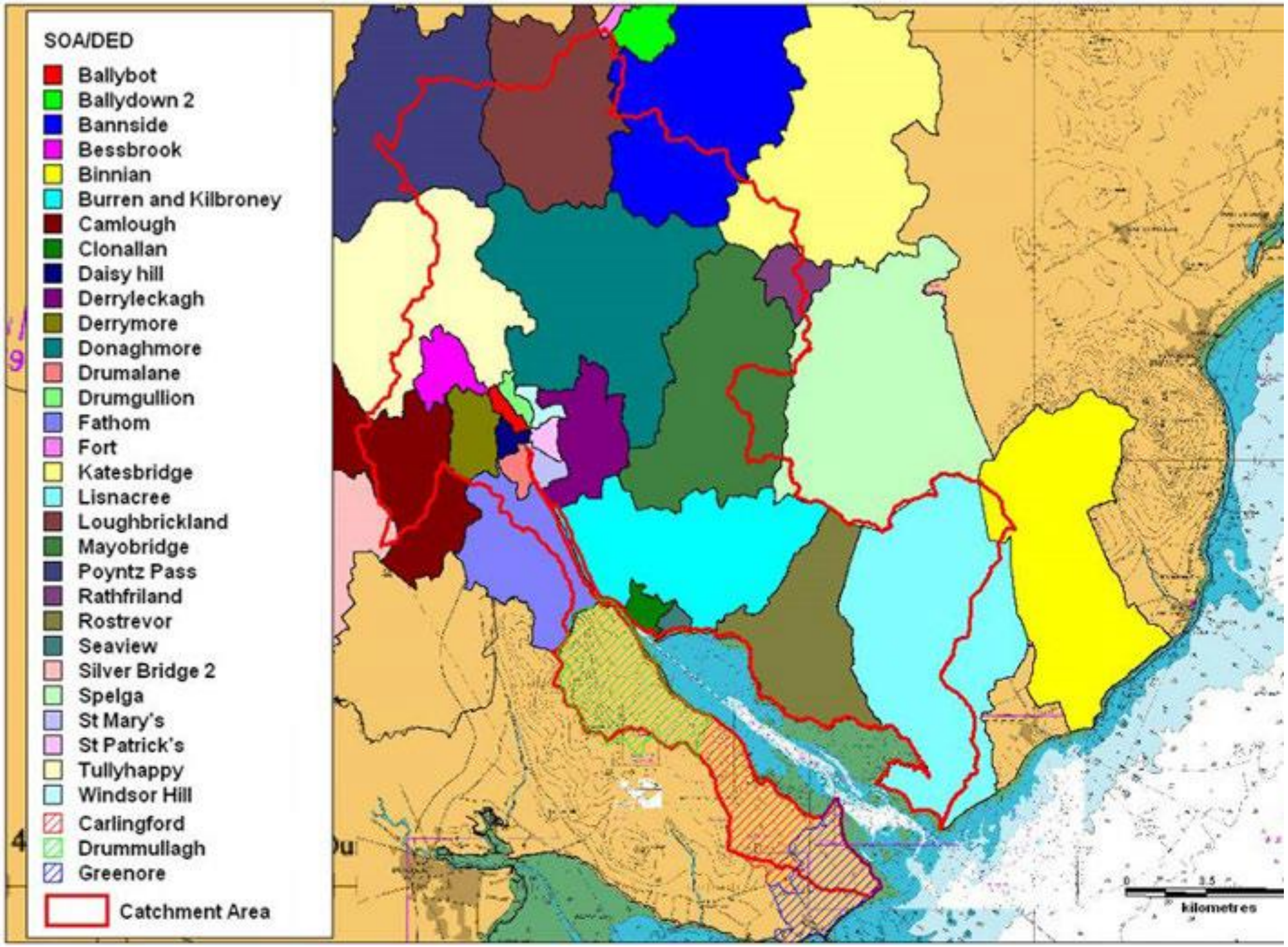
4.1 Desktop Survey

The main sources of *E. coli* are municipal sewage discharges or runoff from failing septic systems, animal feed operations, farms and faeces deposited in woodlands from warm blooded animals. In urban areas, the *E. coli* from the excrement of warm blooded animals (such as pets in a park or on the street) may be washed into creeks, rivers, streams, lakes, or groundwater during rainfalls or snow melts. The contamination in water is often highest immediately following a storm, because of the runoff. Increases can also be evident during the summer months due to higher populations (tourists) in coastal areas. In addition, infected bathers can unknowingly contaminate water, or contamination can occur from boaters discharging wastes directly into the water. This section attempts to document all pollution sources within the Carlingford Lough catchment area.

4.1.1 Human Population

Carlingford Lough and its catchment area are located in Co. Down, Co. Armagh and Co. Louth. Population census data for Northern Ireland is given in units of Super Output Areas (SOA) and for Republic of Ireland in Electoral Divisions (EDs). Figure 4.2 shows the SOAs and EDs within the Carlingford Lough catchment area.

Figure 4.24: SOAs and EDs within the Carlingford Lough Catchment Area.



Data on human populations for 2006 and 2016 for Northern Ireland was obtained from The Northern Ireland Statistics and Research Agency (NISRA) website (NISRA, 2020) and Central Statistics Office (CSO) for the Republic of Ireland (CSO, 2020). Figure 4.3 shows the human population change within the Carlingford Lough catchment area from 2006 – 2016 and Table 4.1 shows this data in tabular form.

Population size around the coast of Carlingford Lough ranges from 1,200 (+22.6%) people in Greenore ED to 4,760 (+17.9) people in Burren and Kilbroney SOA. The largest population centres (>4,000 people) in the study area are located around Newry city. The total population of the SOA which overlap Carlingford Lough Catchment is 100,472 people up 12.8% from the 2011 sanitary survey. However, much of the SOAs and EDs only partially overlap the catchment. Therefore, an effort was made to estimate the population within the catchment based on the percentage of the SOAs within it. Based on this the total population within the Carlingford Lough catchment is estimated at approximately 69,000 people which is an increase of 13.6% on the estimate from the 2011 sanitary survey.

Figure 4.4 and Table 4.2 shows the 2006 and 2015 population size in the main urban centres within the catchment area (NISRA, 2015). Newry (26,893 0.3%) and Warrenpoint (8,721 +14.7%) are the largest population centres, located at the western end of the lough. Rostrevor (2,788 +9.1%) and Rathfriland (2,472, -4%) are the next largest centres. The two remaining settlements are Omeath (603, +37.4%) and Carlingford (1,445, +132%) located in the Republic of Ireland. Although Omeath and Carlingford have relatively small populations their population increase has been significant relative to the settlement size. As Omeath discharges untreated sewage to the lough, this population increase may be of concern. The population increase in Carlingford may also be of concern as the WWTP is currently operating over capacity.

Human population in given areas is obtainable from census data, however relating this information to the level of microbial contamination in coastal waters is difficult and is constrained by the geographic boundaries used. However, it is clear that areas with a higher population will have higher levels of sewage and wastewater entering the Carlingford Lough system.

Figure 4.25: Human population change within the Carlingford Lough Catchment Area from 2006 - 2016 (Source: NISRA, 2020: CSO, 2020).

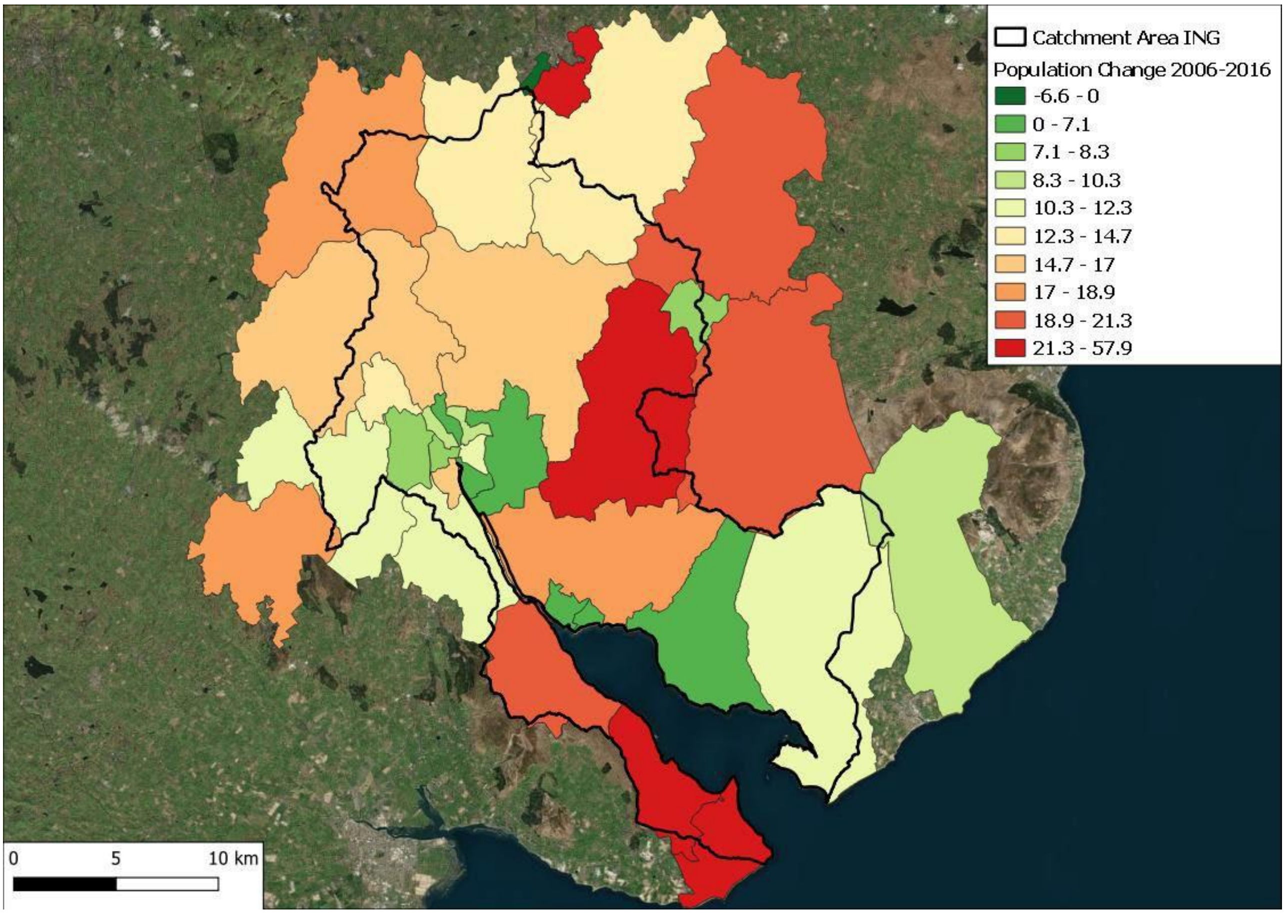


Table 4.9: Human population within the Carlingford Lough Catchment Area (Source: NISRA, 2020: CSO, 2019).

SOA	Pop. 2006	Pop. 2016	% Change
Ballybot	2061	2246	9.0
Ballydown 2	2397	2974	24.1
Bannside	2477	2814	13.6
Bessbrook	2446	2781	13.7
Binnian	2971	3248	9.3
Burren and Kilbroney	4038	4760	17.9
Camlough	3237	3636	12.3
Carlingford	1384	2185	57.9
Clonallan	4238	4489	5.9
Daisy hill	3108	3350	7.8
Derryleckagh	4366	4653	6.6
Derrymore	3074	3314	7.8
Donaghmore	3184	3670	15.3
Drumalane	3035	3527	16.2
Drumgullion	3070	3207	4.5
Drummullagh	1120	1356	21.1
Fathom	3011	3350	11.3
Fort	2437	2277	-6.6
Greenore	979	1200	22.6
Katesbridge	2337	2783	19.1
Lisnacree	2831	3165	11.8
Loughbrickland	2568	2940	14.5
Mayobridge	3617	4390	21.4
Poyntz Pass	2435	2858	17.4
Rathfriland	2514	2718	8.1
Rostrevor	2691	2865	6.5
Seaview	3064	3192	4.2
Silver Bridge 2	1721	2039	18.5
Spelga	3147	3750	19.2
St Mary's	2252	2375	5.5
St Patrick's	3263	3607	10.5
Tullyhappy	2997	3497	16.7
Windsor Hill	2863	3107	8.5
Total	90,933	102,323	13

Figure 4.26: Populations of urban centres within the catchment area 2015 (Source: NISRA, 2015).

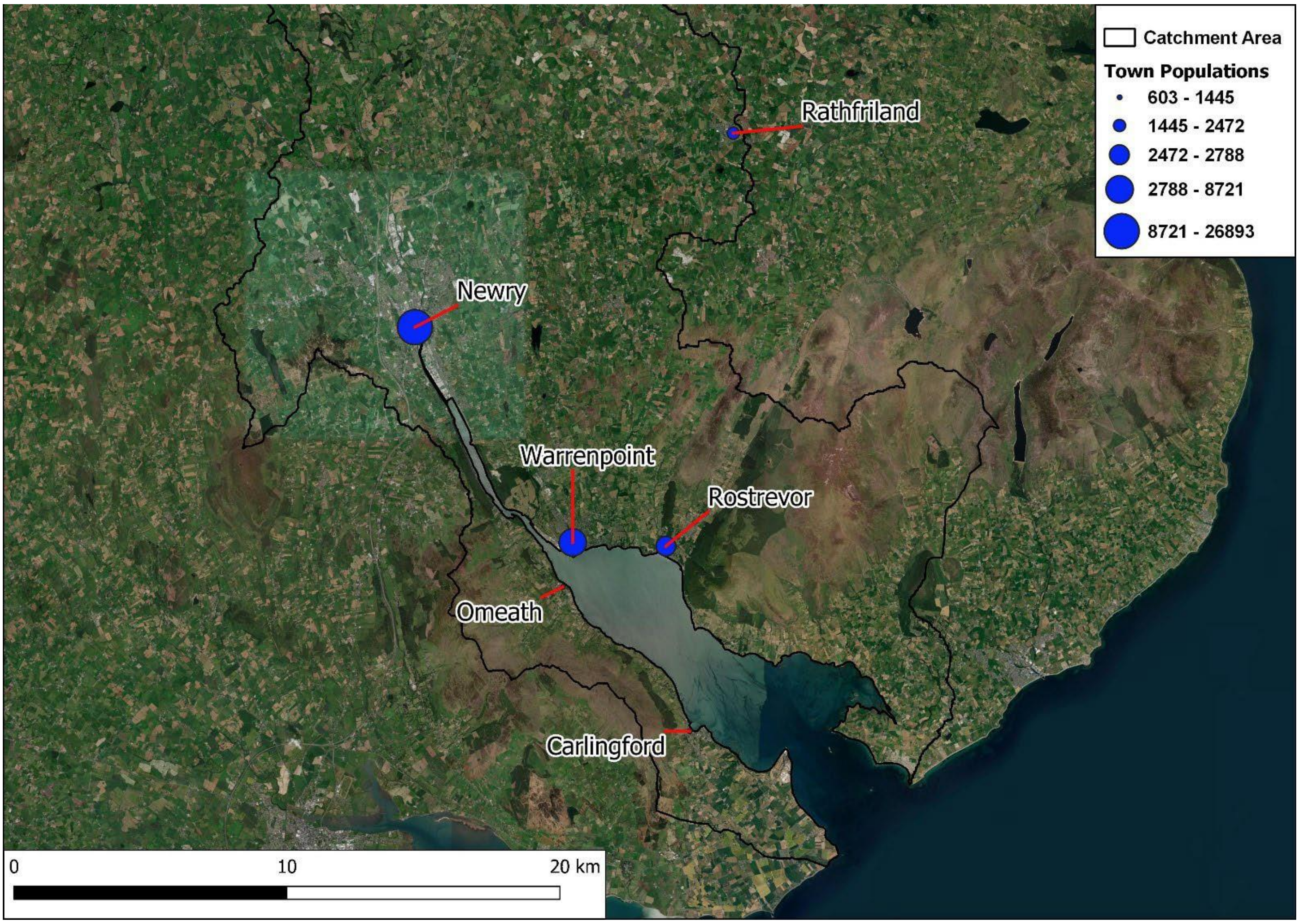


Table 4.10: Change in Populations of urban centres within the catchment area between 2011 and 2015 (Source: NISRA, 2015: CSO, 2020).

Name	Settlement	Population 2011	Population 2015	Population Change %
Rostrevor	Intermediate Settlement	2556	2788	+9.1
Warrenpoint	Small Town	7605	8721	14.7
Newry	Large Town	26,967	26893	-0.3
Rathfriland	Intermediate Settlement	2575	2472	-4
Omeath	Village	439	603	+37.4
Carlingford	Village	623	1445	+132
Total	**-**	**40765**	**42922**	

4.1.2 Tourism

In 2018, 2,809,000 tourists visited Northern Ireland compared to 1,918,000 in 2009 (NITB {Northern Ireland Tourist Board}, 2018). This is a 46.5% increase in tourism to Northern Ireland since the last sanitary survey. Of these tourists, 46% were visiting family and friends and 37% were holidaying, 30% of them arrived in between July and September and 25% of them arrived between April and June and 49% stayed with family or friends while 30% stayed in a hotel/guesthouse/B&B. The Carlingford Lough Catchment partially overlaps two Northern Ireland Local Government Districts (LGD) for tourism numbers Newry /Mourne /Down and Armagh City, Banbridge Craigavon. The Northern Ireland LGD boundaries were changed since the 2011 sanitary survey and so tourism statistics cannot be directly compared. These two LGDs received 638,504 tourists in 2018. As the tourism numbers in Northern Ireland have increased by 46.5% it is likely that the tourism numbers in the Carlingford Lough area have also increased. The catchment also partially overlaps County Louth. County Louth received 172,000 overseas tourists in 2017, an increase of 93.3% from 2011. There is however no way of estimating the number of tourists who visited the Carlingford Catchment area during their stay.

There are numerous activities which tourists can partake in along the shores of Carlingford Lough, i.e. walking, climbing, water activities, golf, camping, caravanning, water sports, adventure centres, beaches, angling and yachting and there is one Blue Flag Beach located in Cranfield Bay and a marina located in Carlingford. Figure 4.5 shows all tourism related activity sites within the Carlingford Lough catchment area. These data were gathered from a Loughs Agency Marine Tourism Audit and from Ordnance Survey maps.

Increases in population in the local area due to tourism may result in an increase in the quantity of sewage discharged within the Carlingford Lough area. In addition, Papadakis et al. (1997) found significant correlations between the number of swimmers present on beaches and the presence of pathogenic bacteria. In 2007, Elmir *et al.* (2007) showed the role of human skin as an intermediate mechanism of pathogen transmission to the water column. The main swimming beach in Carlingford Lough is Cranfield Bay. In addition, waste can enter the lough from recreational vessels. Carlingford marina is the only tourism based marina in the Lough and it has in place waste disposal arrangements to prevent the contamination of water from vessel waste.

In order to identify any significant differences in *E. coli* levels based on seasonality, a one-way analysis of variance (ANOVA) was performed on seasonal E. coli results (for the period 2006 to 2020) from shellfish flesh taken at a number of beds around the lough (Refer to Section 5.1.2 for more details on the sampling points) and box-plots were created. For this analysis, all shellfish flesh results that returned a less than value (i.e., <X) were given that value (*e.g.*, <20 becomes 20). Box-plots are frequently used to assess and compare sample distributions of microbiological data. For the purpose of this analysis the seasons were organized as follow: winter (December, January and February), spring (March, April and May), summer (June, July and August) and autumn (September, October and November).

This analysis found that there was no significant difference between seasons for C7 Ballyedmond oysters, Inner Carlingford mussels, Outer Carlingford mussels or oyster and Ballagan razor clams or oysters. A significant difference was found between seasons for C11 Fairgreen oysters, NW Narrow Water mussels and C1 Rostrevor mussels.

Figure 4.6 to Figure 4.8 show box-plots for each shellfish bed which had a significant seasonal difference in *E. coli* levels. These graphs are composed of a median line (or the middle line of the data), the bottom box, which indicates the first quartile value (25% of the data values are less than or equal to this value), the top box which indicates the third quartile (75% of the data values are less than or equal to this value), the lower whisker or lower limit and the upper whisker or the highest data value within the upper limit.

Fairgreen oysters had significantly higher *E.coli* results in summer and autumn when compared to winter. The *E. coli* levels for autumn were also higher than spring results. NW Narrow Water mussels had significantly higher results in winter than in summer and autumn. The results for spring and autumn where also significantly higher than summer results. C1 Rostrevor mussels had significantly higher *E. coli* results for winter than spring and summer. Autumn also had significantly higher results than summer.

The trend at all of these site appears to be linked to rainfall levels and run-off from land. As such tourism does not appear to have a significant effect on the shellfish quality in the bay.

Figure 4.27: Tourist facilities within the Carlingford Lough Catchment Area.

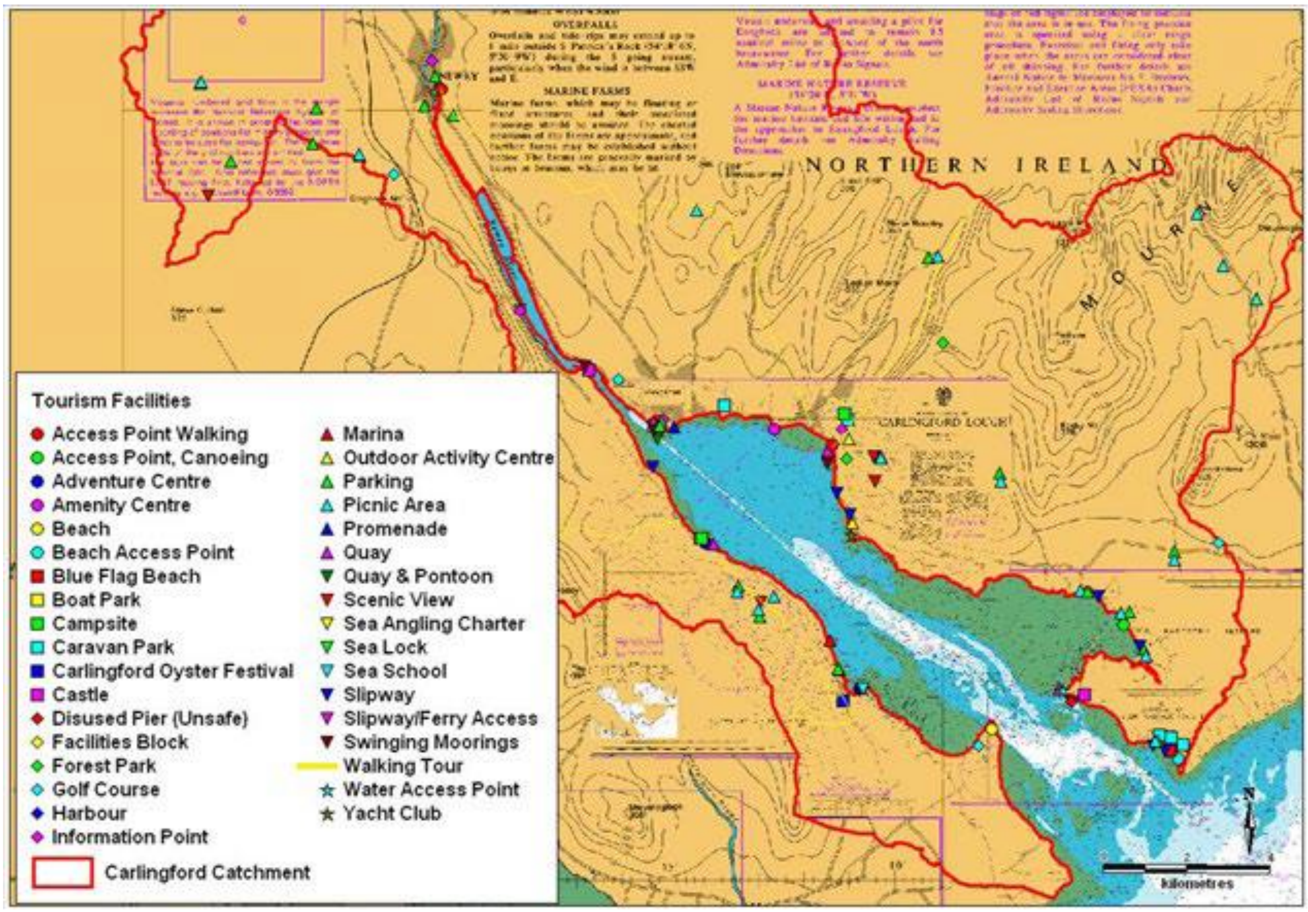


Figure 4.28: Seasonal variation of *E. coli* in oyster flesh from C11 Fairgreen monitoring point.

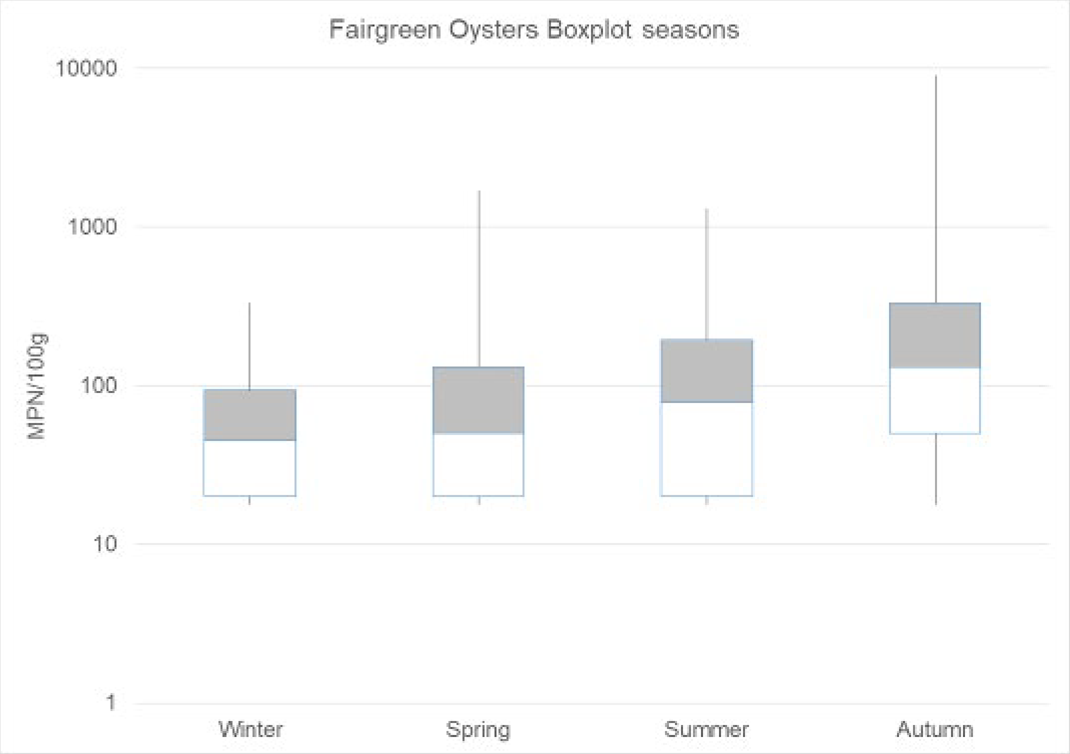


Figure 4.29: Seasonal variation of *E. coli* in mussel flesh from NW Narrow Water monitoring point.

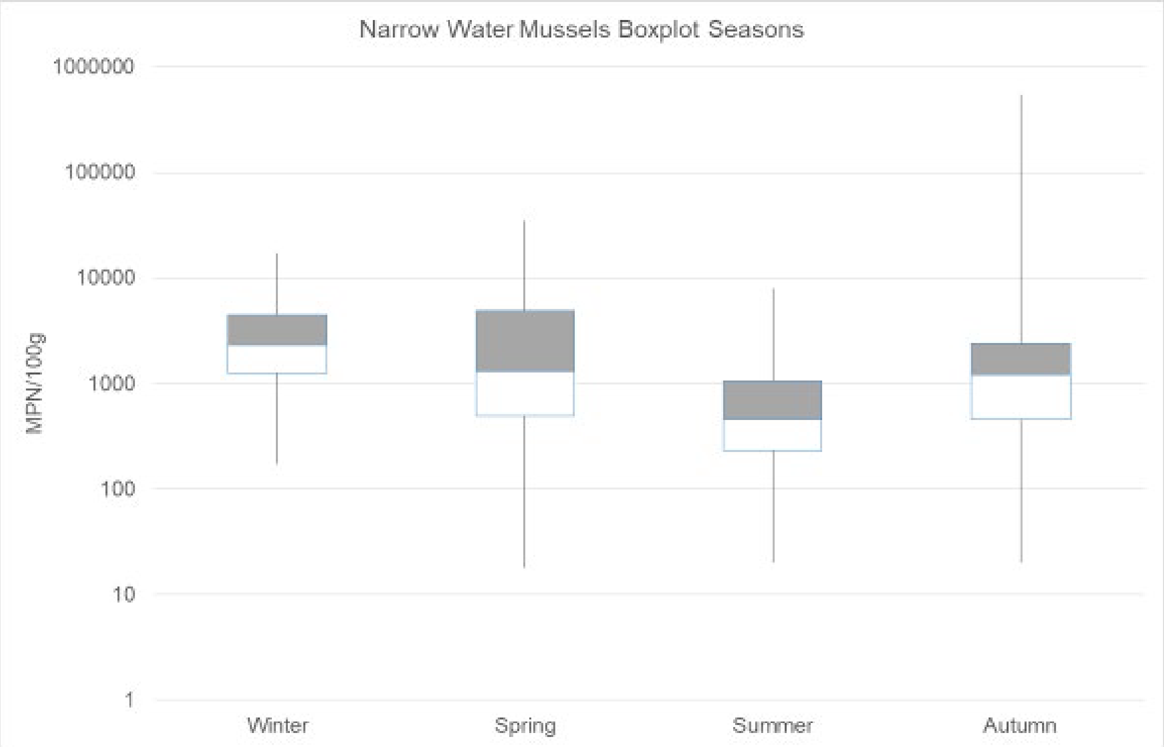
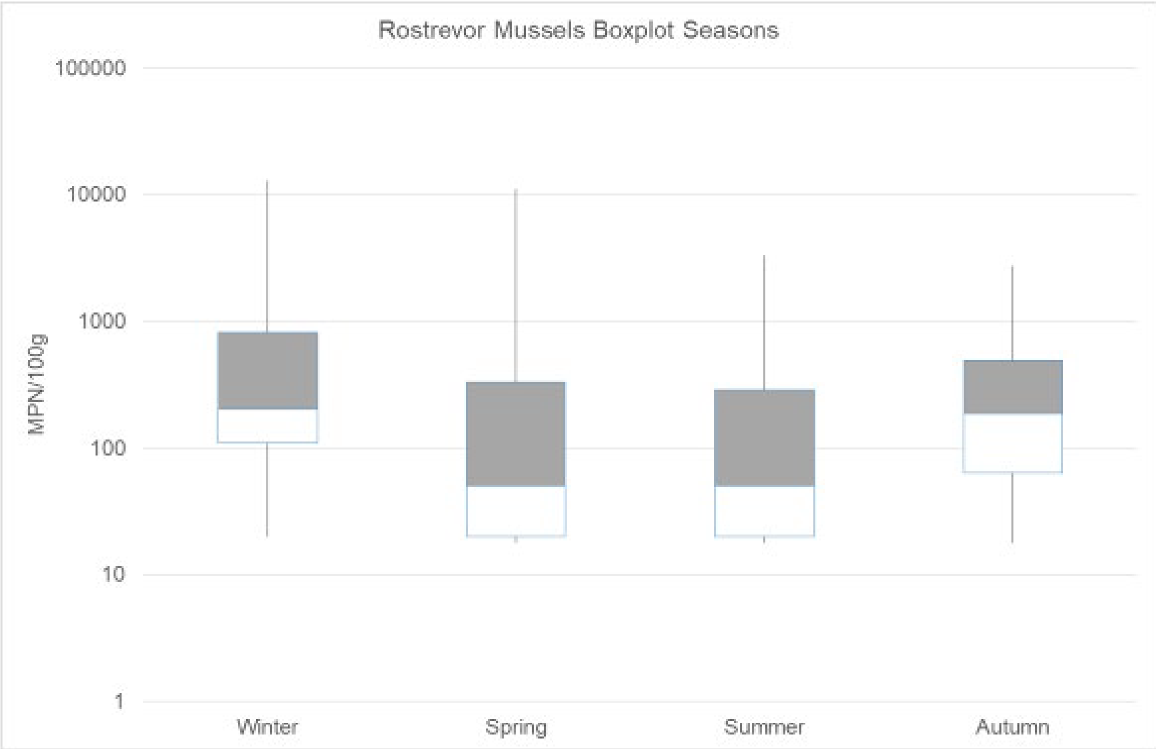


Figure 4.30: Seasonal variation of *E. coli* in mussel flesh from C1 Rostrevor monitoring point.



4.1.3 Sewage Discharges

Sewage effluent can vary in nature depending on the degree to which the sewage has been treated. Discharges of sewage effluent can arise from a number of different sources and be continuous or intermittent in nature:

- treated effluent from urban sewage treatment plants (continuous);
- storm discharges from urban sewage treatment plants (intermittent);
- effluent from 'package' sewage treatment plants serving small populations (continuous);
- combined sewer and emergency overflows from sewerage systems (intermittent);
- septic tanks (intermittent);
- crude sewage discharges at some estuarine and coastal locations (continuous).

Treatment of sewage ranges from:

- none at all (crude sewage);
- preliminary (screening and/or maceration to remove/disguise solid matter);
- primary (settling to remove suspended solids as sewage sludge). Typically removes 40% of BOD (Biochemical Oxygen Demand), 60% of suspended solids; 17% of nitrogen and 20% of phosphorus from the untreated sewage;
- secondary (settling and biological treatment to reduce the organic matter content). Typically removes 95% of BOD, 95% of suspended solids, 29% of nitrogen and 35% of phosphorus from the untreated sewage. Nutrient removal steps can be incorporated into secondary treatment which can reduce ammonia - N down to 5 mg/l and phosphorus to 2mg/l.
- tertiary (settling, biological treatment and an effluent polishing step which may involve a reed bed (unlikely for a coastal works) or a treatment to reduce the load of micro-organisms in the effluent), typically removes 100% of BOD, 100% of suspended solids, 33% of nitrogen and 38% of phosphorus from the untreated sewage.

Figure 4.9 shows all 24 Waste Water Treatment Works within the Carlingford Lough catchment area. Table 4.3 shows the coordinates and population equivalents (p.e.) of these plants. There are 24 Waste Water Treatment Works (WWTWs) in the Carlingford Lough catchment, serving a population of approximately 93,185 p.e. Since the 2011 sanitary survey

3 septic tanks have been upgrade and are now listed as WWTW. All three treatment facilities were upgraded to rotational biological contactors. The major works are those at Newry, Warrenpoint, Cranfield, Rathfriland and Carlingford, these five works together account for 96.7% of the total population equivalent of the catchment. Of the 24 WWTWs 15 are below capacity, 6 are over capacity and 1 had no design p.e. information available. The six plants that are over capacity account for 8.9% of the load on the WWTW in the catchment. Importantly Newry WWTW which accounts for 68.2% of the load on the WWTW in the catchment is operating at just over half its capacity.

Figure 4.31: WWTWs within the Carlingford Lough Catchment Area (Source: NI Water/ EPA).

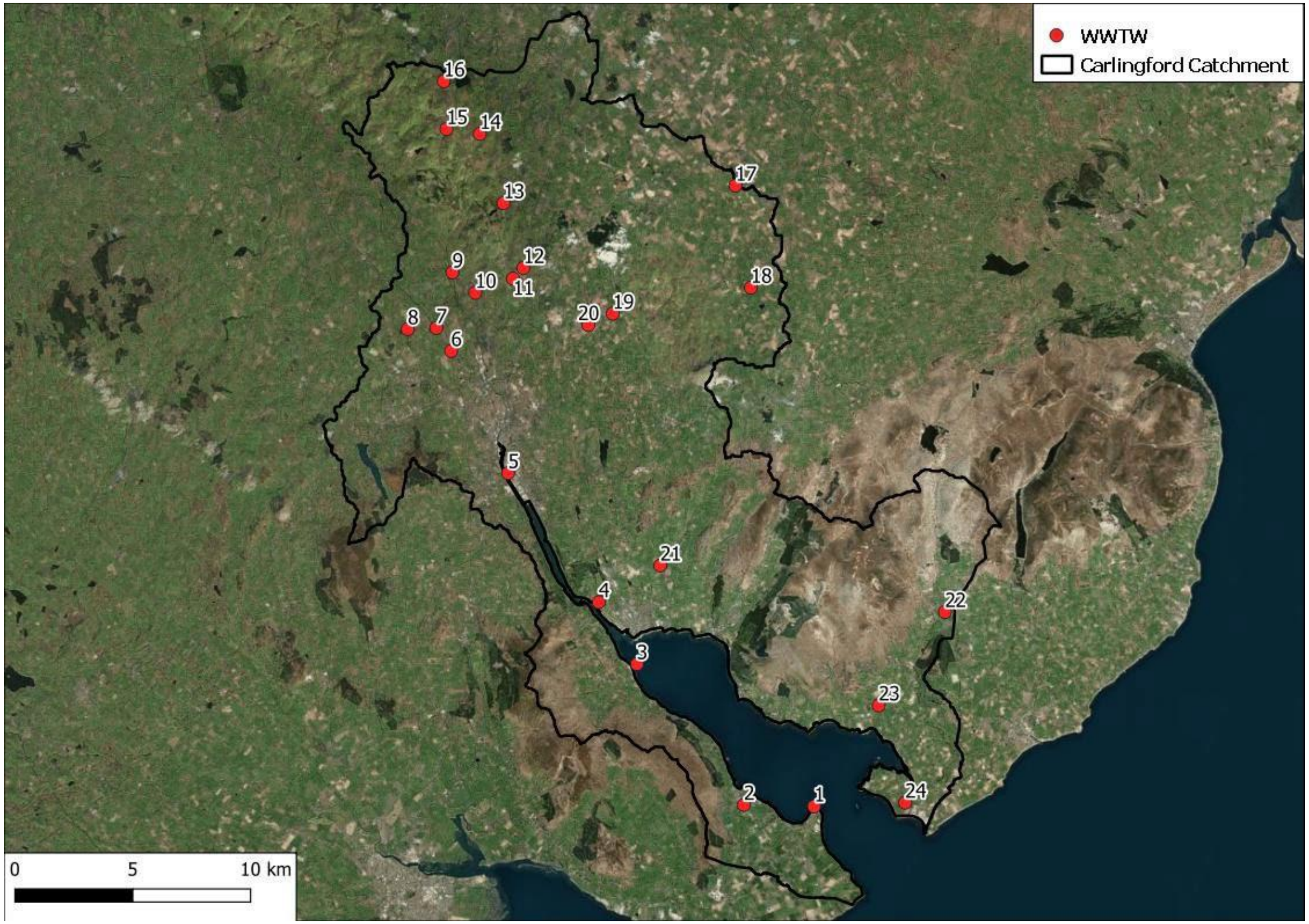


Table 4.11: WWTWs within the Carlingford Lough Catchment Area (Source: NI Water/ EPA).

Map ID	NAME	Easting	Northing	Longitude	Latitude	Current p.e.	Design p.e.	Available capacity
1	Greenore Sewerage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]	300	500	200
2	Carlingford Sewerage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]	2274	2100	-174
3	Omeath Sewerage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]	489	0	-489
4	Warrenpoint WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	16050	16195	145
5	Newry WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	63554	115000	51446
6	Mullaghglass Newry WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	168	200	32
7	Armagh Road Church RBC	[Redacted]	[Redacted]	[Redacted]	[Redacted]	9	10	1
8	Maytown Road RBC	[Redacted]	[Redacted]	[Redacted]	[Redacted]	6	10	4
9	Jerrettspass WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	39	39	0
10	Lurganare WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	407	403	-4
11	Corgary Cottages New WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	19	60	41
12	Beech Hill South WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	54	200	146
13	Glen Villas WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	221	200	-21
14	Killysavan WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	30	30	0
15	Poyntzpass WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	816	730	-86
16	Acton WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	74	153	79
17	Knock Terrace RBC	[Redacted]	[Redacted]	[Redacted]	[Redacted]	36	50	14
18	Rathfriland Drumlough WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	4074	4000	-74
19	Bankside Shinn WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	82	100	18
20	Saval More Cottages RBC	[Redacted]	[Redacted]	[Redacted]	[Redacted]	19	50	31
21	Ballyrussel WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	24	39	15
22	Attical Tullyframe WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	234	359	125

Map ID	NAME	Easting	Northing	Longitude	Latitude	Current p.e.	Design p.e.	Available capacity
23	Ballymaderfy WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	66	100	34
24	Cranfield WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	4140	N/A	N/A

N/A indicates data were Not Available.

4.1.3.1 Continuous Sewage Discharges

Figure 4.10 shows the continuous sewage discharges associated with the WWTWs within the Carlingford Lough catchment area. Table 4.4 shows the coordinates for the continuous discharges from WWTW.

All of the WWTW shown in Figure 4.7 above have continuous discharge pipes associated with them, however, coordinates for some discharge pipes were not available (those marked with * in Table 4.4). Assumptions as to the location of their discharge pipes were made based on the plant's location in relation to the nearest water body.

In total, there are 5 direct discharges into Carlingford Lough and the remainder discharge into rivers which ultimately discharge into the lough.

Figure 4.32: Location of Continuous Sewage Discharges within the Carlingford Lough Catchment Area (Source: NI Water/ EPA).

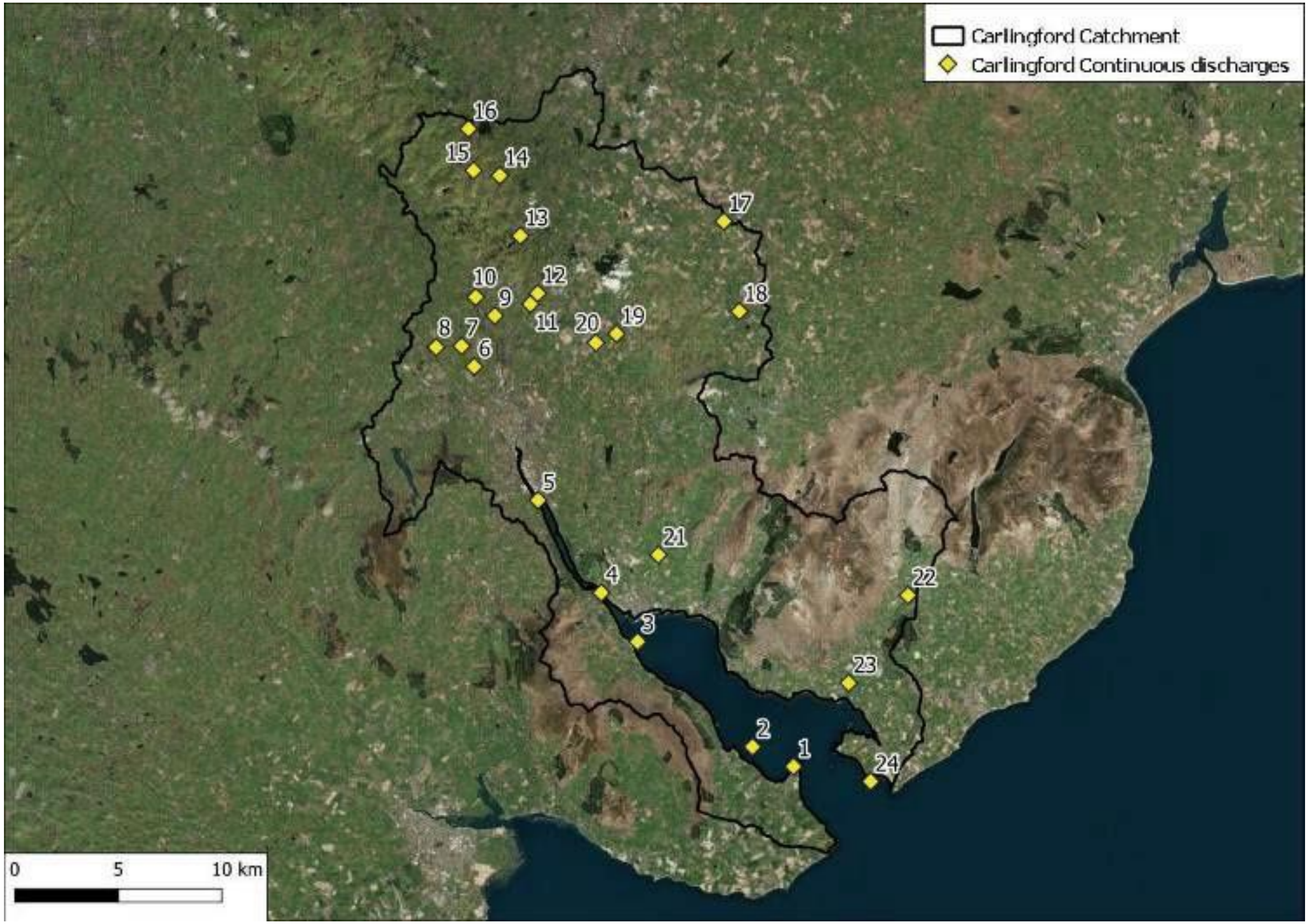


Table 4.12: WWTW Continuous Discharges within the Carlingford Lough Catchment Area (Source: NI Water/ EPA).

Map ID	Plant	Longitude	Latitude	Easting	Northing
1	Greenore Sewage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]
2	Carlingford Sewage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]
3	Omeath Sewage Scheme	[Redacted]	[Redacted]	[Redacted]	[Redacted]
4	Warrenpoint WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]
5	Newry WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
6	Mullaghglass WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
7	Armagh road RBC	[Redacted]	[Redacted]	[Redacted]	[Redacted]
8	Maytown Road RBC*	[Redacted]	[Redacted]	[Redacted]	[Redacted]
9	Lurganare WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
10	Jerrettspass WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
11	Corgary Cottages WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
12	Beech Hill South WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]
13	Glen Villas WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
14	Killysavan WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
15	Poyntzpass WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
16	Acton WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
17	Knock Terrace RBC*	[Redacted]	[Redacted]	[Redacted]	[Redacted]
18	Rathfriland WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
19	Bankside WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
20	Saval More Cottages RBC*	[Redacted]	[Redacted]	[Redacted]	[Redacted]
21	Ballyrussel WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
22	Attical WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
23	Ballymaderfy WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
24	Cranfield WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]

4.1.3.2 Rainfall Dependent Sewage Discharges

Figure 4.10 to Figure 4.12 show all rainfall dependent discharges *i.e.,* overflows, group septic tanks and private sewage treatment respectively, within the catchment area. Table 4.5 documents the Combined Sewer Overflows (CSO) and Sewage Pumping Station (SPS) overflows which discharge into Carlingford Lough or a tributary of it and Table 4.6 documents the septic tanks. There are 71 rainfall dependent discharges, 28 group septic tanks within the Carlingford Lough catchment area. There are 506 private sewage systems in the Northern Ireland extent of the catchment. The locations of private sewage systems in the Republic of Ireland are not available, however, the number present in the catchment has been estimated at 563 from the 2016 census data.

Figure 4.33: All overflow discharges within the Carlingford Lough Catchment Area (Source: NI Water/ EPA).

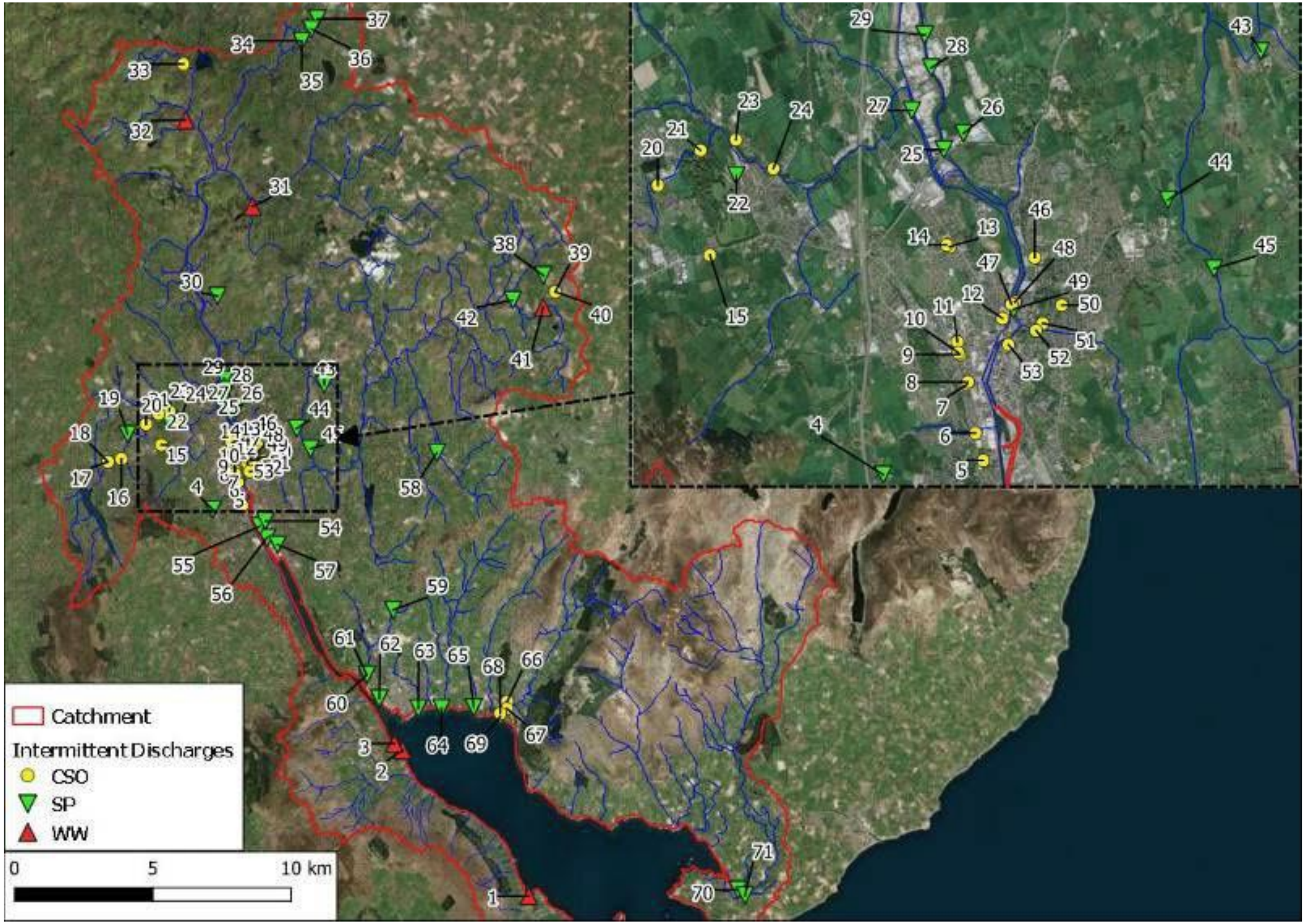


Figure 4.34: All septic tanks within the Carlingford Lough Catchment Area (Source: NI Water).

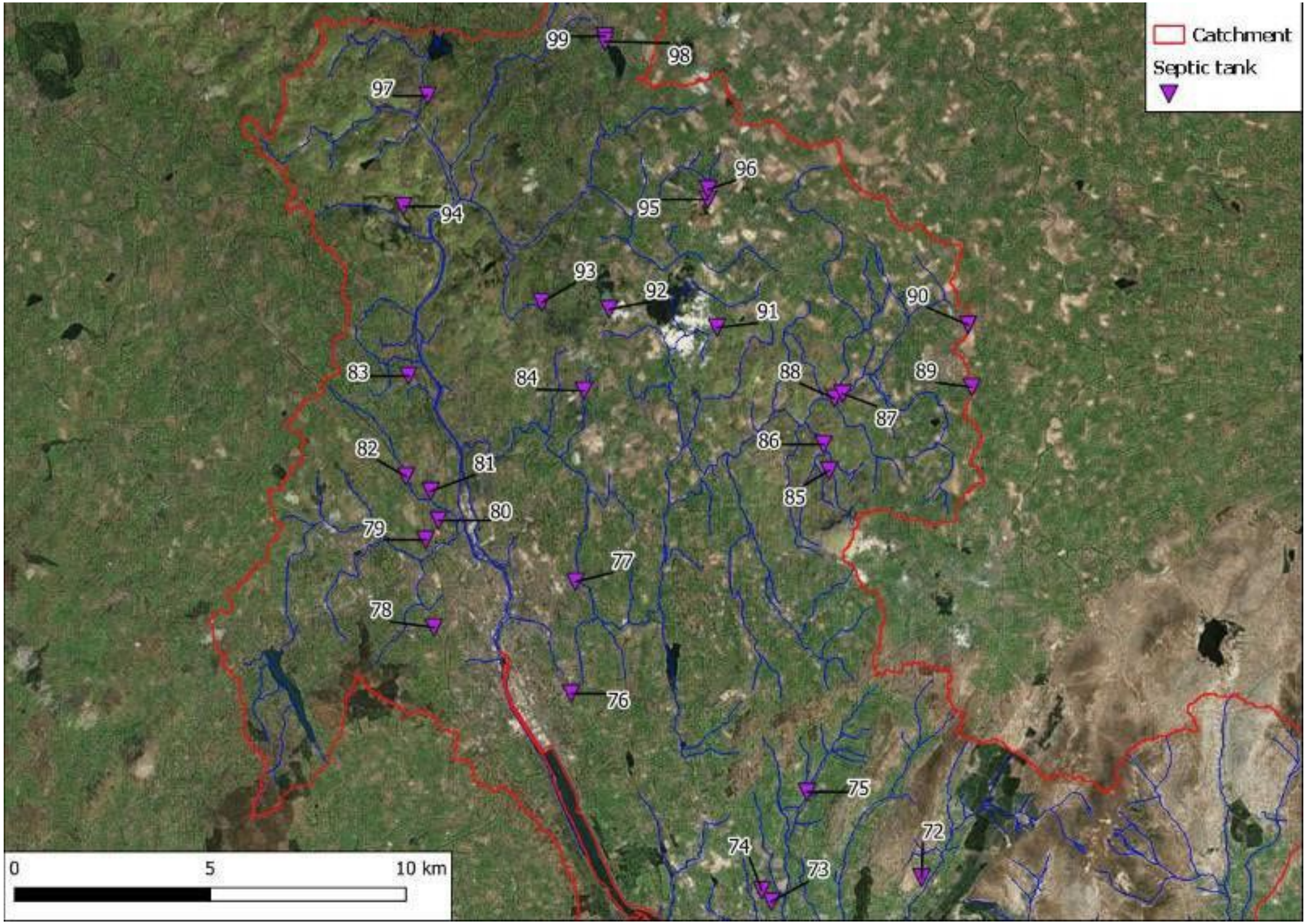


Figure 4.35: All private sewage systems within the Carlingford Lough Catchment Area (Source: NI Water).

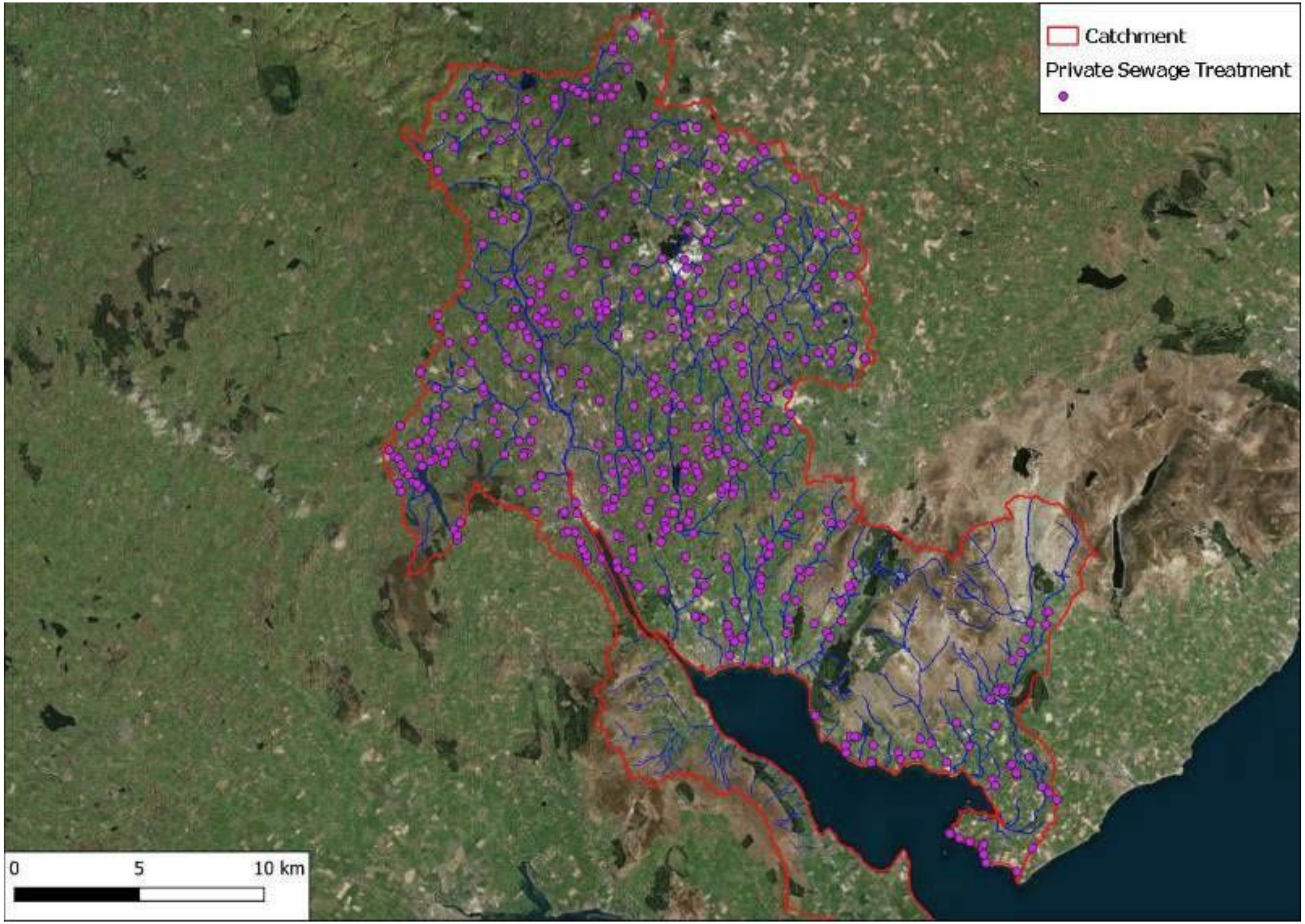


Table 4.13: CSO and WwPS overflows within the Carlingford Lough catchment Area (Source: NI Water/ EPA).

Map ID	Name	Longitude	Latitude	Easting	Northing	Function
1	Carlingford WWTP	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
2	Omeath WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
3	Omeath WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
4	Chancellors Road Newry WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
5	Drumalane CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
6	Dublin Road Newry CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
7	Kiln Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
8	Patrick Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
9	James Connolly Park Patrick Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Surface
10	Patrick Street Yard CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Surface
11	Monaghan Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
12	Canal Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
13	Violet Hill Avenue West CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
14	Violet Hill Avenue East CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
15	Camlough Road CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
16	Crawfords Glen CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
17	Chapel Road St Malachys 2 CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Surface
18	Chapel Road St Malachys 1 CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
19	Cambrook WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
20	Mill Road Carrickbracken CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
21	Derrymore Road CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
22	Woodvale WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
23	Millvale Road North CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
24	Millvale Road South CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined

Map ID	Name	Longitude	Latitude	Easting	Northing	Function
25	Carnbane Shepherds Way 3 WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
26	Adria Factory WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
27	Carnbane Gardens WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
28	Lisduff WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
29	Newry Depot WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
30	Cluain Air WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
31	Glen Villas WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
32	Poyntzpass WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
33	Acton CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
34	Loughbrickland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
35	Loughbrickland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
36	Oaklands Loughbrickland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
37	Newry Road Loughbrickland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
38	Ashleigh Grove WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
39	Iveagh Cresent CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
40	Iveagh Crescent 1 CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
41	Rathfriland Drumlough WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
42	Ivy Cottages Rathfriland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
43	Saval Beg WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
44	Ashtree Cottages WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
45	Crown Bridge WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
46	Belfast Road Ashgrove Road CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
47	Erskine Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
48	Erskine Street Canal Quay CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
49	Islandbank WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
50	Arthur Street Windsor Hill CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined

Map ID	Name	Longitude	Latitude	Easting	Northing	Function
51	Sandys Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
52	Bagot Street Stream Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
53	Kildare Street Town Hall CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
54	Warrenpoint Road One WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
55	Greenbank One WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
56	Greenbank Two WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
57	Warrenpoint Road Two WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
58	Mayobridge WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
59	Carrickdesland WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
60	Mound Road WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
61	Warrenpoint IPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
62	Warrenpoint Docks WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
63	Springfield Road Ringmackilroy WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
64	Dobbins Point WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
65	Drumsesk Road 1 WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
66	Cherry Hill South CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
67	Water Street CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
68	Horners Lane CSO	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
69	Shore Road Rostrevor 2 WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Combined
70	Cranfield One WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul
71	Cranfield Three WwPS	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Foul

Table 4.14: Septic tanks within the Carlingford Lough catchment Area (Source: NI Water).

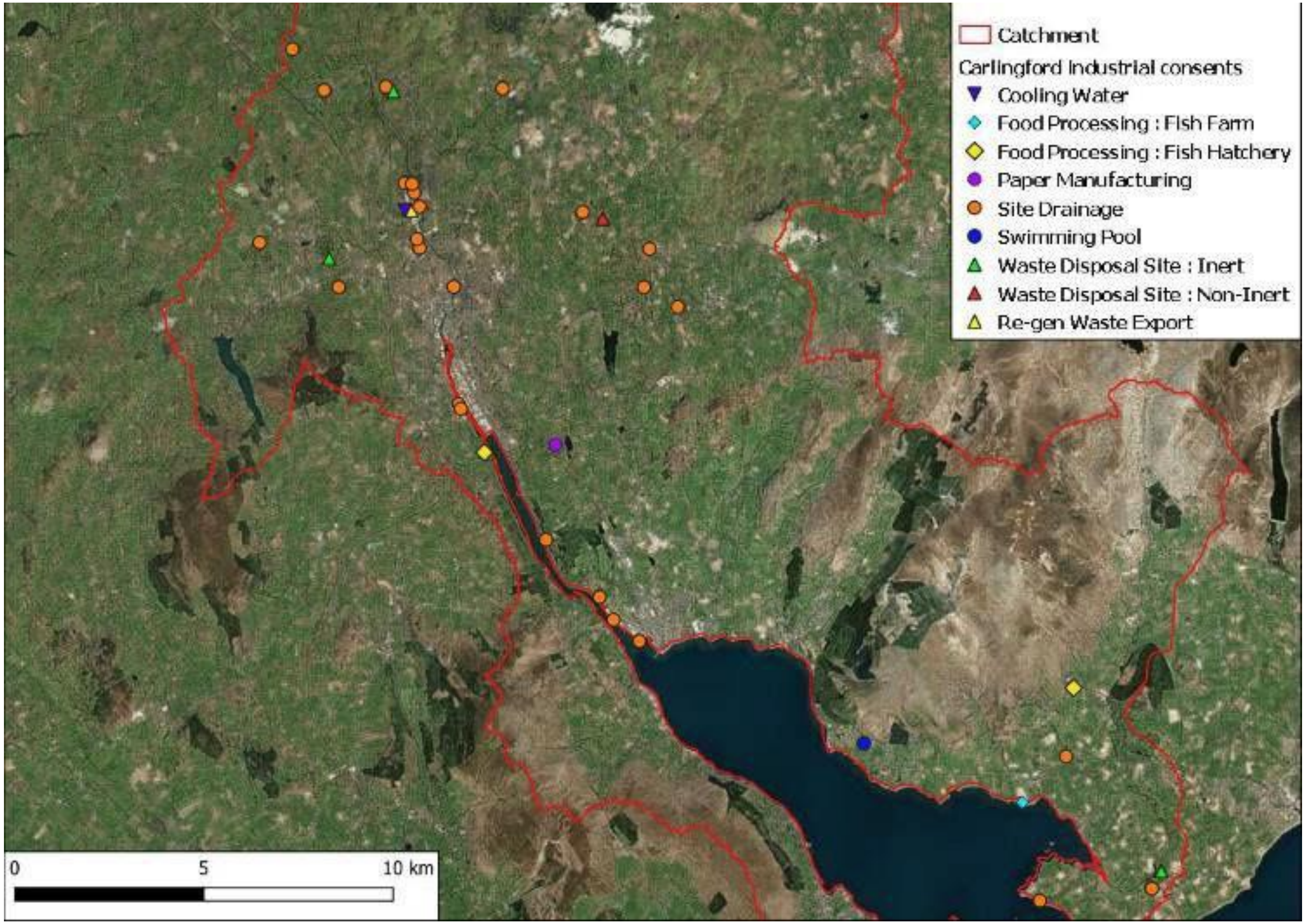
Map Id	Name	Longitude	Latitude	Easting	Northing
72	Kilbroney Park ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
73	Ballymaconaghy Road ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
74	Ballymaconaghy Warrenpoint ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
75	Drumgrevagh ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
76	Commons School Road 8-10 WwTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]
77	Carneyhough ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
78	Corrinshigo ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
79	Arch View Terrace ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
80	Armagh Road Glassdrummond ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
81	Goragh Road ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
82	Armagh Road Derrywilligan ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
83	Jockeys Brae ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
84	Corcreechy Road ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
85	Lurgancahone Road Two ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
86	Lurgancahone Road One ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
87	Newry Road Rathfriland ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Map Id	Name	Longitude	Latitude	Easting	Northing
88	St Patricks Villas ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
89	Hilltown Road ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
90	Glen View Rathfriland ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
91	Shinn Road ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
92	Mountain View Tullymurry ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
93	Fourmile ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
94	Demoan Villas ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
95	Glasker Road 11 ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
96	Glascar Road 28-30 ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
97	Loughdian ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
98	Greenan ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]
99	Lake View ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]

4.1.4 Industrial Discharges

Figure 4.14 shows the industrial discharges within the Carlingford Lough catchment area accounted for during the desk-based assessment. In total, there are 39 industrial discharges within the catchment. Since the 2011 sanitary survey Re-gen waste now stores waste in Newry for export through Warrenpoint.

Figure 4.36: All industrial discharges within the Carlingford Lough Catchment Area (Source: NIEA water information request viewer).



4.1.5 Land use Discharges

Figure 4.15 shows the Corine land use within the Carlingford Lough catchment area for 2009 and 2018.

Within the catchment area, Land use proportions have changed somewhat. The dominated Land use type remains pastures and has increased from 63.2% to 63.6%), followed by natural grasslands (down from 9.8% to 7.9%) and moors and heathland (up from 5.9% to 7.4%) (see Figure 4.16). Forestry (coniferous, broad-leafed and mixed) has remained at 4% of the Land use). Land associated with agricultural activities (non-irrigated arable land, pastures, complex cultivation patterns and agriculture/natural vegetation) has increased from 70.7 to 78.9% of the Land use in the area.

Figure 4.37: Corine land use within the Carlingford Lough Catchment Area 2009 (Left) and 2018 (Right) (Source: CLC, 2018).

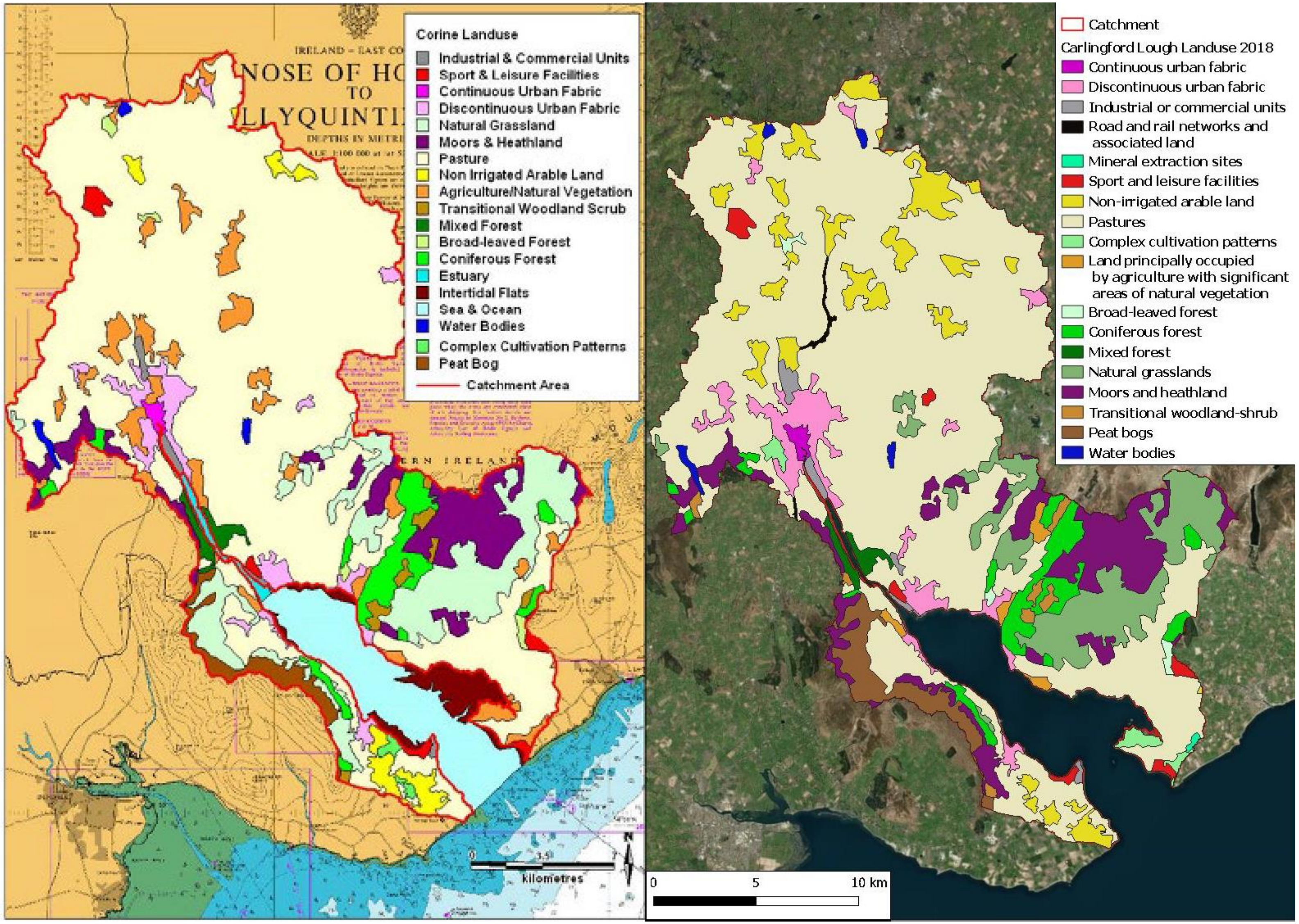
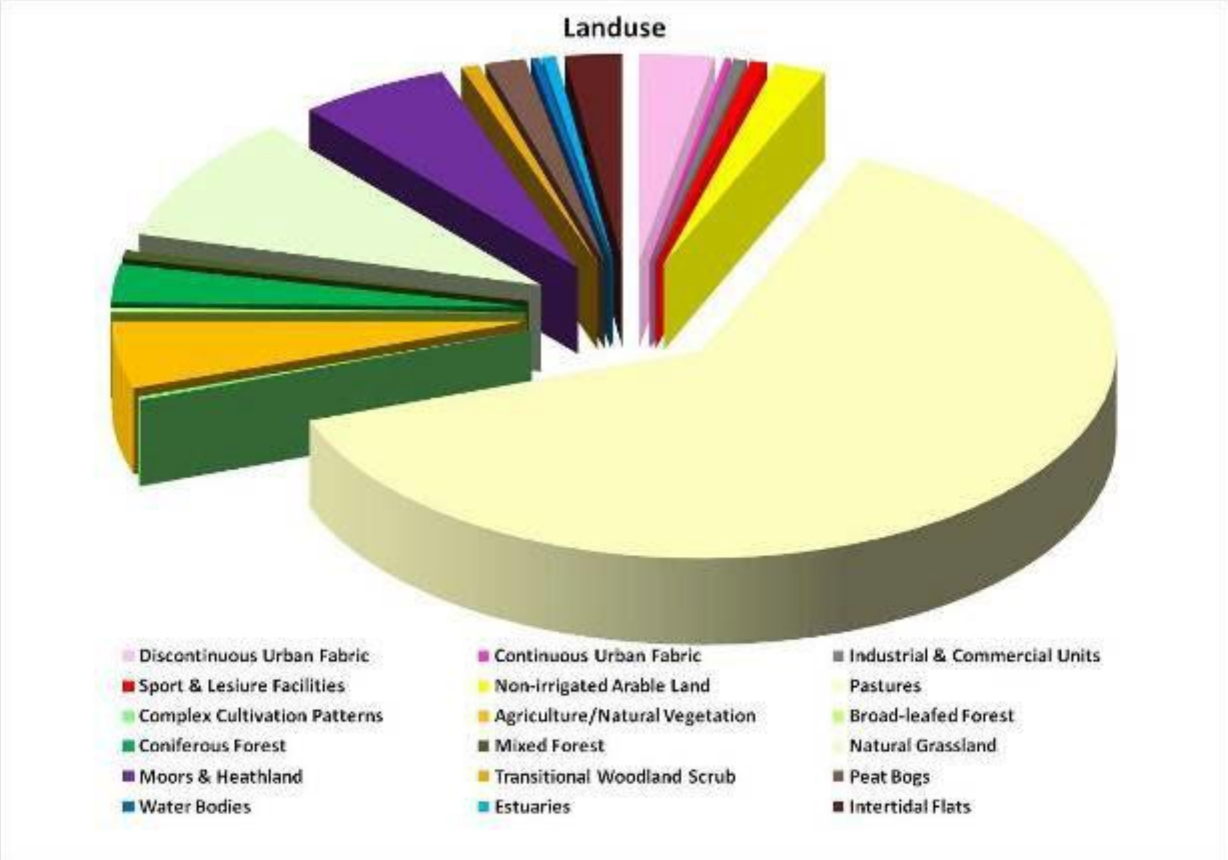
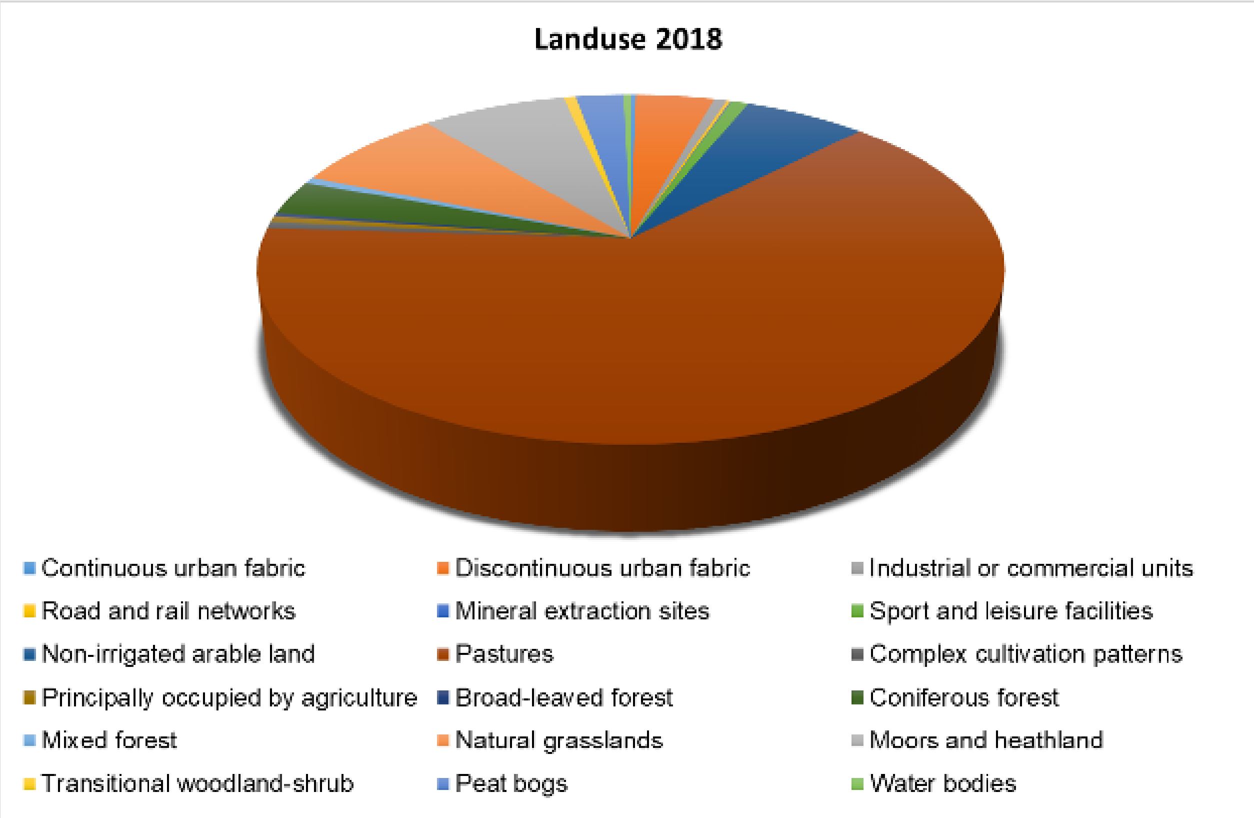


Figure 4.38: Breakdown of Land use within the Carlingford Lough Catchment Area 2009 (Top) and 2018 (Bottom).





Agricultural data used in the 2009 sanitary survey were organised by SOA (Super Output Area) for Northern Ireland; however, the 2018 agricultural data are not available in this format. The 2018 data have been organised by wards which are similar to SOA boundaries but vary somewhat. Changes in agricultural data can therefore not be directly compared. However, visual representation of these data can be used to compare the distribution of farming practices in the catchment (Figure 4.17 to Figure 4.24). The highest number of farms and area farmed remain in the north and north east of the catchment. The majority of land used for crops is located is still located in the divisions in the north of the catchment. A large proportion of the farmland in all divisions is used for grasses. The highest numbers of cattle are present in the north of the catchment similar to that of 2009. The highest number of sheep are located in the north and east of the catchment for both 2009 and 2018. The highest numbers of pigs are also farmed in the north and east of the catchment. The highest density of poultry framing is in the north of the catchment.

Although individual divisions cannot be compared due to the change in division type some comparison can be made on a catchment scale. As some of the wards (2018) or SOAs (2009) only partially overlap the catchment an attempt was made to account for this. The percentage of each division within the catchment was estimated in GIS. This percentage was then applied to the agri data to estimate the proportion within the catchment. Based on this area used for crops has increased by 0.08% (2ha) and sheep numbers have increased by 2.3% (2,075). Cattle numbers have increased by 1,365 (2.3%), pigs by 3,114 (24.7%) and poultry by 317,000 (91.8%). Although these appear to be relatively high increases the area of farmland within the catchment needs to be considered, which has also increased by 2,501ha (8%). When spread across all farmland within the catchment cattle have decreased by 0.1 per ha, sheep have decreased by 0.15 per ha, pigs have increased 0.06 per ha and poultry have increased 8.6 per ha. Jones and White (1984) estimated the potential daily load for different livestock. Based on this the change in stocking densities of the different species will lead to an estimated reduction in daily *E. coli* load by $0.59x10^9$ per ha.

Figure 4.39: Number of farms within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018: CSO, 2019a).

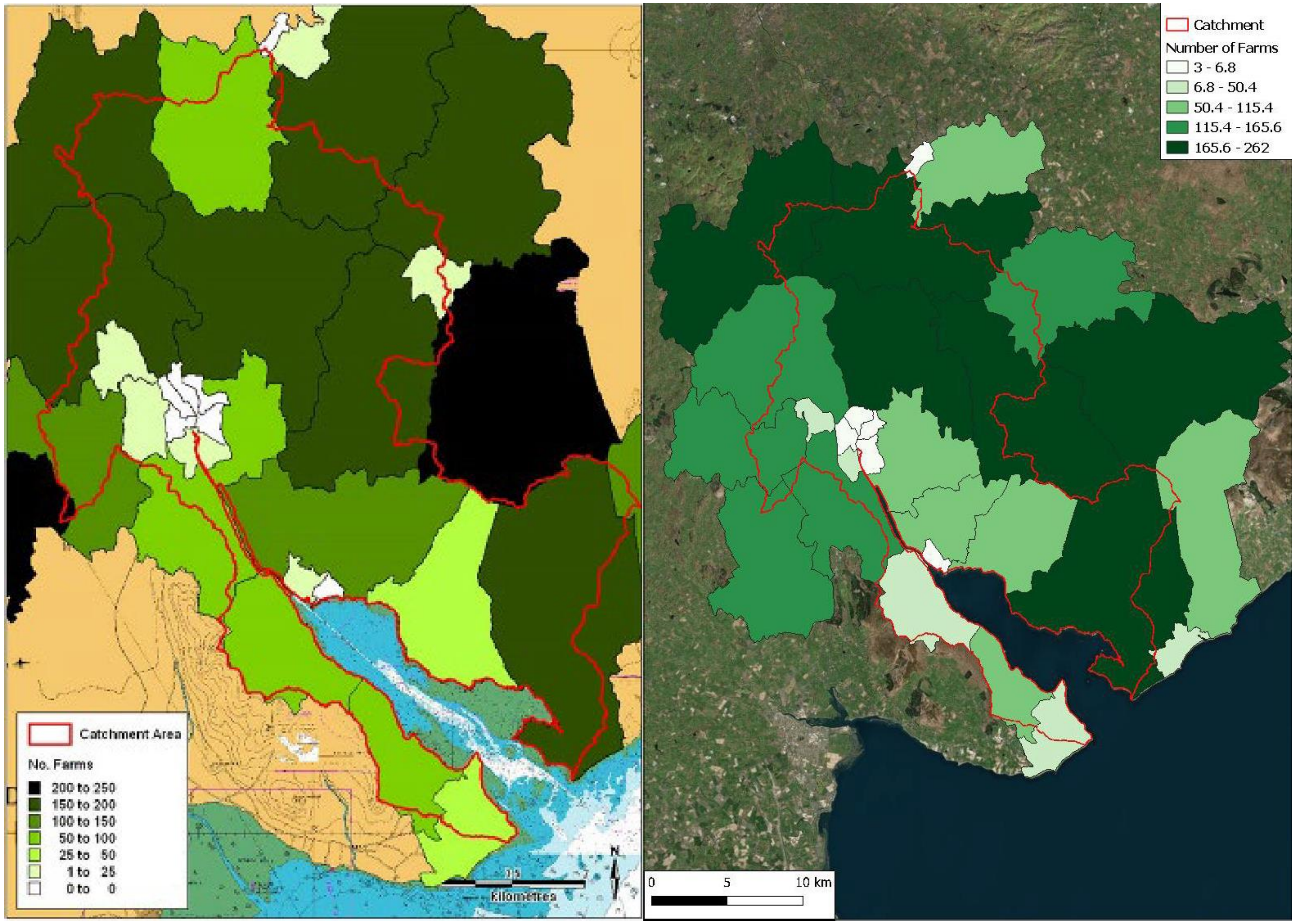


Figure 4.40: Area farmed (ha) within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

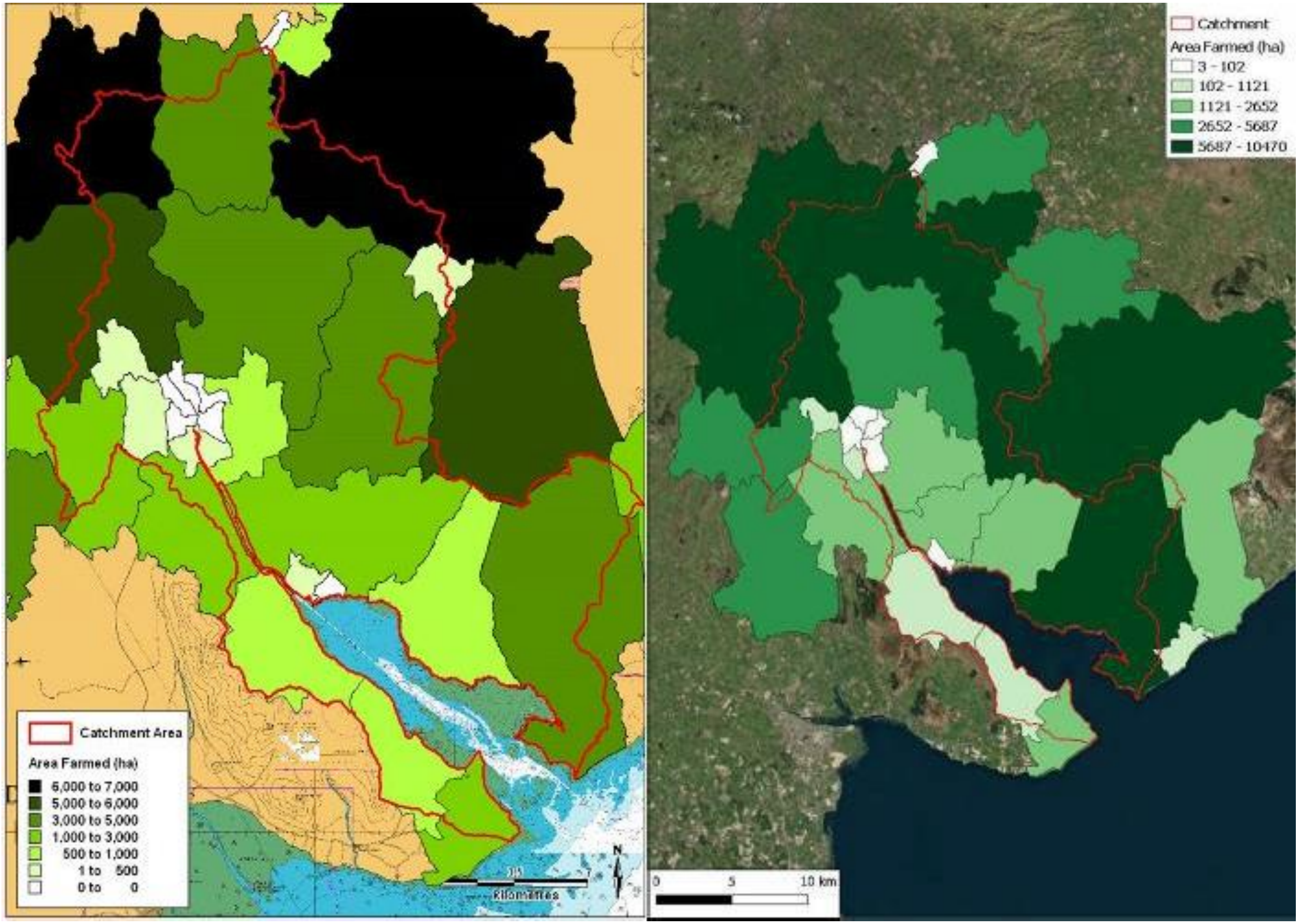


Figure 4.41: Total crops within the Carlingford Lough Catchment area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

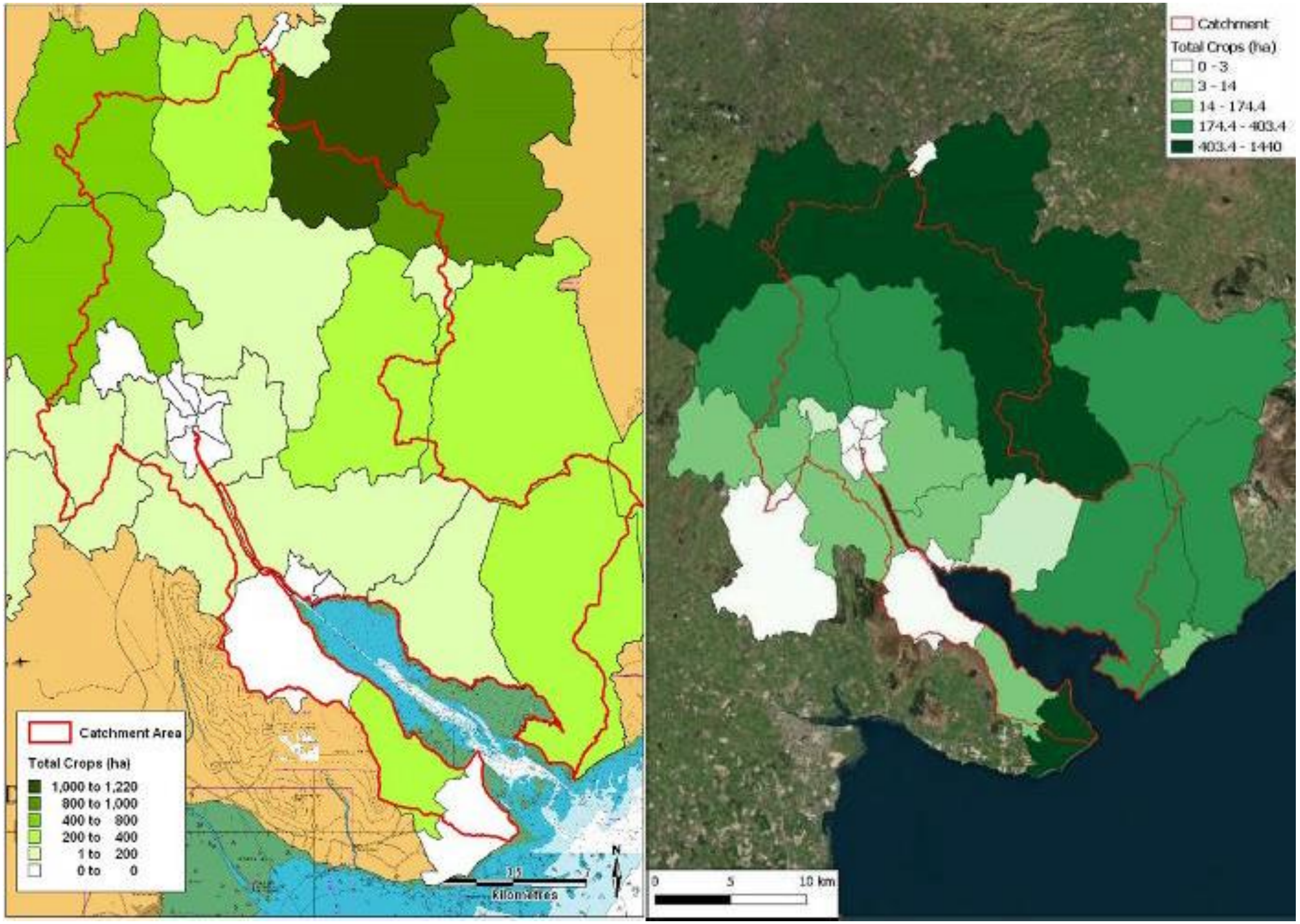


Figure 4.42: Total grasses within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

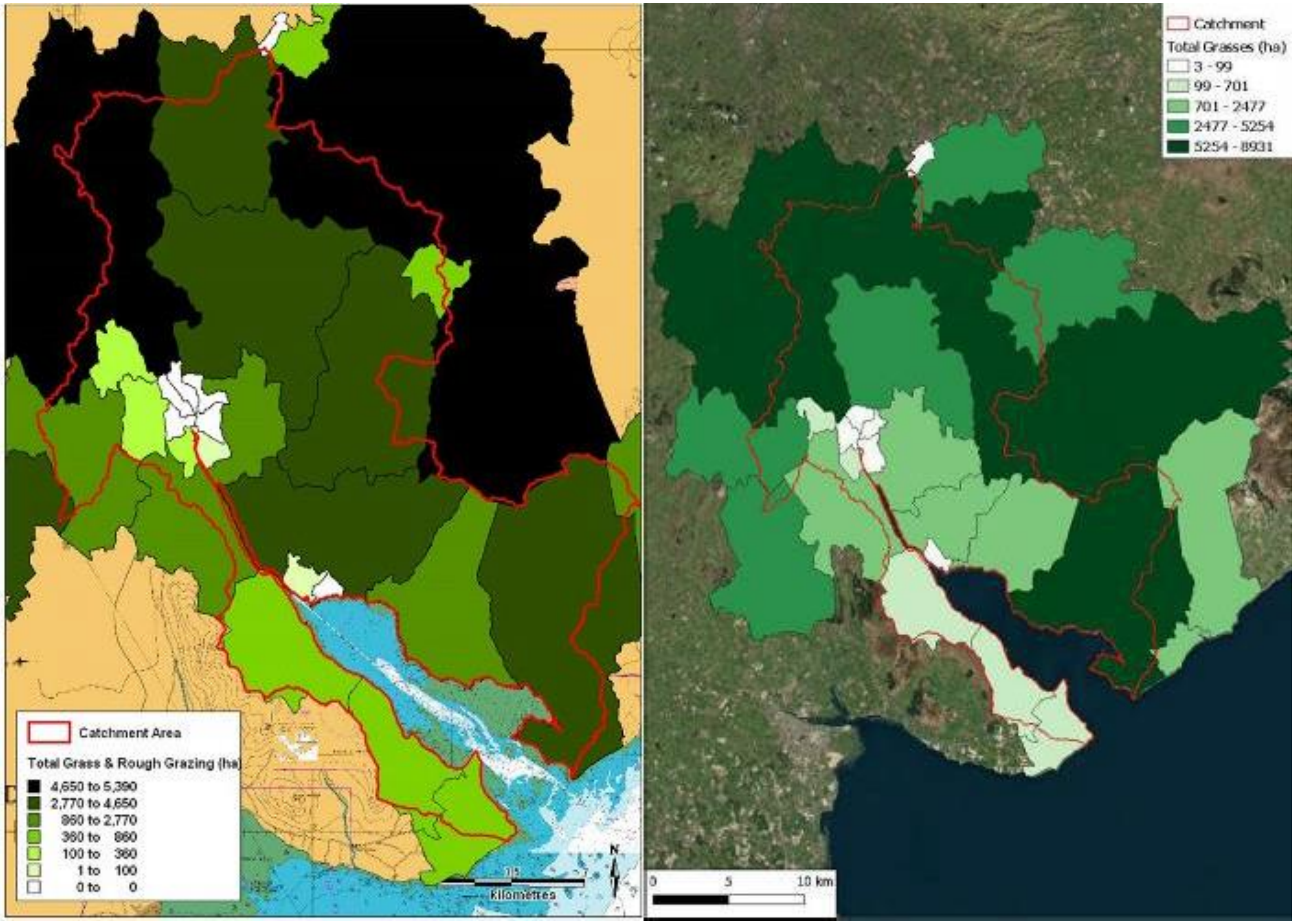


Figure 4.43: Cattle within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

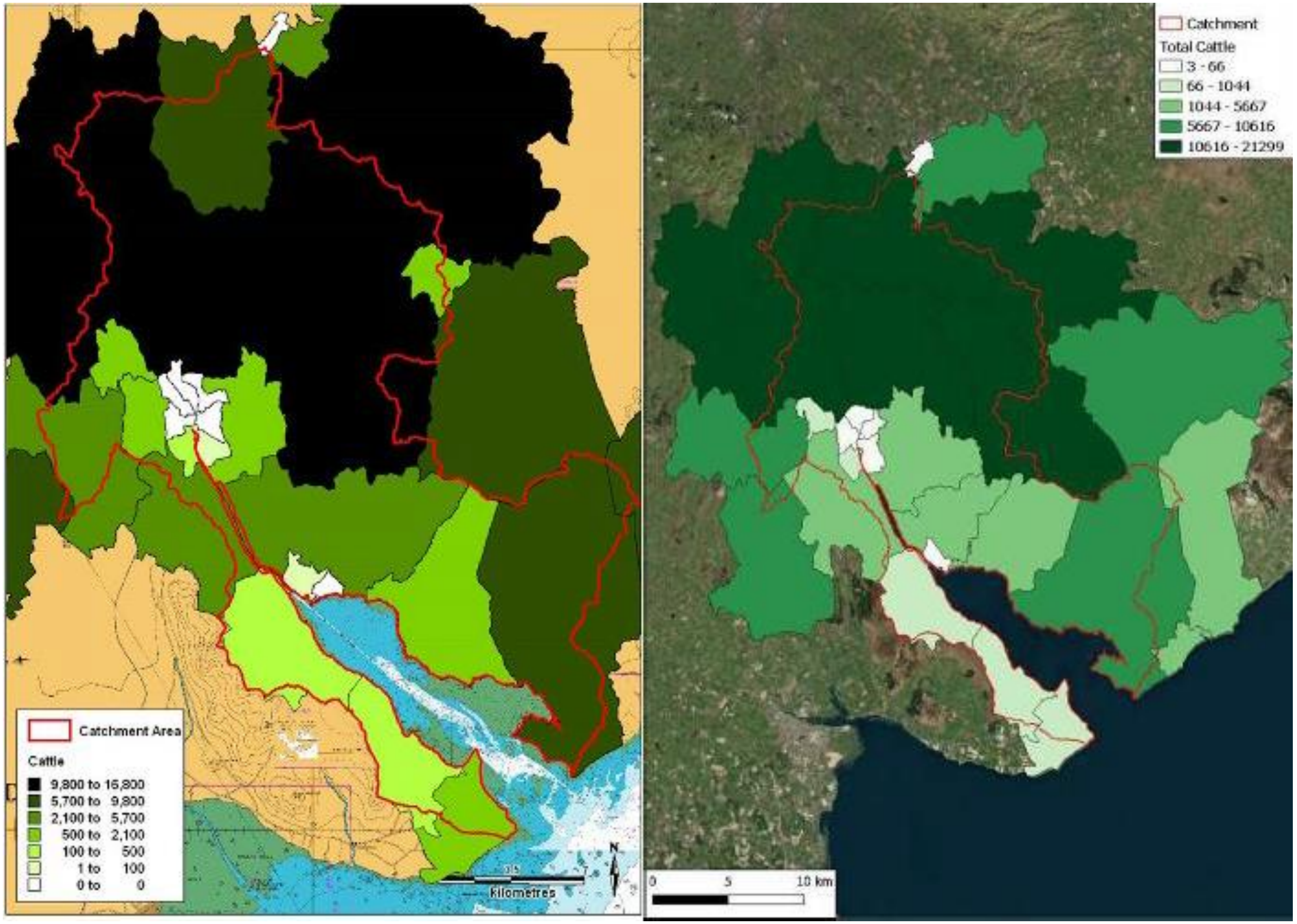


Figure 4.44: Sheep within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

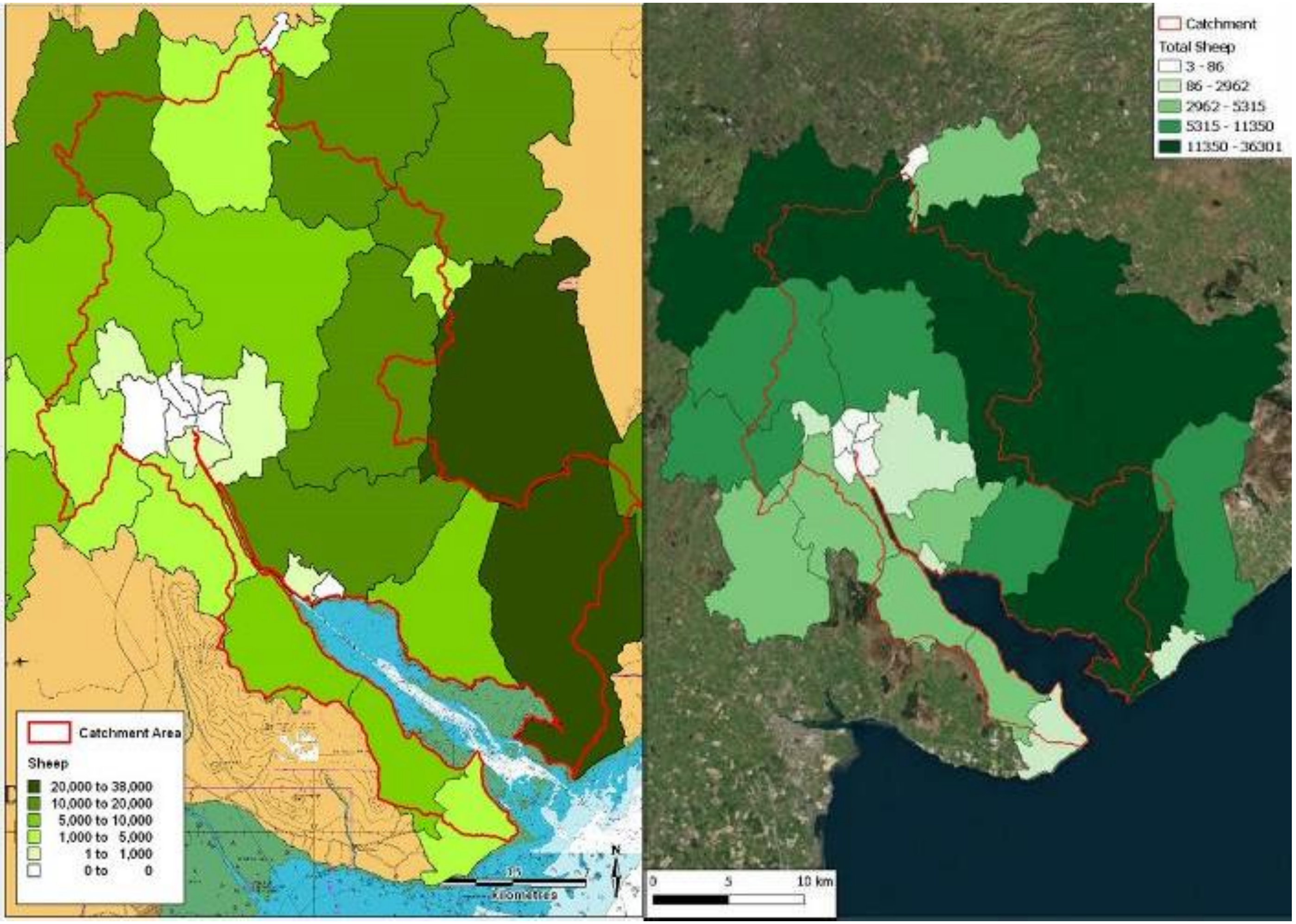


Figure 4.45: Pigs within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).

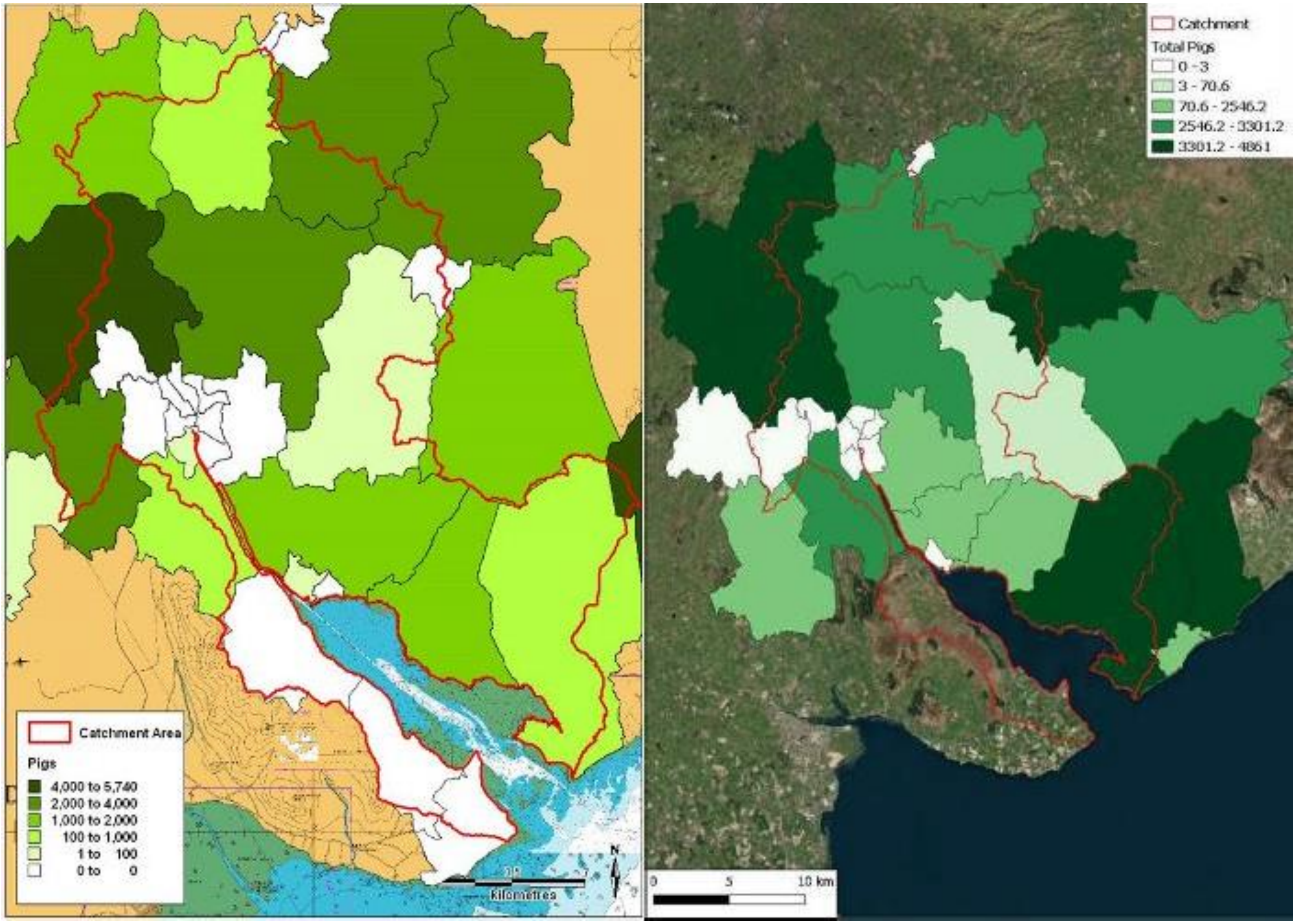
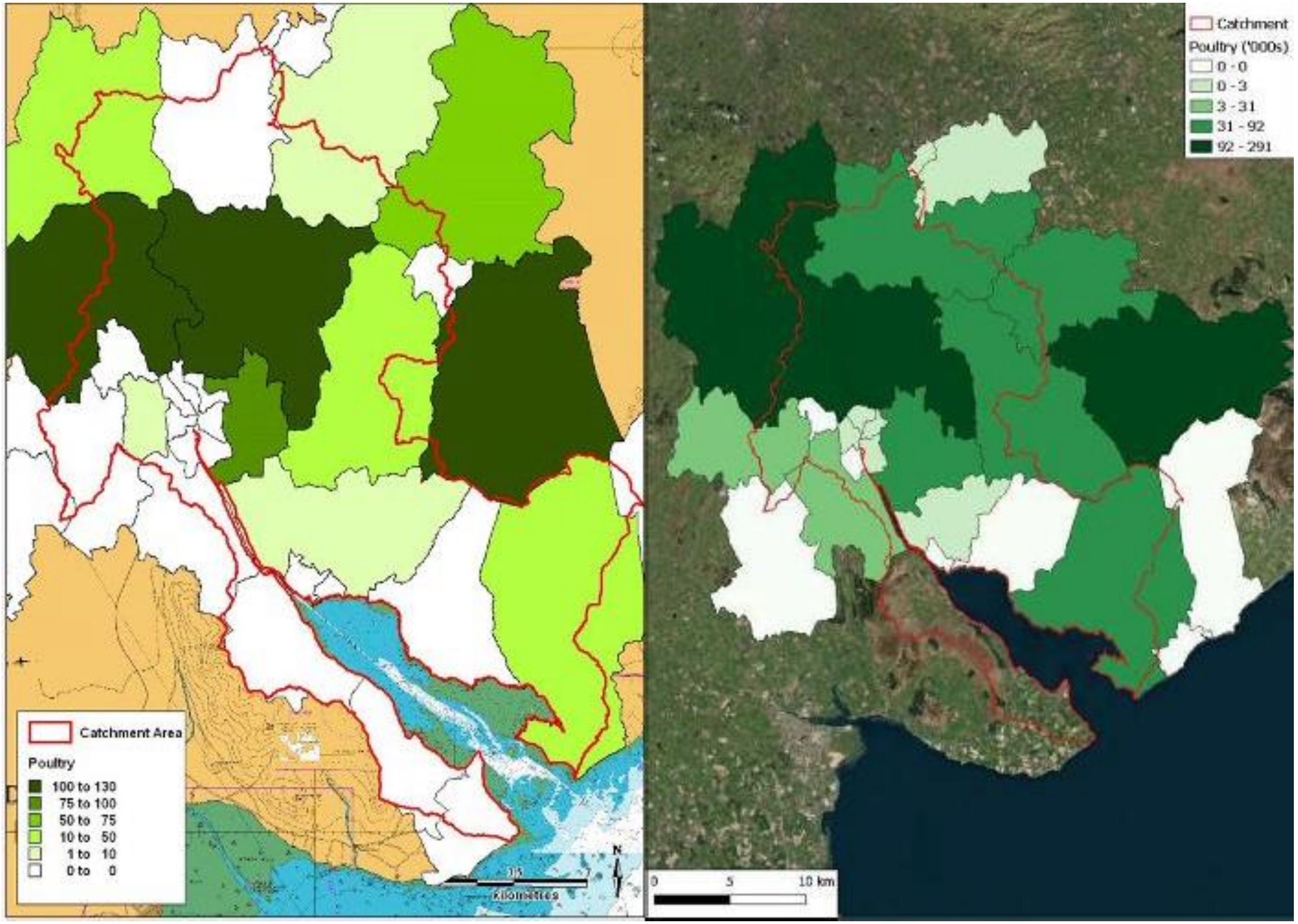


Figure 4.46: Poultry within the Carlingford Lough Catchment Area for 2009 (Left) and 2018 (right) (Source: DAERA, 2009 & 2018; CSO, 2019a).



A number of studies have reported a strong association between intensive livestock farming areas and faecal indicator concentrations of microorganisms in streams and coastal waters due to run-off from manure, especially during high flow conditions, both from point and non-point sources of contamination (*for example,* Crowther *et al.,* 2002).

4.1.6 Other Pollution Sources

4.1.6.1 Shipping

Operational waste from vessels, if not properly managed, can end up in the sea where the potential for contamination or pollution occurs. Wastes generated or landed in ports and harbours can be broadly divided into a) operational and domestic waste from ships and boats, b) waste from commercial cargo activities and c) wastes generated from maintenance activities and associated maritime industry activities.

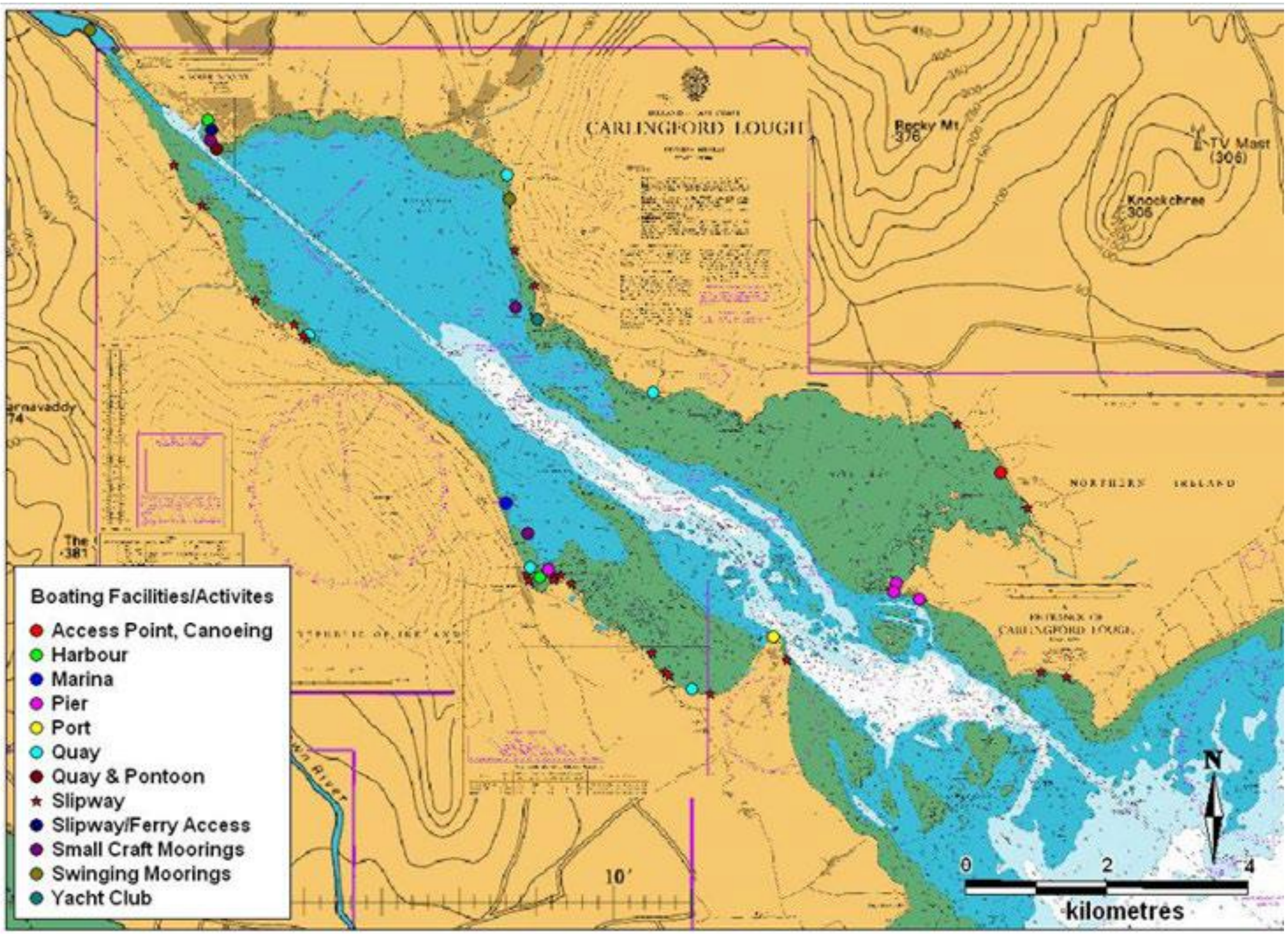
Marpol Annex IV defines sewage as “drainage from medical premises, toilets, urinals, spaces containing live animals and other waste waters when mixed with sewage waste streams”. Although adopted in 1973, the Annex did not come into effect until September 2003, with subsequent amendments entered into force in August 2005. Annex IV requires ships to be equipped with either a sewage treatment plant, a sewage comminuting and disinfecting system or a sewage holding tank. Within 3 miles of shore, Annex IV requires that sewage discharges be treated by a certified Marine Sanitation Device (MSD) prior to discharge into the ocean. Sewage discharges made between 3 and 12 miles of shore must be treated by no less than maceration and chlorination and sewage discharged greater than 12 miles from shore are unrestricted. Annex IV also established certain sewage reception facility standards and responsibilities for ports and contracting parties.

Ship sewage originates from water-borne human waste, wastewaters generated in preparing food, washing dishes, laundries, showers, toilets and medical facilities. However, as waste enters the lough environment from many sources, it makes the identification of specific impacts from ship/boat waste very difficult. It is widely recognised that the majority of pollution entering the marine environment comes from land-based sources and atmospheric inputs from land based industrial activities, with only an estimated 12% originating from shipping activities (GESAMP [Joint Group of Experts on the Scientific Aspects of Marine environmental Pollution], 1990).

Figure 4.25 shows all boat facilities and activities in Carlingford Lough. The main commercial port in Carlingford Lough is Warrenpoint. The tonnage of goods has increased significantly from 1,841,000 tonnes in 2009 to 3,321,000 tonnes in 2019 (NISRA, 2019). Cargo passing through Warrenpoint include Agricultural products (e.g. grain, soya), Coal, Crude oil, Forestry products, metal and other typical freight. No live animals on the hoof have passed through Warrenpoint since 2001 (NISRA, 2019). There has been a further increase due to divergence from Dublin to Warrenpoint as it has become the point of entry. It is unclear if this is a temporary change or not. There has also been a significant increase of traffic to Greenore Port which has increased from 390,000 tonnes of goods in 2009 to 1,188,000 tonnes in 2020 (CSO, 2021). The types of cargo passing through Greenore port are not available for 2020. Live animals on the hoof do pass through the port although numbers or tonnage is not available. Feacal matter from live animals being shipped may enter the lough during transport and loading/unloading if management practices are not sufficient.

While data on sewage discharge levels from shipping activities in Carlingford Lough are not available, it is highly likely that discharging does occur within the Lough. The effect is likely to be the greatest in enclosed areas and shallow water with little or no tidal flow in the summer and autumn when temperatures are at their highest, coinciding with the peak of the boating season. However, it is also likely that these levels are very low compared with land-based discharges.

Figure 4.47: Location of all boating facilities and activities in Carlingford Lough (Source: DAERA-NI, 2021).



4.1.6.2 Birds

It is important to document the bird populations in the Carlingford Lough area as bird faeces are rich in faecal bacteria (Oshira & Fujioka, 1995) and have been shown to be a source of faecal contamination in the marine environment (Jones *et al.* 1978; Standridge *et al.* 1979; Levesque *et al.* 1993, Alderisio & DeLuca 1999, Levesque *et al.* 2000, Ishii *et al.* 2007).

Figure 4.26 shows the locations of the Carlingford Lough Special Protection Areas (SPA) and Ramsar Sites. The Carlingford Lough SPA (Site Code:IE004078) and the Carlingford Lough Ramsar Site (Site Code: UK9020164) are both located in the outer third of the lough.

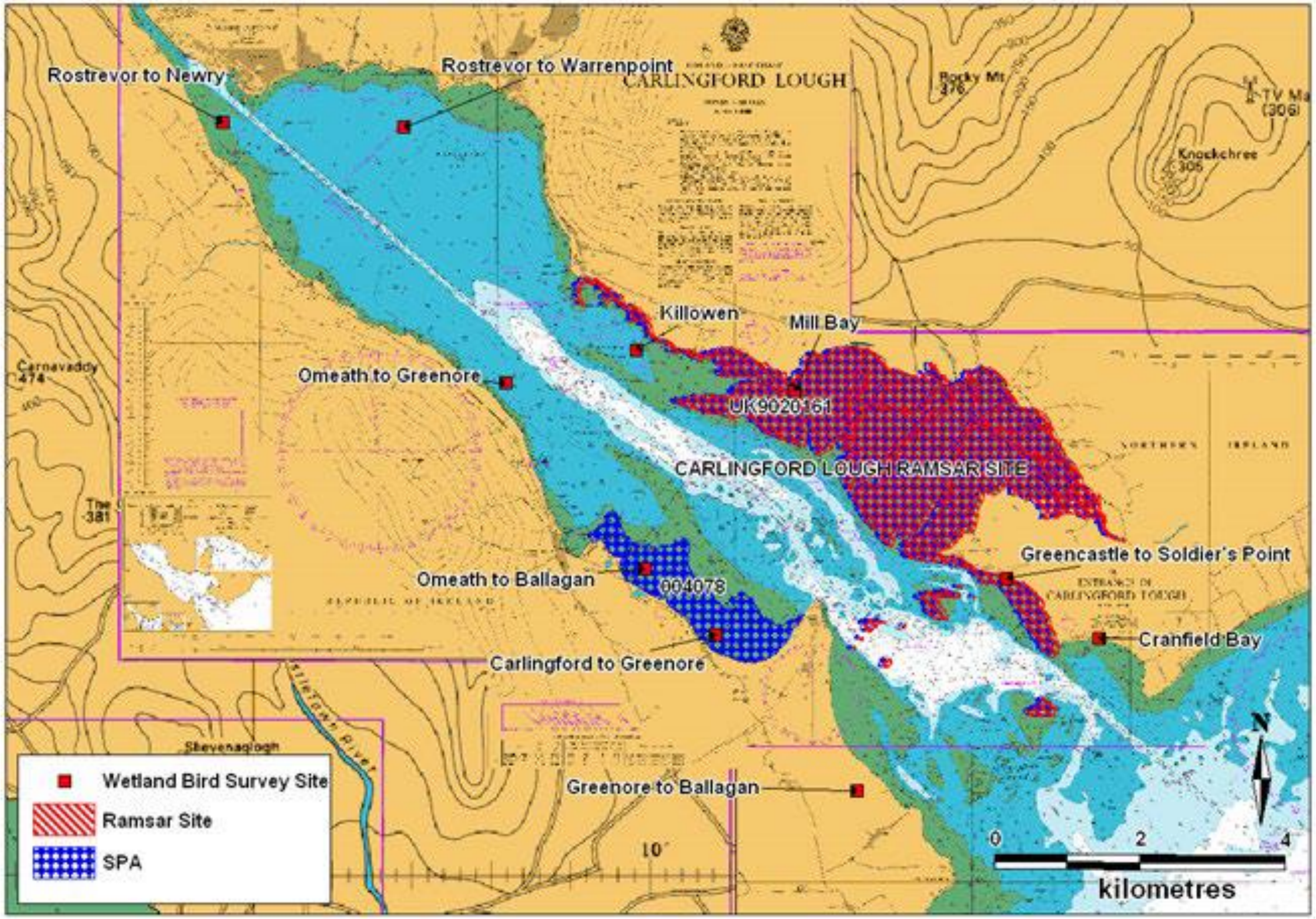
Carlingford Lough routinely surveyed by the British Trust for Ornithology (BTO) (Through the WeBS [Wetland Bird Survey] Project) and Birdwatch Ireland (Through the I-WeBS[Irish Wetland Birds Survey] project). Table 4.7 shows 5-year data used for the 2011 survey and the most recent 5-year set of data. Although the annual bird number were more variable in the most recent data there has been little change in the 5-year average. The 5-year average has increased slightly from 10,360 to 10,584 for the most recent 5 year period.

Table 4.15: Total number of water birds in Carlingford Lough from 2004/05 to 2008/09 and 2013/14 to 2017/18 (Source: Frost et al., 2020; Birdwatch Ireland).

Site Name	2004/05	2005/06	2006/07	2007/08	2008/09	5 year Mean
Carlingford Lough	10,952	10,165	9,692	10,705	10,289	10,360

Site Name	2013/14	2014/15	2015/16	2016/17	2017/18	5 year Mean
Carlingford Lough	4,934	10,057	9,708	16,369	11,854	10,584

Figure 4.48: Carlingford Lough SPA and Ramsar Sites.



Bird populations in the Carlingford area are typically higher in early winter and late spring due to migratory events and they are typically higher in mid-winter than spring and summer as the local birds tend to move off-site in the summer months to breed. Therefore, it is probable that the contribution made by wildfowl to pollution levels in Carlingford Lough is higher in the winter months. However, it is likely that these levels are low when compared with land-based discharges.

4.2 Shoreline Survey Report

A shoreline survey was carried out on the 7th, 8th and 9th of March 2022. The entire shoreline with the exception of the Warrenpoint Commercial port was walked over the course of the three days by three surveyors. Figure 4.26 shows the GPS (Global Positioning System) and photography sites accounted for during the 3 survey days.

The aim of this survey was to identify/confirm and mark all discharges, pollution sources, waterways and marinas along the shoreline. GPS coordinates were recorded for all features and marked on a map. In addition, all features were photographed digitally. Notes were made on the numbers and types of farm animals obvious from the shoreline and on wild fowl/populations of wild animals with an estimation of their numbers. Table 4.8 shows the details of each feature recorded. Figure 4.27 to Figure 4.29 show the locations of each feature with cross referenced Map IDs to Table 4.8.

Features identified during the shoreline survey include 151 discharges, 37 rivers/streams, 15 piers, 30 slipways, 8 locations with livestock and 2 locations with birds feeding on the shore. The 2010 shoreline survey recorded 69 discharges. A greenway was constructed along the southern side of the lough in 2018. Surface water discharges installed as part of this development account for a large proportion of the extra discharges. A number of extra discharge points were also recorded between Warrenpoint and Rostrevor, which were mostly for road runoff or land drainage from private properties. Overall, very few of the discharges and watercourses recorded during this survey showed any signs of nutrient enrichment or contamination.

Figure 4.49: Location of features identified during shoreine survey.

Table 4.16: Details of features identified during shorline survey.

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
1	Discharge	Manhole and dicharge	54.02981	-6.07067	326473	310671
2	Discharge	Multiple surface water discharges	54.02998	-6.07327	326302	310685
3	Access	Shore access	54.03002	-6.07432	326233	310687
4	Discharge	Two sluiced discharges	54.02995	-6.07594	326127	310676
5	Birds	Barnacle Geese X21 on shore	54.02983	-6.07711	326051	310661
6	Discharge	Surface water discharges from private residence	54.03357	-6.08509	325517	311063
7	Access	Shore access used by harvesters	54.03460	-6.08575	325470	311176
8	Pier	Ferry Pier	54.03796	-6.09747	324692	311530
9	Pier	Fishing Pier	54.03895	-6.10042	324496	311635
10	Discharge	Discharge from private residence	54.03996	-6.10337	324300	311742
11	Discharge	Discharge from private residence	54.03998	-6.10427	324241	311742
12	Pier	Greencastle Pier	54.04127	-6.10649	324092	311882
13	Discharge	Foul discharge from boatyard, red algae and smell	54.04130	-6.10620	324111	311886
14	Discharge	Drains from boat yard	54.04130	-6.10610	324117	311886
15	Discharge	Old drain at access road	54.04130	-6.10550	324156	311887
16		Farm at waters edge	54.04140	-6.10463	324213	311900
17	Discharge	Drain at edge of farm gate, appears to come from farm	54.04220	-6.10320	324304	311992
18	Discharge	Grass dumped in yard at edge of water, visible seepage under wall	54.04220	-6.10320	324304	311992
19	Access	Several access points and entrances to fields along this area	54.04330	-6.10100	324445	312118
20	Discharge	Run off from field	54.04520	-6.09900	324570	312333
21	Livestock	Cows in field at waters edge	54.04820	-6.09440	324863	312675
22	Discharge	Drain through field, active dischage, anoxic sediment and smell	54.04900	-6.09150	325050	312769
23	River	River outflow	54.04560	-6.08200	325683	312407
24	River	River outflow	54.05591	-6.08308	325581	313553
25	Birds	50 barnacle geese	54.05590	-6.08300	325586	313552

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
26	River	River	54.06160	-6.10290	324266	314151
27	Discharge	Large drain	54.06270	-6.10640	324034	314267
28	Discharge	Drain, comes under field, active discharge	54.06270	-6.10640	324034	314267
29	Discharge	Blue drainpipe, active discharge	54.06290	-6.11450	323503	314276
30	Discharge	Drain, comes under field, active discharge	54.06290	-6.11450	323503	314276
31	Discharge	Stream coming from field	54.06410	-6.11840	323244	314402
32	Discharge	Stream coming from field	54.06410	-6.11840	323244	314402
33	Discharge	Stream coming from field	54.06470	-6.11890	323209	314468
34	River	Stream bordering farmland	54.06583	-6.12203	323001	314588
35	River	Stream bordering farmland	54.06532	-6.13347	322254	314512
36	River	Stream clear, cattle and sheep upstream with access to stream	54.06383	-6.14382	321581	314328
37	River	Stream clear, cattle and sheep upstream with access to stream	54.06559	-6.14876	321252	314516
38	Discharge	Field drain, cattle and sheep upstream with access	54.06587	-6.15012	321162	314544
39	Discharge	Discharge at shore access, no sign of pollution	54.06592	-6.15248	321007	314546
40	Slipway	Slipway	54.07570	-6.18410	318910	315581
41	Discharge	Old drain, no active discharge	54.07570	-6.18410	318910	315581
42	Pier	Pier	54.07770	-6.18460	318871	315803
43	Discharge	Drain from house	54.07790	-6.18450	318877	315825
44	Discharge	Drain from house	54.07790	-6.18460	318871	315825
45	Discharge	Drain from house	54.07790	-6.18460	318871	315825
46	Discharge	Drain from house	54.07800	-6.18460	318870	315836
47	Discharge	Drain from house	54.07810	-6.18450	318877	315847
48	Discharge	Drain from house	54.07830	-6.18450	318876	315870
49	Slipway	Slipway from house	54.07840	-6.18460	318869	315881
50	Discharge	Surface water discharge from private residence	54.07858	-6.18459	318870	315900
51	Slipway	Private slipway	54.07935	-6.18469	318860	315986
52	Slipway/Pier	Slipway and pier	54.09250	-6.19000	318476	317441

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
53	Discharge	Old drain, no active discharge	54.09360	-6.19070	318427	317562
54	Discharge	Discharge with flow, grey water smell and discolouration	54.09372	-6.19068	318427	317576
55	Pier	Pier	54.09370	-6.19060	318433	317573
56	Discharge	Drain from yard at fuel store	54.09390	-6.19090	318413	317595
57	Discharge	Drain from yard at fuel store	54.09400	-6.19100	318406	317606
58	Discharge	Drain at side of house, active discharge	54.09400	-6.19100	318406	317606
59	Discharge	Discharge with flow, no sign of polution	54.09472	-6.19199	318339	317684
60	Discharge	Discharge with flow, no sign of polution	54.09528	-6.19321	318258	317745
61	Discharge	Surface water discharges	54.09606	-6.19515	318128	317828
62	Pier	Shore access (pier)	54.09740	-6.19889	317880	317971
63	Discharge	Manhole, discharge below water line	54.09740	-6.19893	317877	317971
64	Discharge	Discharge pipe crossing under river, outfall below water line.	54.09730	-6.19932	317852	317960
65	River	River, no sign of polution	54.09756	-6.19927	317855	317988
66	Discharge	Two manholes, disharge below water line	54.09797	-6.20091	317746	318031
67	River	River, no sign of polution	54.09870	-6.20329	317589	318109
68	Discharge	Manhole, discharge below water line	54.09873	-6.20507	317472	318109
69	Discharge	Manhole, discharge below water line	54.09856	-6.20580	317425	318089
70	River	Stream, no sign of polution	54.09854	-6.20600	317412	318087
71	Discharge	Manhole, discharge below water line	54.09849	-6.20725	317330	318078
72	Discharge	Number of surface water discharges	54.09825	-6.21268	316976	318043
73	Discharge	Surface water discharge	54.09863	-6.21279	316967	318085
74	Discharge	Discharge, likely sewage related (damaged)	54.09897	-6.21321	316939	318123
75	Discharge	Sluiced discharge, likely surface water discharge	54.09919	-6.21310	316946	318147
76	River	River, no signs of pollution	54.10000	-6.21373	316902	318236
77		Old shore access	54.10018	-6.21407	316879	318255
78	Discharge	Surface water discharges	54.10019	-6.21402	316883	318257
79	Discharge	Surface water discharge	54.10047	-6.21472	316836	318287

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
80	Discharge	Number of surface water discharges	54.10053	-6.21580	316765	318292
81	Discharge	Surface water runoff points from road above	54.10056	-6.21710	316680	318293
82	Discharge	Surface water discharges	54.10066	-6.21815	316611	318302
83	River	Culverted stream, some signs of enrichment	54.10065	-6.21946	316525	318299
84	Slipway	Old slipway, access blocked	54.10037	-6.22072	316444	318266
85	Discharge	Number of surface water discharges	54.10037	-6.22072	316444	318266
86	Access	Shore access (damaged due to errosion)	54.10038	-6.22069	316446	318267
87	Discharge	Surface water runoff points from road above	54.10018	-6.22153	316392	318244
88	Slipway	Old slipway	54.10109	-6.22421	316213	318340
89	Discharge	Dishcarge point, no flow, no sewage fungus	54.10113	-6.22489	316169	318344
90	Discharge	Surface water runoff points from road above	54.10111	-6.22562	316121	318339
91	Discharge	Number of surface water drains in wall from private residence	54.10071	-6.22890	315908	318289
92	Discharge	Number of surface water drains in wall from private residence	54.10064	-6.22915	315891	318281
93	River	River flowing through Rostrevor, no sign of pollution	54.10033	-6.23167	315727	318243
94	Discharge	Large drain, visible discharge	54.10130	-6.23380	315586	318348
95	Discharge	2 dry drains	54.10140	-6.23410	315566	318358
96	River	River no sign of contamination	54.10100	-6.23770	315331	318308
97	Discharge	Large road drain	54.10090	-6.23840	315286	318296
98	Discharge	Drain, visible discharge	54.10090	-6.23840	315286	318296
99	Slipway	Slipway	54.10090	-6.23970	315201	318293
100	Discharge	Several small drains in wall along this section	54.10060	-6.24110	315110	318258
101	Discharge	Drain, small amount of discharge	54.10050	-6.24140	315091	318246
102	Discharge	Large drain, significant outflow	54.10050	-6.24150	315084	318246

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
103	Discharge	Drain, small amount of discharge	54.10050	-6.24160	315078	318246
104	Discharge	Several small drains in wall	54.10050	-6.24170	315071	318246
105	Discharge	Large drain, no visible outflow, may be disused	54.10000	-6.24320	314974	318188
106	Discharge	Drain through wall	54.09980	-6.24370	314942	318165
107	Discharge	Road drain, several along road	54.09980	-6.24370	314942	318165
108	Discharge	Drains through wall, staining below	54.09970	-6.24550	314825	318150
109	Discharge	Drain from wall, staining below	54.09960	-6.24580	314805	318139
110	Discharge	Road drain with small drain beside it	54.09950	-6.24650	314760	318127
111	Slipway	Slipway	54.09900	-6.24790	314670	318069
112	Discharge	Drain from pool	54.09860	-6.24800	314664	318024
113	Discharge	Old discharge pipe, bottom not visible with tide	54.09850	-6.24800	314665	318013
114	Pier	Pier with swimming pool	54.09840	-6.24910	314593	318000
115	Discharge	Drain through wall, no flow out but wet underneath	54.09830	-6.24920	314587	317989
116	Discharge	Drain through wall, no flow out but wet underneath	54.09820	-6.24950	314567	317977
117	Discharge	Drain, dry	54.09780	-6.25000	314536	317932
118	Discharge	Drain through wall, no flow out but wet underneath	54.09780	-6.25010	314529	317932
119	Discharge	Drain through stone wall	54.09770	-6.25040	314510	317920
120	Discharge	Drains from road surface, multiple along length of road by seafront	54.09740	-6.25100	314471	317886
121	Slipway	Slipway	54.09760	-6.25220	314392	317906
122	Pier	Pier	54.09780	-6.25330	314320	317926

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
123	Discharge	Drain from boat yard	54.09930	-6.25560	314165	318090
124	Port	Warrenpoint harbour, no access inside of gate	54.10050	-6.25510	314195	318224
125	Slipway/Pier	Slipway and pier	54.10050	-6.25510	314195	318224
126	River	River, marked on map	54.10330	-6.27220	313068	318508
127	Slipway	Slipway	54.10200	-6.27020	313203	318367
128	Discharge	Drains from road surface	54.10200	-6.27020	313203	318367
129	Discharge	Small drain at edge of river	54.10030	-6.26850	313319	318180
130	River	On map as river but flows underwater for a long distance above sea front	54.10030	-6.26860	313312	318180
131	Discharge	Drain, end not visible	54.09860	-6.26640	313461	317994
132	Discharge	Drain, coming from house	54.09720	-6.26530	313536	317840
133	Livestock	Horses in field	54.09670	-6.26480	313570	317785
134	Livestock	Field at waters edge, no sheep but wool on fence	54.09630	-6.26450	313591	317741
135	Slipway	Slipway	54.09460	-6.26330	313674	317554
136	Discharge	Old drain, appears blocked	54.09460	-6.26330	313674	317554
137	Discharge	Two drains from house, seem dry	54.09460	-6.26320	313681	317554
138	Discharge	Drain from house, no visible discharge	54.09450	-6.26320	313681	317543
139	Discharge	Drain from house, visible discharge	54.09440	-6.26320	313681	317532
140	Discharge	Drain, coming from garden of house, no visible discharge but staining on wall	54.09430	-6.26300	313695	317521
141	Slipway	Old small slipway	54.09310	-6.26220	313750	317389
142	Discharge	Old drain, appears blocked	54.09260	-6.26180	313778	317334
143	River	River discharge, not on map	54.09250	-6.26170	313785	317323

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
144	Slipway	Old slipway no longer accessible	54.09207	-6.26112	313824	317276
145	Slipway	Slipway	54.09150	-6.26110	313827	317213
146	Discharge	Drain through wall, visible outflow	54.09090	-6.26070	313855	317147
147		Construction at sea front	54.09020	-6.26010	313896	317070
148	Discharge	Large drain	54.08990	-6.25980	313916	317037
149	Discharge	Discharge, no sign of contamination	54.08984	-6.25929	313950	317031
150	Discharge	Large drain, green algae, visible outflow	54.08920	-6.25740	314075	316963
151	Slipway	Slipway	54.08910	-6.25740	314075	316952
152	Discharge	Drain at pier	54.08910	-6.25720	314088	316952
153	Pier	Pier at Omeath	54.08910	-6.25670	314121	316953
154	Discharge	Drain, coming under road from house	54.08850	-6.25600	314169	316887
155	Discharge	Drain, coming under road from house	54.08835	-6.25533	314213	316872
156	Discharge	Drain, coming under road from house	54.08840	-6.25570	314189	316876
157	Discharge	2 old drains, both dry	54.08830	-6.25520	314222	316866
158	Discharge	Old drain in sand, appears blocked	54.08790	-6.25450	314268	316823
159	Discharge	Drain coming out under road, pipe just at water.	54.08690	-6.25290	314376	316714
160		Construction at sea front	54.08083	-6.24919	314635	316044
161	Discharge	Outlet from house, under road	54.07859	-6.24708	314780	315799
162	Discharge	Outlets in wall from road surface, along length of road	54.07841	-6.24643	314823	315780
163	River	River	54.07702	-6.24458	314948	315628
164	Discharge	Blue pipe outlet into river	54.07684	-6.24488	314928	315608
165	Slipway	Slipway	54.07533	-6.24168	315142	315444
166	Discharge	Dry outlet, comes from ditch	54.07457	-6.23904	315317	315364
167	River	River outlet	54.07438	-6.23780	315399	315345

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
168	River	River outlet	54.07520	-6.23644	315485	315439
169	Discharge	Water flowing over wall, green algae	54.07421	-6.23710	315445	315328
170	Discharge	Outlet at bottom of shore, orange pipe visible	54.07419	-6.23705	315448	315325
171	Septic tank	Possible disused septic tank for old holiday village, no longer in use.	54.07415	-6.23671	315471	315321
172	Discharge	Old outlet, appears blocked	54.07311	-6.23584	315531	315207
173	Slipway	Slipway	54.07290	-6.23530	315566	315184
174	Discharge	Large outlet with active discharge	54.07261	-6.23505	315584	315152
175	River/ Drain	2 outlets from under greenway, comes from stream in ditch above	54.07243	-6.23441	315626	315134
176	River	River	54.07248	-6.23439	315627	315139
177	Discharge	Black drainage pipe with inner blue tube. Draining from stream running through the house just above the greenway path	54.07210	-6.23367	315675	315097
178	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete. No flow	54.07156	-6.23317	315710	315039
179	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete. No flow	54.07013	-6.22962	315946	314886
180	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete.	54.06996	-6.22943	315959	314867
181	River	Old stream discharge	54.06937	-6.22816	316043	314804
182	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete.	54.06886	-6.22617	316175	314750
183	Discharge	Black discharge pipe. Possible drainage.	54.06887	-6.22605	316183	314751
184	Discharge	Older stone drain under greenway.	54.06877	-6.22555	316216	314741
185	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete. No flow	54.06879	-6.22528	316234	314743
186	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete. No flow	54.06851	-6.22314	316374	314715

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
187	Discharge	Land drain	54.06809	-6.22238	316426	314670
188	River	Large stream discharge under bridge on greenway.	54.06678	-6.21609	316841	314535
189	Discharge	Drainage for land above greenway.	54.06403	-6.20963	317272	314239
190	River	Stream discharge from under greenway	54.06339	-6.20856	317344	314170
191	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete	54.06335	-6.20844	317352	314166
192	River	Stream discharge from under greenway	54.06338	-6.20823	317365	314170
193	Discharge	Drainage discharge for fields above greenway. 45 Sheep in field above.	54.06147	-6.20403	317645	313964
194	Discharge	Stream discharge/drainage under greenway. 21 Sheep in nearby field.	54.06003	-6.20081	317860	313809
195	Discharge	Drainage discharge under greenway. Blue pipe surrounded by concrete	54.05882	-6.19861	318008	313678
196	River	Stream and bridge under greenway.	54.05757	-6.19699	318118	313542
197	River	Discharge point for stream running under greenway.	54.05558	-6.19475	318270	313324
198	Discharge	Discharge pipe under greenway west of boatyard. Exiting from rock armour	54.05504	-6.19440	318294	313264
199	River	Stream running under marina structure.	54.05227	-6.19315	318384	312958
200	River	Stream running under marina structure.	54.05192	-6.19289	318402	312919
201	River	Stream running under marina structure.	54.05129	-6.19271	318416	312850
202	Marina	Marina	54.05115	-6.19253	318428	312834
203	Slipway	Marina Slip	54.05063	-6.19193	318469	312778
204	River	River discharging under road	54.05062	-6.19134	318507	312778
205	River	Stream into drain. Discharge not visible	54.05009	-6.19159	318492	312718
206	Discharge	Discharge pipe. (No flow) after marina barrier	54.04985	-6.19133	318510	312691
207	Discharge	White pipe exiting high up shoreline, come under greenway from private house	54.04717	-6.18986	318614	312396

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
208	Pier	Pier	54.04492	-6.18790	318748	312149
209	Slipway	Slipway	54.04494	-6.18794	318746	312151
210	Slipway	Old slipway, limited access from above	54.04328	-6.18644	318849	311969
211	Pier	Carlingford West Pier	54.04309	-6.18655	318842	311947
212	River	Stream before marina barrier can't see discharge	54.04275	-6.18664	318837	311909
213	Discharge	Outlet by slipway, green algae and foamy in water	54.04246	-6.18662	318839	311878
214	Discharge	Oulet at far side of pier	54.04222	-6.18657	318844	311851
215	Slipway	Slipway	54.04213	-6.18632	318860	311841
216	Slipway	Slipway	54.04151	-6.18564	318906	311773
217	Discharge	Large manhole with flow out	54.04152	-6.18568	318904	311774
218	Discharge	Large manhole with flow out	54.04102	-6.18538	318925	311719
219	Discharge	Flow out at bottom of wall at private house	54.04101	-6.18515	318940	311719
220	Discharge	Large outlet, small amount of discharge	54.04073	-6.18398	319018	311690
221	Discharge	Flow out through cracks in rock wall	54.04019	-6.18303	319081	311630
222	Discharge	Large outlet, comes under main road	54.04024	-6.18295	319086	311636
223	Discharge	Large outlet, comes under main road	54.04021	-6.18276	319099	311633
224	Discharge	Large outlet, small amount of discharge	54.04032	-6.18258	319110	311646
225	Discharge	Drain from adventure centre yard	54.04181	-6.18082	319221	311814
226	Discharge	Drain from adventure centre yard	54.04176	-6.18055	319239	311810
227	Discharge	Storm water outlet at edge of slipway	54.04204	-6.18029	319255	311841
228	Pier	Slip at sailing club	54.04194	-6.17919	319328	311832

Map ID	Feature	Comments	Latitude	Longitude	Easting	Northing
229	Pier	Slip at park area before sailing club.	54.04113	-6.17658	319501	311746
230	Discharge	Sluiced pipe originating in the rock armour. No Flow	54.04070	-6.17606	319536	311700
231	Discharge	Pipe connecting artificial lagoon on opposite side of road, slight scum on water	54.03583	-6.16830	320059	311170
232	River	Large arch with pipe inside. Possible stream. Under Greenore road.	54.03344	-6.16188	320486	310915
233	Slipway	Slip to shore from greenore road	54.03243	-6.15940	320652	310807
234	Discharge	Discharge pipe no flow. Possible storm drain. Exits under Greenore road	54.03083	-6.15805	320744	310631
235	Discharge	Discharge pipe from yard beside oyster company (No Flow)	54.02998	-6.15685	320826	310538
236	Slipway	Slip from Oyster Company	54.03014	-6.15639	320855	310557
237	Discharge	Northern discharge from Oyster Company (Sampled)	54.02983	-6.15574	320899	310524
238	Discharge	Eastern discharge pipe from Oyster Company	54.02939	-6.15562	320908	310475
239	Slipway	Second slip access trail leads into golf club.	54.02776	-6.15052	321247	310303
240	Slipway	Slip accessesable through Greenore golf club.	54.02721	-6.14700	321479	310247
241	Slipway	Greenore ferry slip	54.03434	-6.13109	322501	311069
242	Slipway	Slipway	54.03167	-6.13030	322560	310772
243		Sea defence structure	54.02450	-6.12952	322633	309976
244	Livestock	Sheep grazing near the shore	54.01941	-6.12829	322728	309411
245	Slipway	Cooley oysters shore access	54.01900	-6.12786	322757	309367
246	Discharge	Discharge opposite farmyard	54.01151	-6.11765	323449	308550
247	River	Stream no signs of polution	54.00964	-6.11540	323602	308347
248	River	Stream, slight signs of nutrient enrichment	54.00627	-6.11134	323878	307978
249	Discharge	Dry field drain	54.00509	-6.11044	323941	307849
250	Livestock	Horses grazing near upper shore	54.00091	-6.10397	324377	307395
251	Discharge	Field drain from tillage land	54.00045	-6.10353	324408	307345

Figure 4.50: Shoreline features numbered for Carlingford Lough, features 1-30 and 231-251 (Numbering refers to Table 4.8).

Figure 4.51: Shoreline features numbered for Carlingford Lough, features 30-51 and 165-231 (Numbering refers to Table 4.8).

Figure 4.52: Shoreline features numbered for Carlingford Lough, features 51-164 (Numbering refers to Table 4.8).

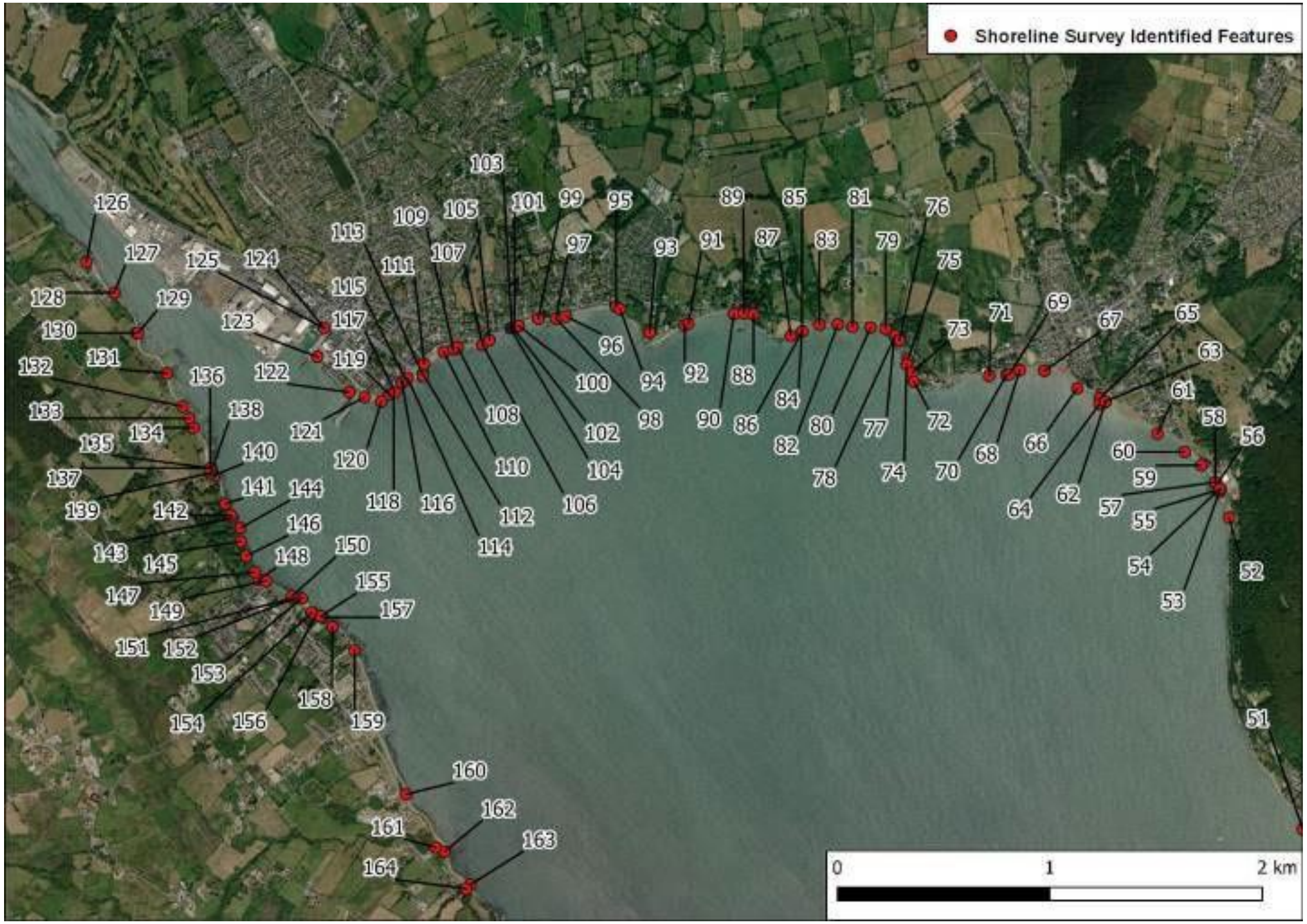


Figure 4.53: Images of features identified in shoreline survey 1-15 (numbering refers to Table 4.8).

Figure 4.54: Images of features identified in shoreline survey 16-30 (numbering refers to Table 4.8).

Figure 4.55: Images of features identified in shoreline survey 31-45 (numbering refers to Table 4.8).

Figure 4.111: Images of features identified in shoreline survey 46-60

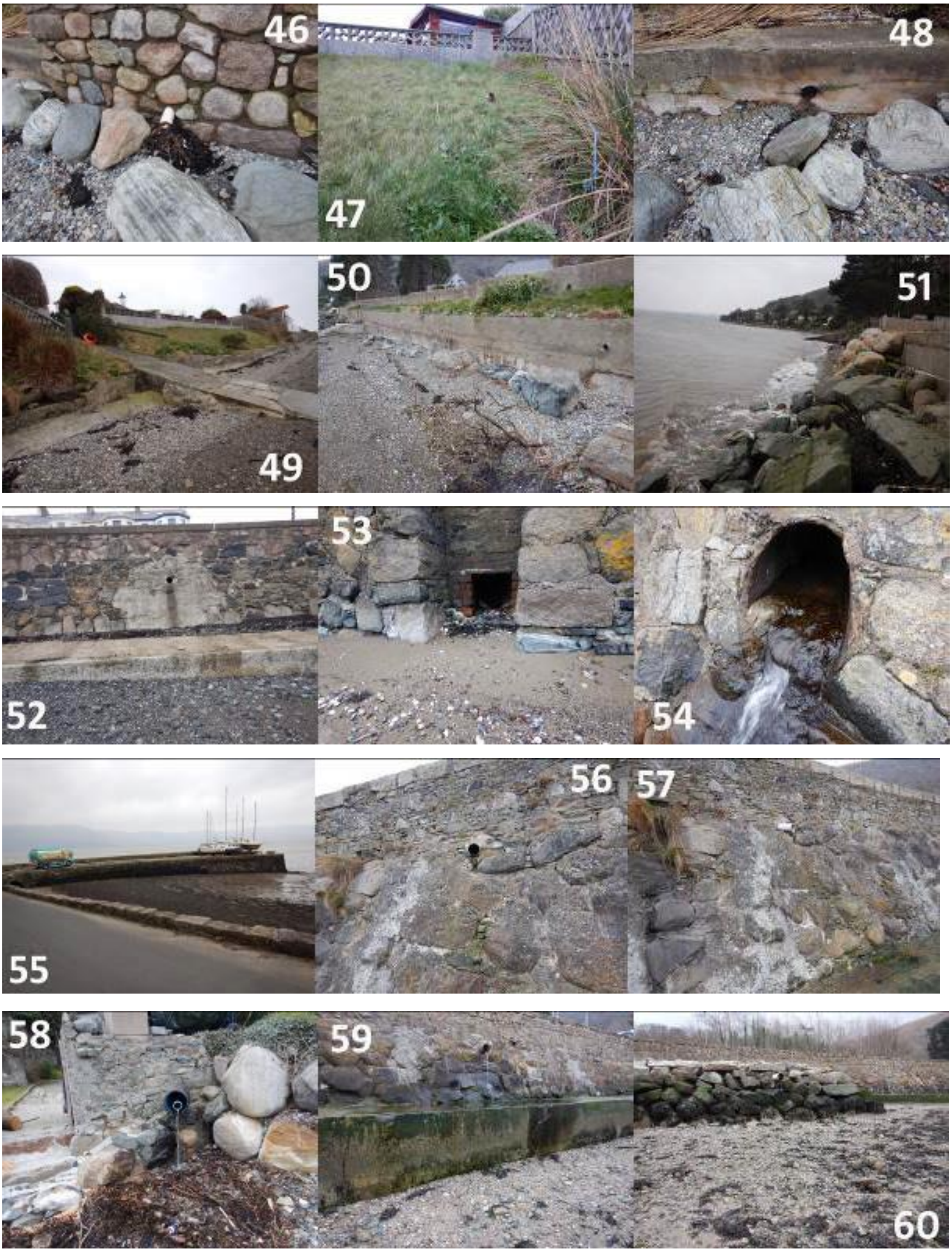


Figure 4.112: Images of features identified in shoreline survey 61-75

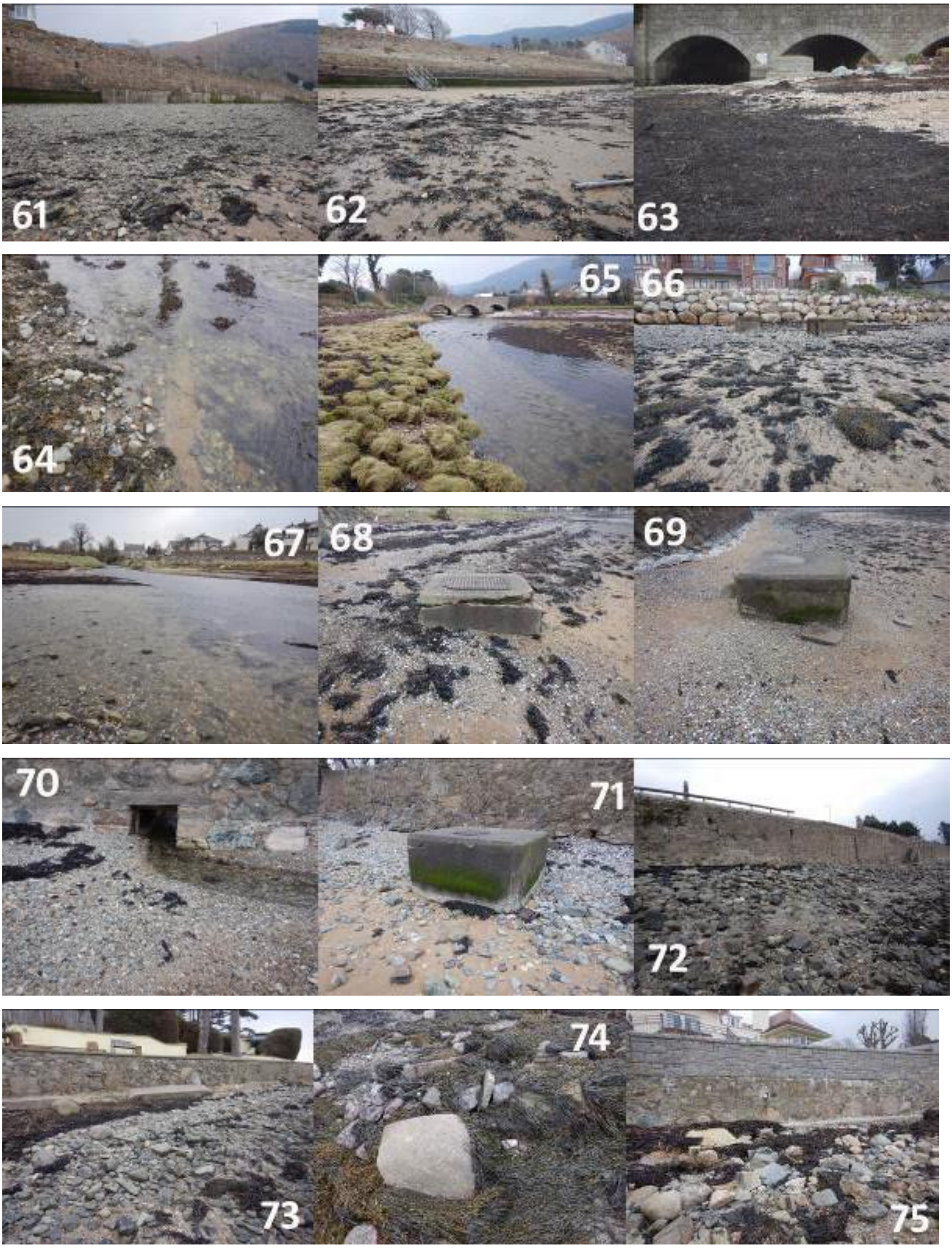


Figure 4.113: Images of features identified in shoreline survey 113-113

Figure 4.114: Images of features identified in shoreline survey 114-114

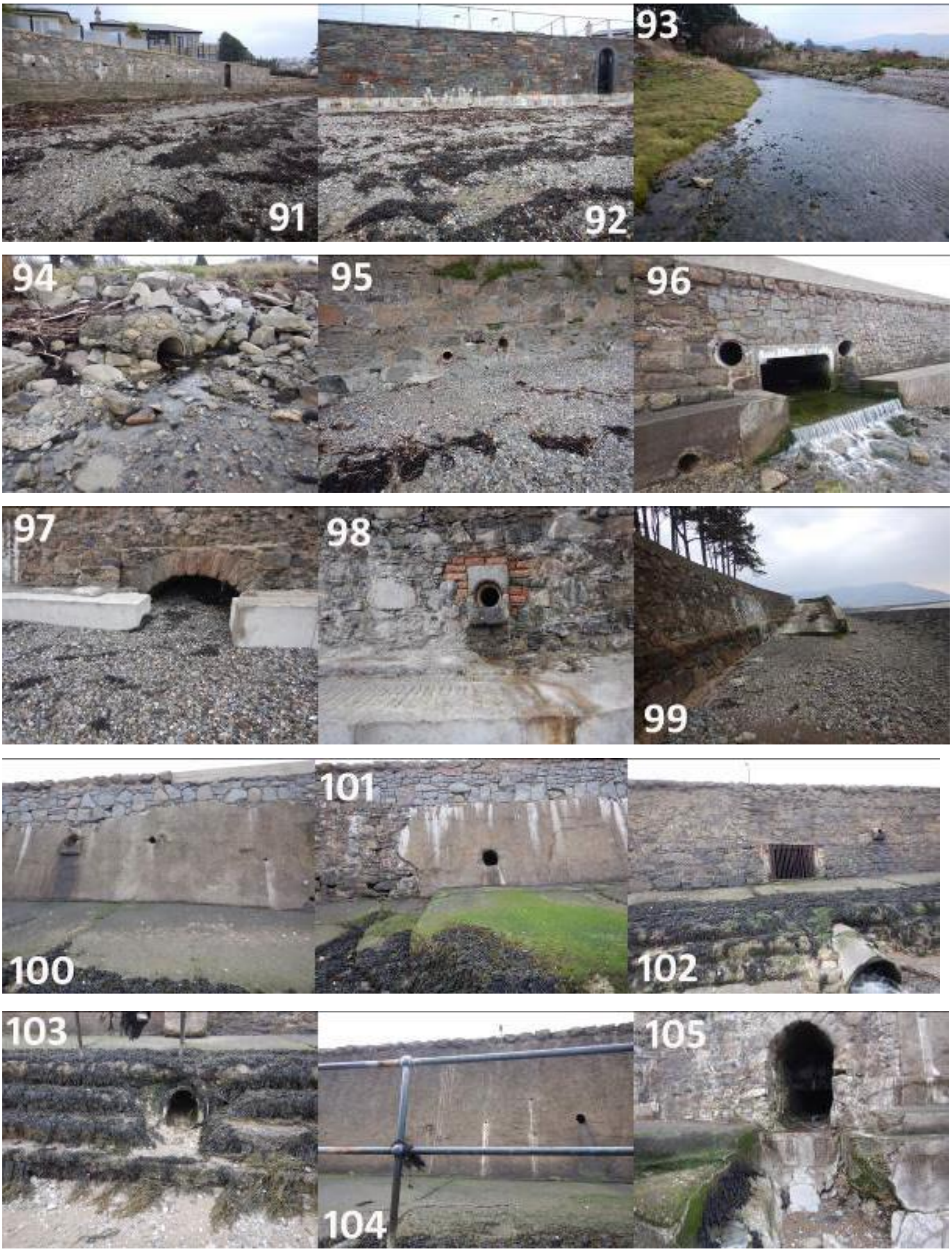


Figure 4.115: Images of features identified in shoreline survey 115-115 (numbering refers to Table 4.8).

Figure 4.116: Images of features identified in shoreline survey 116-116 (numbering refers to Table 4.8).

Figure 4.62: Images of features identified in shoreline survey 136-152, no image for feature 144 and 149 (numbering refers to Table 4.8).

Figure 4.63: Images of features identified in shoreline survey 153-168, no image for feature 155 (numbering refers to Table 4.8).

Figure 4.64: Images of features identified in shoreline survey 169-183 (numbering refers to Table 4.8).

Figure 4.120: Images of features identified in shoreline survey 184-198

Figure 4.121: Images of features identified in shoreline survey 199-213

Figure 4.122: Images of features identified in shoreline survey 122-122 (numbering refers to Table 4.8).

Figure 4.123: Images of features identified in shoreline survey 123-123 (numbering refers to Table 4.8).

Figure 4.69: Images of features identified in shoreline survey 244-252 (numbering refers to Table 4.8).

5. Shellfish and Water Sampling

5.1 Historical Data

5.1.1 Shellfish Water Quality

DAERA Water Management Unit monitors a number of shellfish growing waters around the Northern Irish coastline as part of the Water Framework Directive. However, Carlingford Lough has not been monitored since 2013.

5.1.2 Shellfish Flesh Quality

In accordance with Regulation (EU) 2017/625 and its subsequent Implementing Regulation (EU) 2019/627, the Food Standards Agency of Northern Ireland (FSA in NI), as competent authority, is required to establish the location and fix the boundaries of shellfish harvesting areas.

The Regulations stipulate that the competent authority must monitor the levels of *E. coli* within the harvesting area and that according to the sample results, must classify the area as being one of three categories A, B or C.

An A classification allows for the product to be placed directly on the market, whereas a B or C classification requires the product to go through a process of depuration, heat treatment or relaying before it can be placed on the market.

The FSA in NI and SFPA both monitor shellfish flesh in Carlingford Lough for microbiological contamination on a monthly basis and these results are reviewed annually to determine the classification awards in NI currently sample shellfish flesh in the C7 Ballyedmond, C11 Fair Green, NW Narrow Water and C1 Rostrevor harvesting areas for classification purposes. SFPA currently sample shellfish flesh at Ballagan, Carlingford outer and Carlingford Inner harvesting areas for classification purposes. The species currently monitored in the Lough include oysters, mussels and razor clams from within the classified area shown in Figure 5.1, although, razor clams have not been monitored since 2016.

Carlingford Lough has historically always been classified as a mixture of A and B harvesting areas. Table 5.1 summaries this system. Table 5.2 shows the current and historical (back to 2006) classifications within Carlingford Lough.

Table 5.17: Classification system for shellfish harvesting areas.

Classification	Permitted Levels	Outcome
A	80% of sample results ≤230 *E.coli* 100g, no results exceeding 700 *E.coli*/100g –	Molluscs can be harvested for direct human consumption provided the end product standard is met.
B	90% of sample results must be less than or equal to 4,600 *E. coli*/100g with none exceeding 46,000 *E. coli*/100g	Molluscs can go for human consumption after: • purification in an approved establishment, or • relaying in a classified Class A relaying area, or an *E. coli* approved heat treatment process.
C	Less than 46,000 *E.coli*/100g flesh	Molluscs must be subject to relaying for a period of at least 2 months or cooked by an approved method.

Figure 5.70: **Locations of FSA in NI and SFPA shellfish monitoring points for classification purposes.**

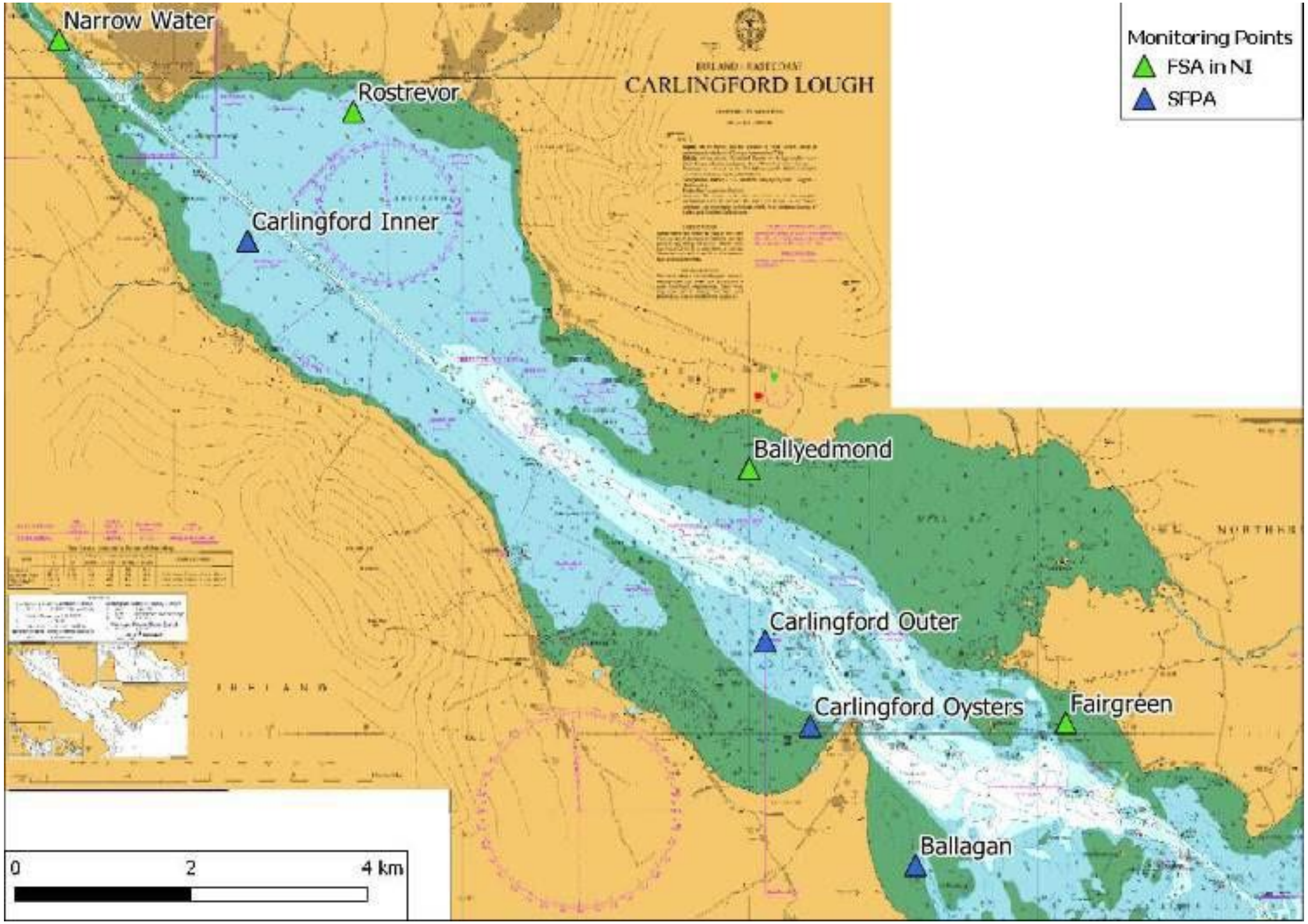


Table 5.18: Current and historical classification of shellfish beds in Carlingford Lough (2006 – 2020).

Bed Name	Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ballyedmond	Oysters	A	A	B	B	B	B	A*	A*	A*	A*	A*	B	B	B	B
Fairgreen	Oysters	A	A	B	B	B	B	B	B	B	B	B	B	B	B	B
Narrow Water	mussels	B*	B*	B	B*	C	B	B	B	B	B^	B^	B^	B^	B^	B^
Rostrevor	mussels	A	A	B	B	B	B	B	B	B	B	B	B	B	B	B
Ballagan R5	Razors	A	A	A	A	A	A	A	A	A	A**	A##	A##			
Ballagan	Oysters	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carlingford Inner M3	Mussels	-	-	-	-	-	-	B	B	B	B	B	B	B	B	B
Carlingford Outer M5	Mussels	-	-	-	-	-	-	A^^	A	A	A	A	A	A***	A	A
Carlingford/ Greenore O5	Oysters	A	A	A	A	A#	A	A	A	A	A	A	A	A	A	A

*Provisional Classification - Classifications are described as provisional when an area is being classified for the first time or after a period in suspension. The term may also be used where an incomplete dataset of results was to hand.

Seasonal A 01 May – 01 Jan due to viral issues

** Seasonal Classification 01 Sept – 01 Apr reverts to Class B at other times.

Seasonal Classification 01 July – 01 Apr reverts to Class B at other times.

***Seasonal Classification 01 Sept – 01 Feb reverts to Class B at other times.

^ B - Seasonal: 1st July 2015 - 31st October 2015 and C - Seasonal: 1st November 2015 - 30th June 2016

^^Seasonal Classification 01 Feb – 30 Aug reverts to Class B at other times

Figure 5.2 to Figure 5.10 show the *E. coli* results for mussels, oysters and razor clams for all monitoring points from 2006 to 2020. Classification monitoring results from previous years can be found on the National Archives website.

Table 5.2 above shows the annual classification of all site monitored in Carlingford Lough from 2006 to 2020. C7 Ballyedmond oysters had an **A** classification in 2007 and 2008 and a **provisional A** from 2012 to 2016. All other years were classified as **B.**

C11 Fairgreen oysters had a **B** classification for all year except 2007 and 2008 when they received an **A** classification.

NW Narrow Water mussels were given a **provisional B** classification in 2006, 2007 and 2009. A **B** classification was given for 2008 and 2011 to 2014. Since 2015 NW Narrow Water has been classified as **seasonal B** between July and October and as **C** for the remainder of the year. In 2010 the production area was classified as **C.**

C1 Rostrevor mussels had a **B** classification for all year except 2007 and 2008 when they received an **A** classification.

Ballagan oysters have had an **A** classification from 2006 to 2020. Razors had an **A** classification from 2006 to 2014 and a **seasonal A** classification from 2015 to 2017. Razors have not been classified since 2017.

Carlingford Inner mussels have consistently received a **B** classification from 2012 to 2020. Carlingford outer mussels have been classified as **A** over the same period with the exception of 2012 and 2018 when a **seasonal A** classifications was given.

Carlingford oysters have received an **A** classification for every year between 2006 and 2020 except for 2010 when a **seasonal A** classification was awarded. The monitoring point for Carlingford oysters was moved slightly in 2011. The Classification has remained the same, however, the *E. coli* results at the new monitoring point are noticeably lower. This can be seen in Figure 5.10 below.

Figure 5.71: ***E. coli*** **results from oysters at C7 Ballyedmond from 2006-June 2020 (Source: FSA in NI).**

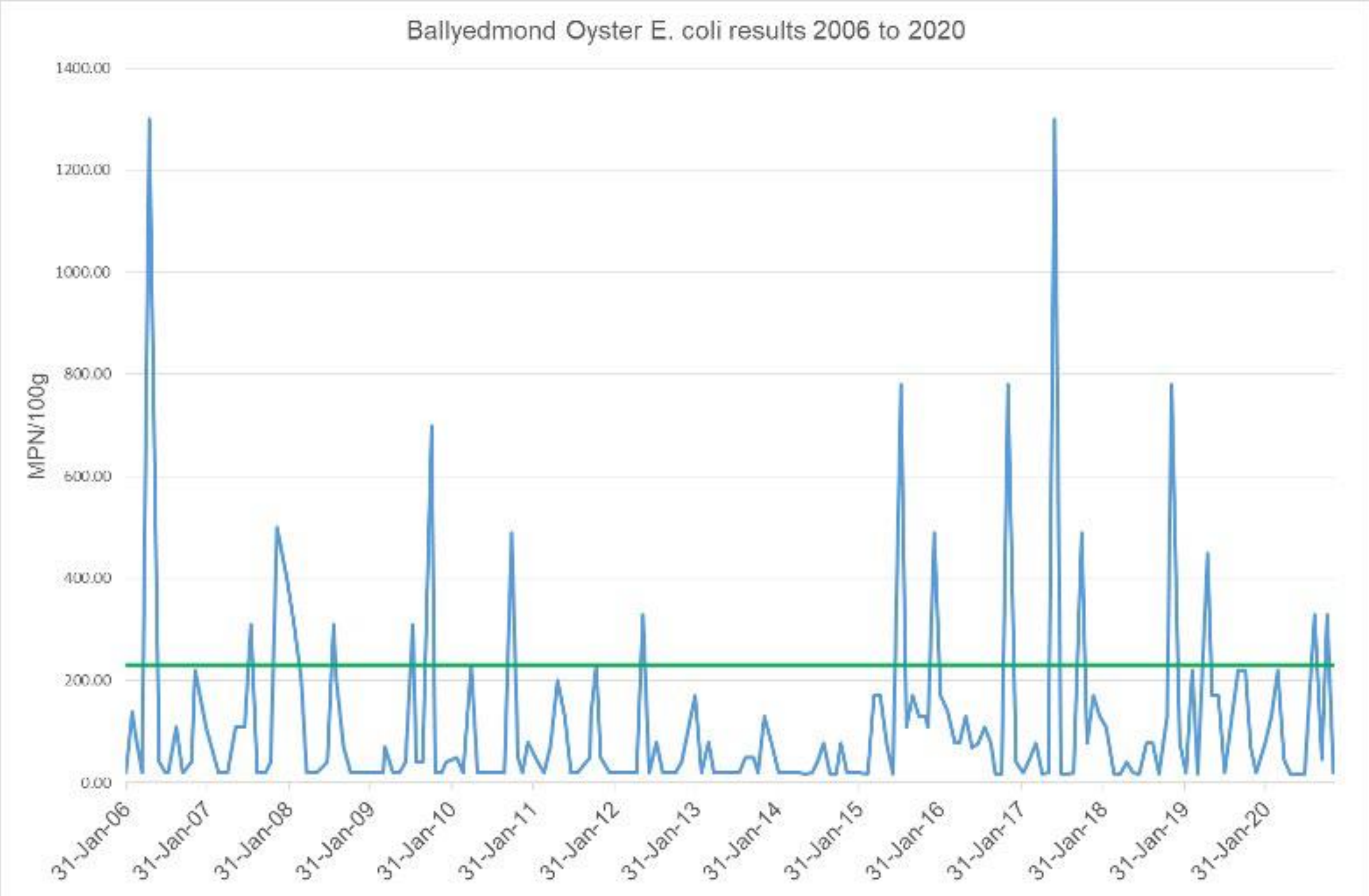


Figure 5.72: *E. coli* levels from oysters at C11 Fairgreen from 2006 to June 2020 (Source: FSA in NI).

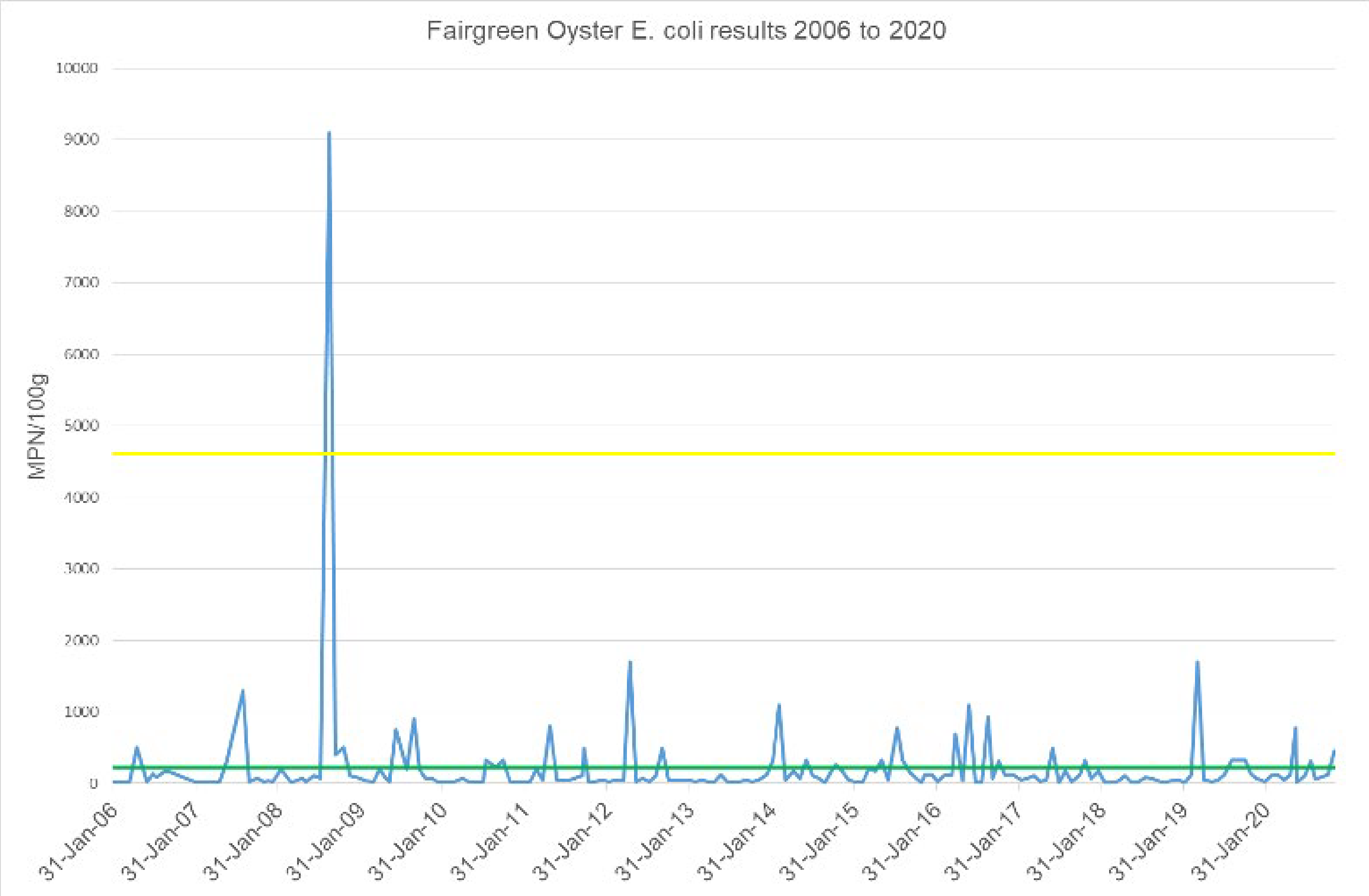


Figure 5.73: *E. coli* levels from mussels at NW Narrow Water from 2006 to 2020 (Source: FSA in NI).

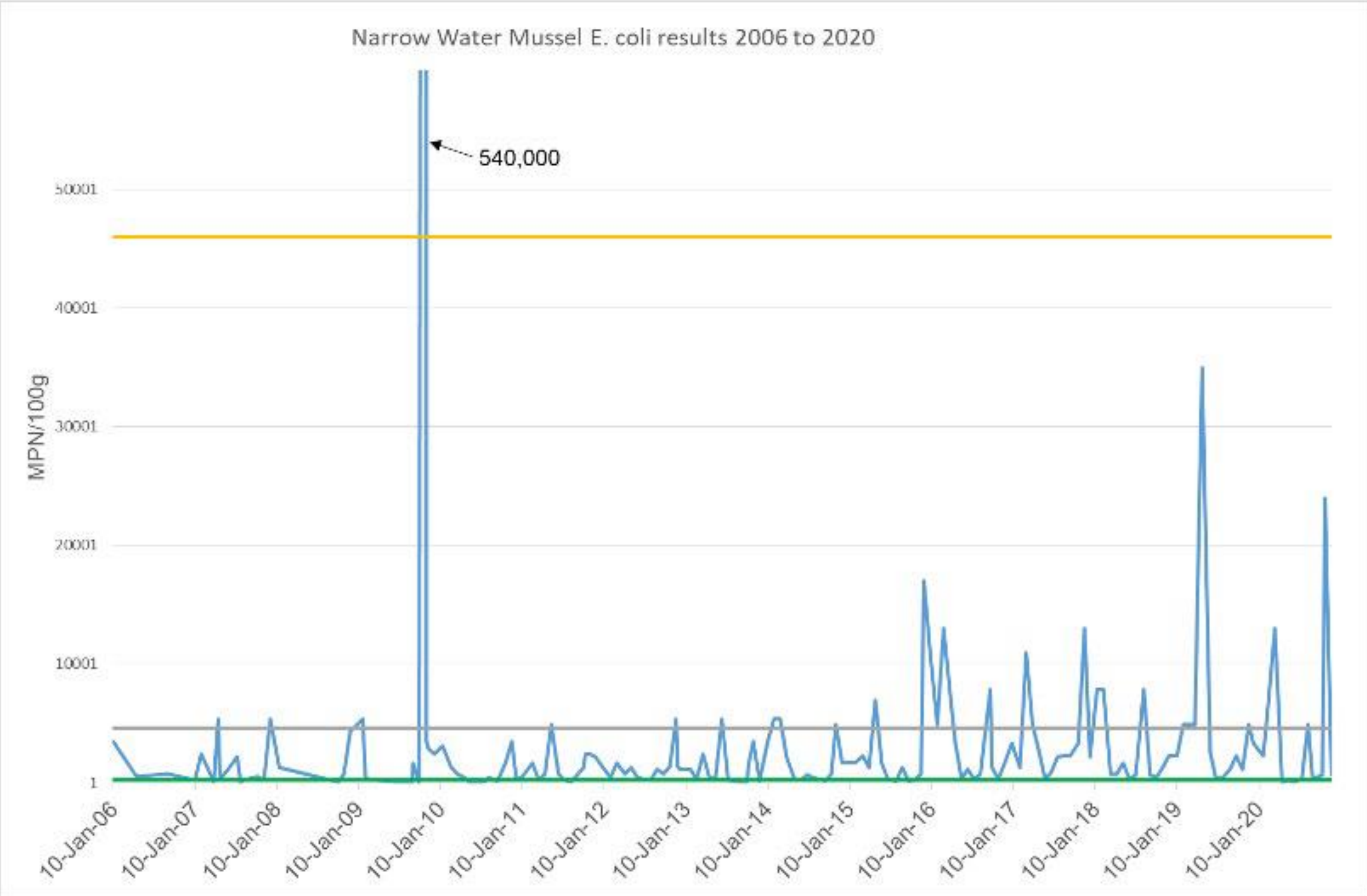


Figure 5.74: *E. coli* levels from mussels at C1 Rostrevor from 2006 - 2020 (Source: FSA in NI).

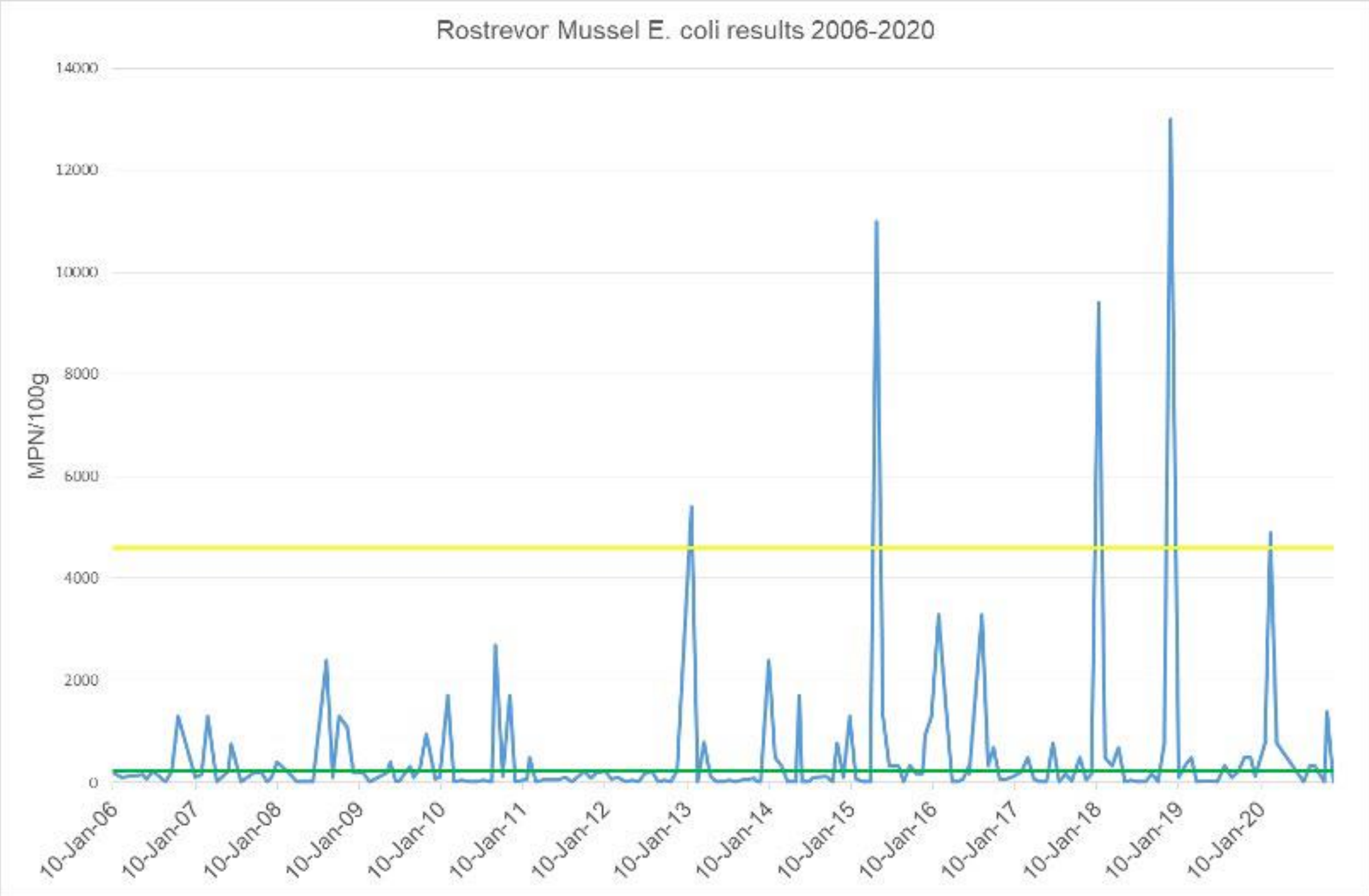


Figure 5.75: *E. coli* levels from razor clams at Ballagan from 2006 - 2016 (Source: SFPA).

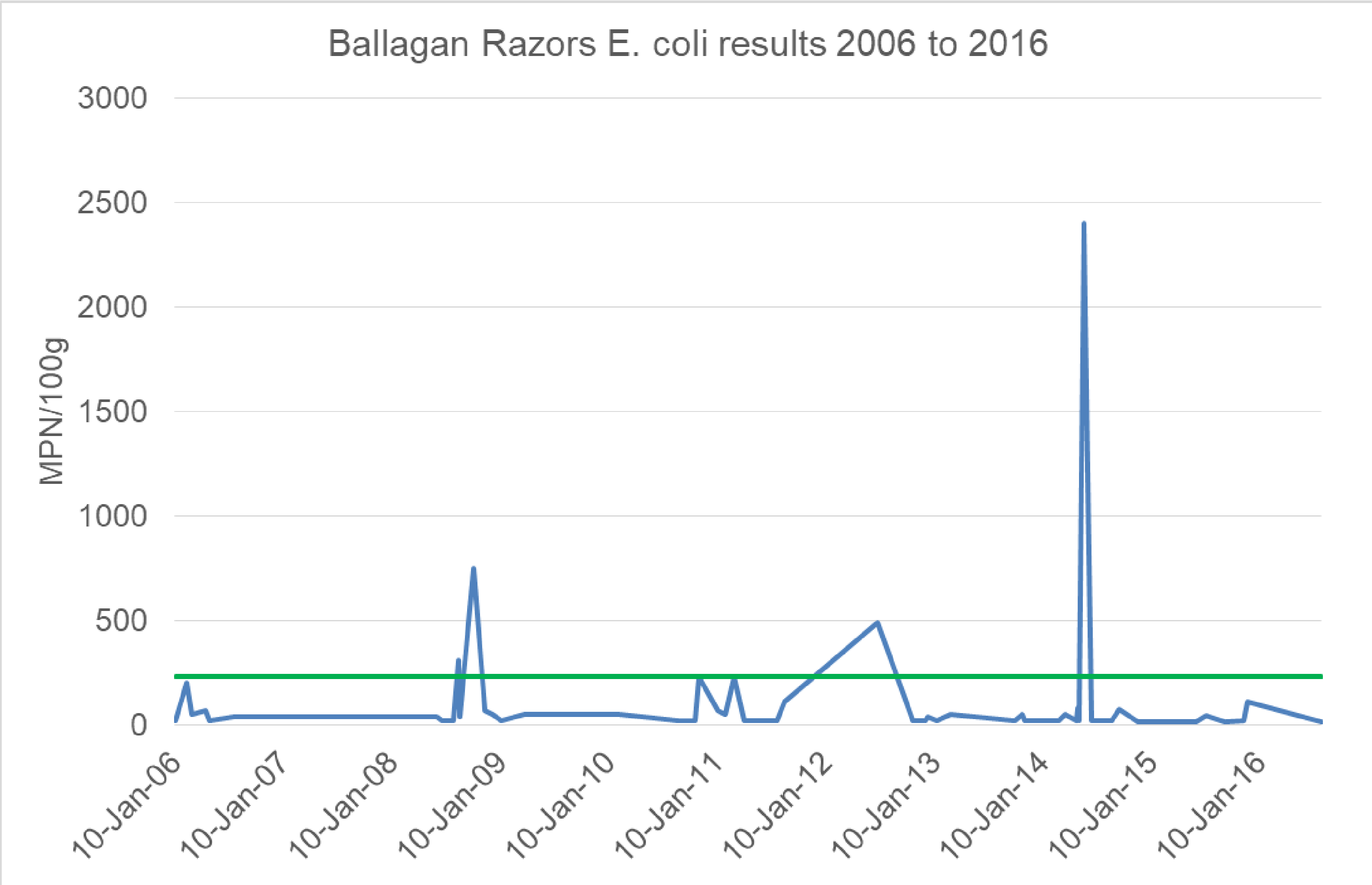


Figure 5.76: *E. coli* levels from oysters at Ballagan from 2006 - 2016 (Source: SFPA).

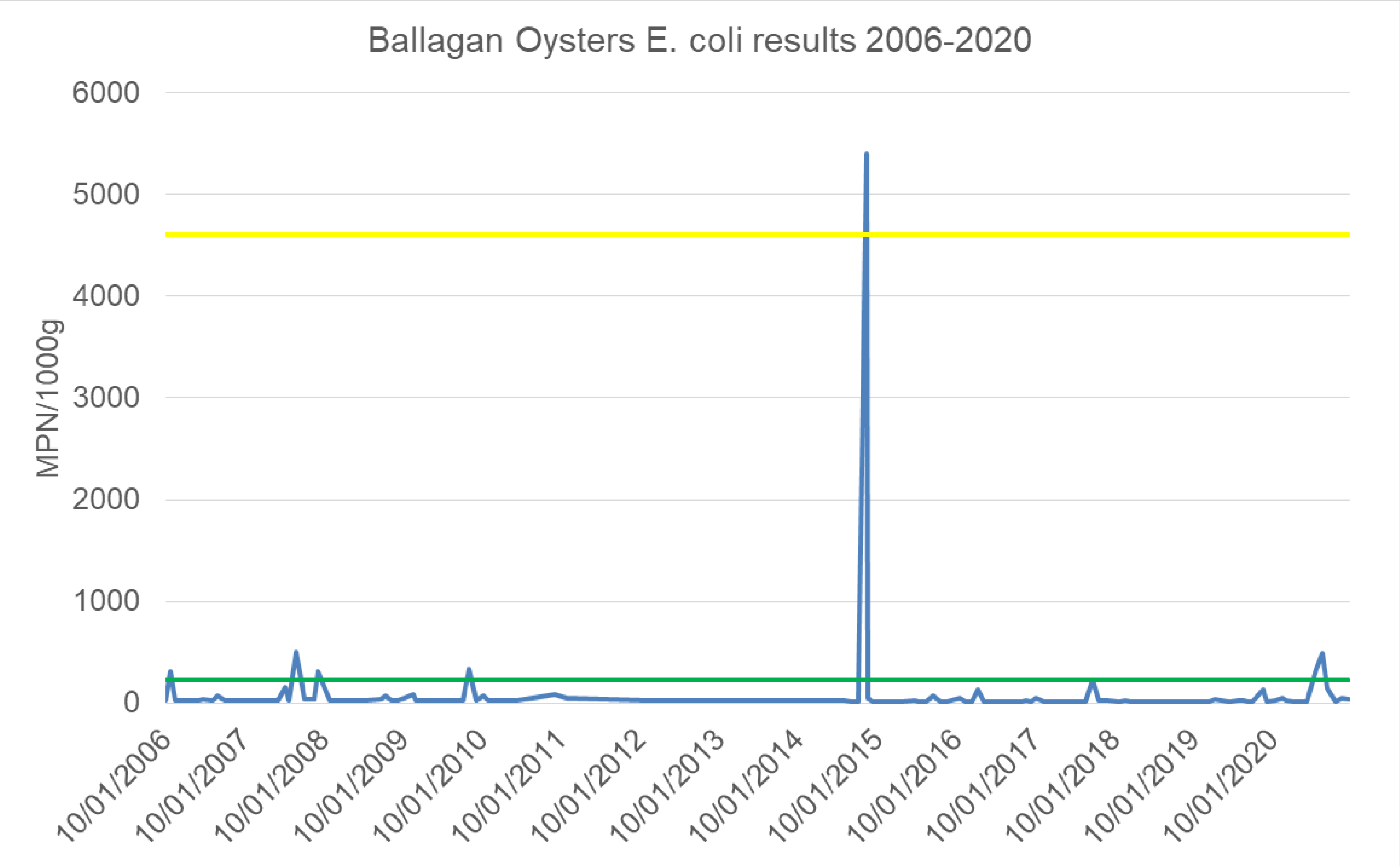


Figure 5.77: *E. coli* levels from mussels at Carlingford Inner from 2011 - 2020 (Source: SFPA).

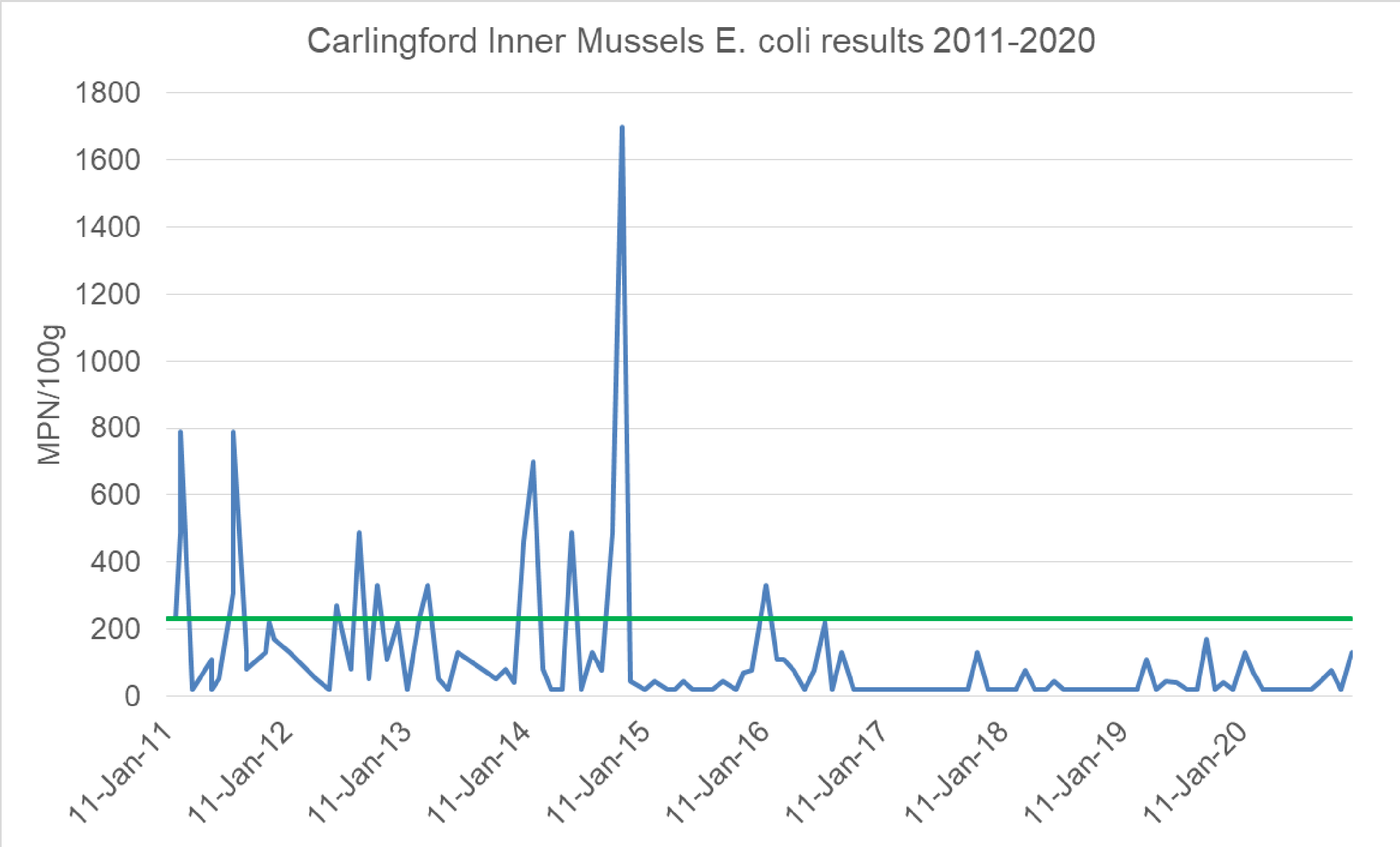


Figure 5.78: *E. coli* levels from mussels at Carlingford Outer from 2011 - 2020 (Source: SFPA).

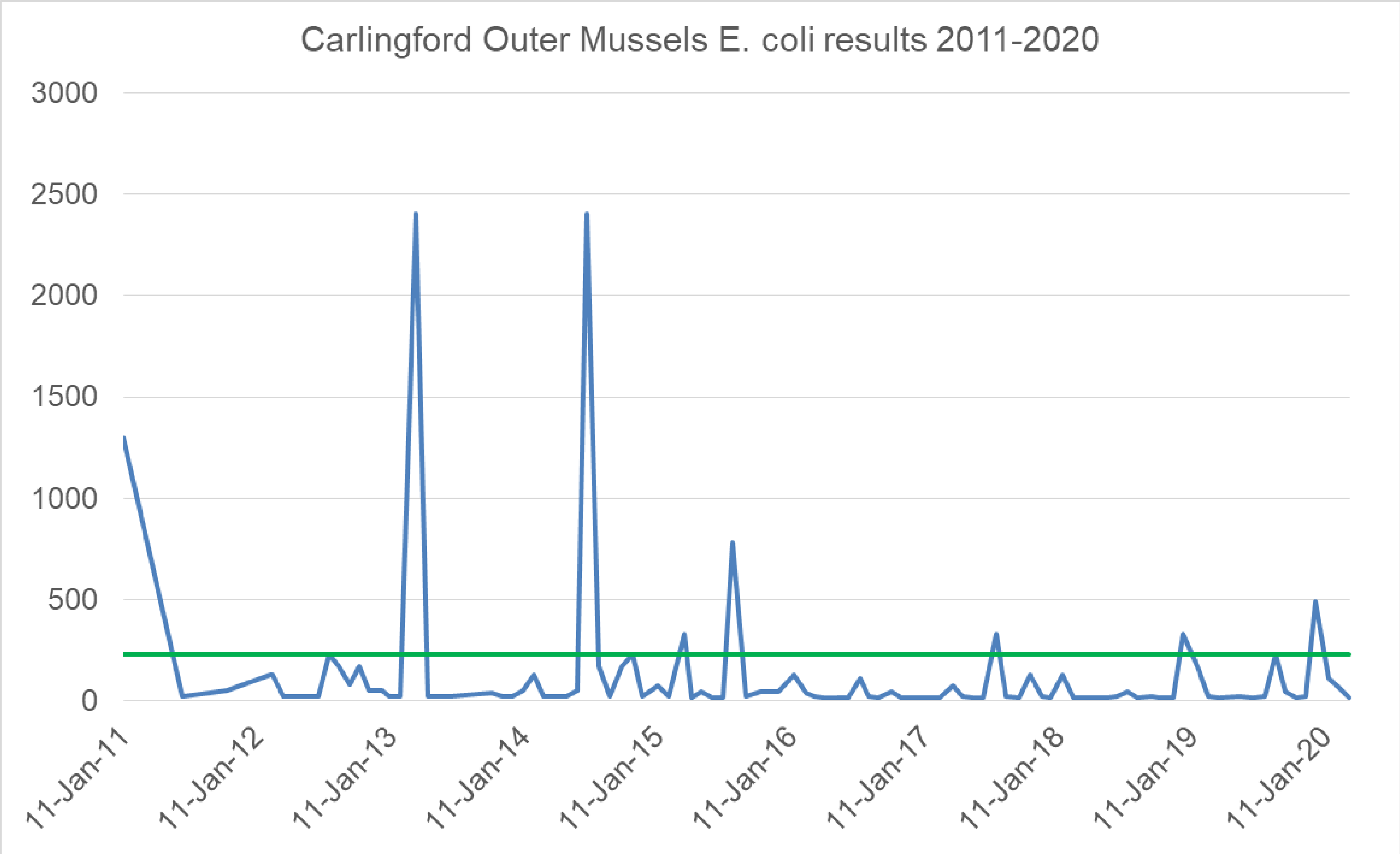


Figure 5.79: *E. coli* levels from oysters at Carlingford Outer from 2006 - 2020 (Source: SFPA).

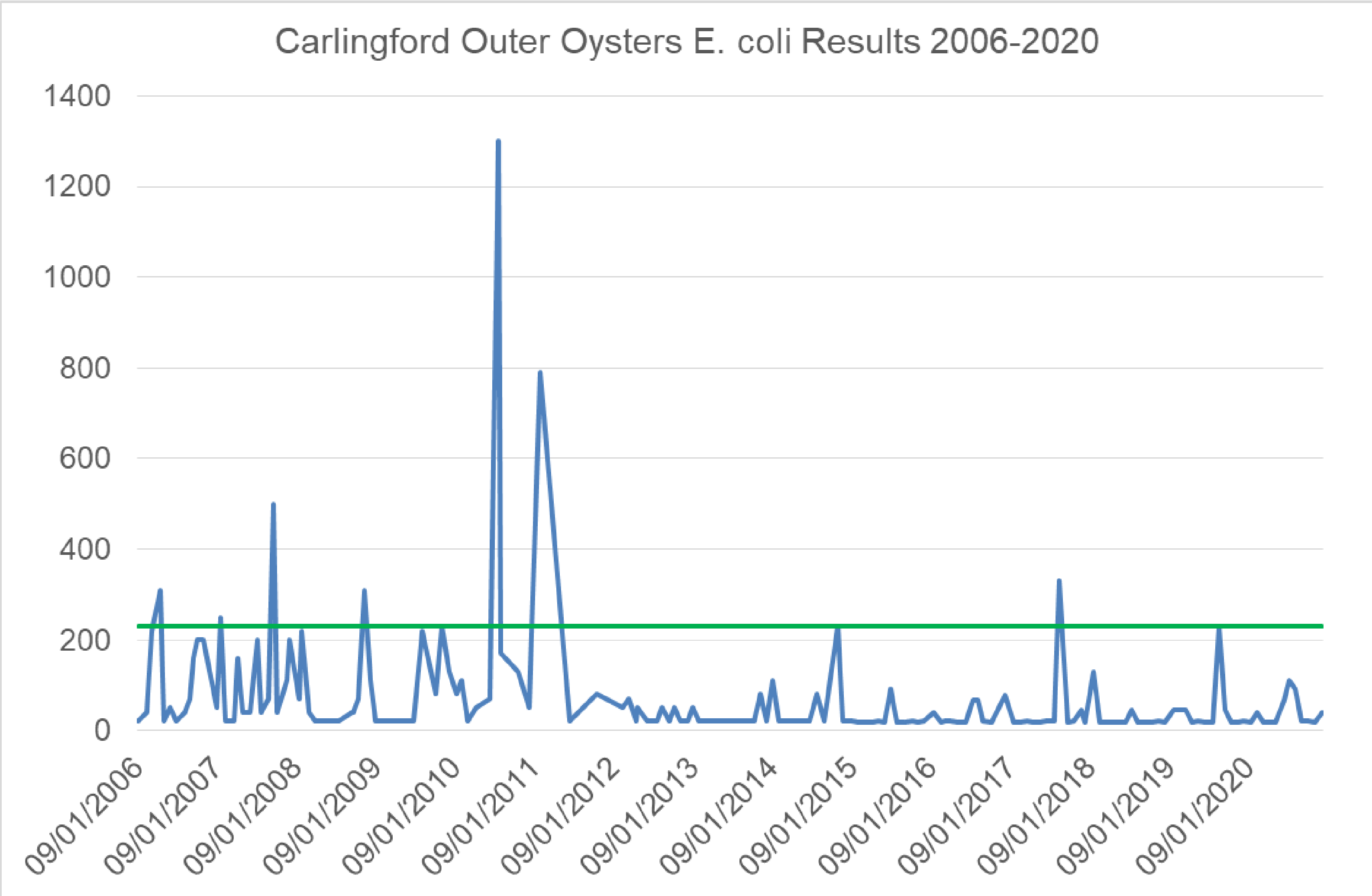


Table 5.8 shows the summary statistics for the *E. coli* historical data (2006 to 2020) from the 9 shellfish beds classified over the period.

The geometric mean of *E. coli* levels was highest for mussels at NW Narrow water (1055.2 MPN/100g), followed by mussels at C1 Rostrevor (135.9 MPN/100g) and oysters at C11 Fairgreen (76.7 MPN/100g). The lowest geometric mean was for oysters at Ballagan (28.8 MPN/100g).

Table 5.19: Summary statistics of historical *E. coli* data monitored from shellfish beds in Carlingford Lough.

Site	Species	Date 1st Sample	Date last Sample	Min *E. coli* (MPN/100g)	Max *E. coli* (MPN/100g)	Median *E. coli* (MPN/100g)	Geometric Mean *E. coli* (MPN/100g)
C7 Ballyedmond	Oysters	31-Jan-06	30-Nov-20	18	1300	40	54.8
C11 Fairgreen	Oysters	31-Jan-06	30-Nov-20	18	9100	70	76.7
NW Narrow Water	mussels	10-Jan-06	30-Nov-20	18	540000	1300	1055.2
C1 Rostrevor	mussels	10-Jan-06	30-Nov-20	18	13000	130	135.9
Ballagan R5	Razors	10-Jan-06	05-Aug-16	18	2400	20	37.1
Ballagan	Oysters	10-Jan-06	29-Dec-20	18	5400	20	28.8
Carlingford Inner M3	Mussels	11-Jan-11	14-Dec-20	18	1700	45	56.7
Carlingford Outer M5	Mussels	11-Jan-11	18-Mar-20	18	2400	20	43.4
Carlingford O5	Oysters	09-Jan-06	14-Dec-20	18	1300	20	37.9

Table 5.9 shows the variations of the annual geometric means of *E. coli* for the shellfish beds monitored in Carlingford Lough. Figure 5.11 and Figure 5.12 shows the trend in geometric mean from 2006 to 2020 for all 9 shellfish beds. The geometric mean for oysters at C7 Ballyedmond ranged from 28.0 – 100.5 MPN/100g. The geometric mean for oysters at C11 Fairgreen ranged from 31.7 – 144.9 MPN/100g. The geometric mean for mussels at NW Narrow Water ranged from 392.6 – 2596.9 MPN/100g. The geometric mean for mussels at C1 Rostrevor ranged from 65.6 – 270.3 MPN/100g. The geometric mean for razors at Ballagan ranged from 24.7 – 52.9 MPN/100g and for oysters at the same location from 18.7 – 47.8 MPN/100g. The geometric mean for mussels at Carlingford Inner ranged from 21.8 – 135.5 MPN/100g. The geometric mean for mussels at Carlingford outer ranged from 29.0 – 71.4 MPN/100g. The geometric mean for oysters at Carlingford ranged from 21.4– 108.1 MPN/100g.

Table 5.20: Variation of annual geometric means of *E. coli* from shellfish beds monitored in Carlingford Lough.

Site	Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
C7 Ballyedmond	Oysters	59.7	58.3	70.0	39.8	42.0	62.4	30.0	36.5	28.0	82.3	100.5	56.2	54.8	85.8	69.5
C11 Fairgreen	Oysters	66.6	41.9	110.9	106.3	47.2	67.3	70.3	31.7	144.9	100.2	119.4	78.8	39.9	110.6	110.1
NW Narrow Water	mussels	1094.9	549.9	639.9	1144.7	392.6	846.4	948.5	530.4	1059.9	1043.8	2014.1	2567.3	1487.5	2596.9	952.2
C1 Rostrevor	mussels	153.6	126.5	185.5	157.7	99.1	78.1	65.6	66.2	126.4	240.1	270.3	102.3	223.9	127.8	242.9
Ballagan R5	Razors	47.3		49.3	31.6	46.3	44.0	52.9	25.1	36.0	24.7	-	-	-	-	-
Ballagan	Oysters	30.6	41.3	27.9	32.3	31.0		20.0		47.8	20.8	23.1	25.4	18.7	23.6	45.4
Carlingford Inner M3	Mussels	-	-	-	-	-	134.3	117.8	68.1	135.5	29.6	58.5	21.8	22.1	31.9	43.2
Carlingford Outer M5	Mussels	-	-	-	-	-	71.4	69.4	36.8	71.1	49.0	29.0	31.4	29.7	42.4	51.3
Carlingford O5	Oysters	72.0	78.1	48.2	45.0	98.7	108.1	31.3	25.8	33.1	21.4	30.1	25.6	23.1	30.7	31.2

Figure 5.80: Trend in geometric mean of *E. coli* levels from 2006 to June 2020 for all 9 monitoring points.

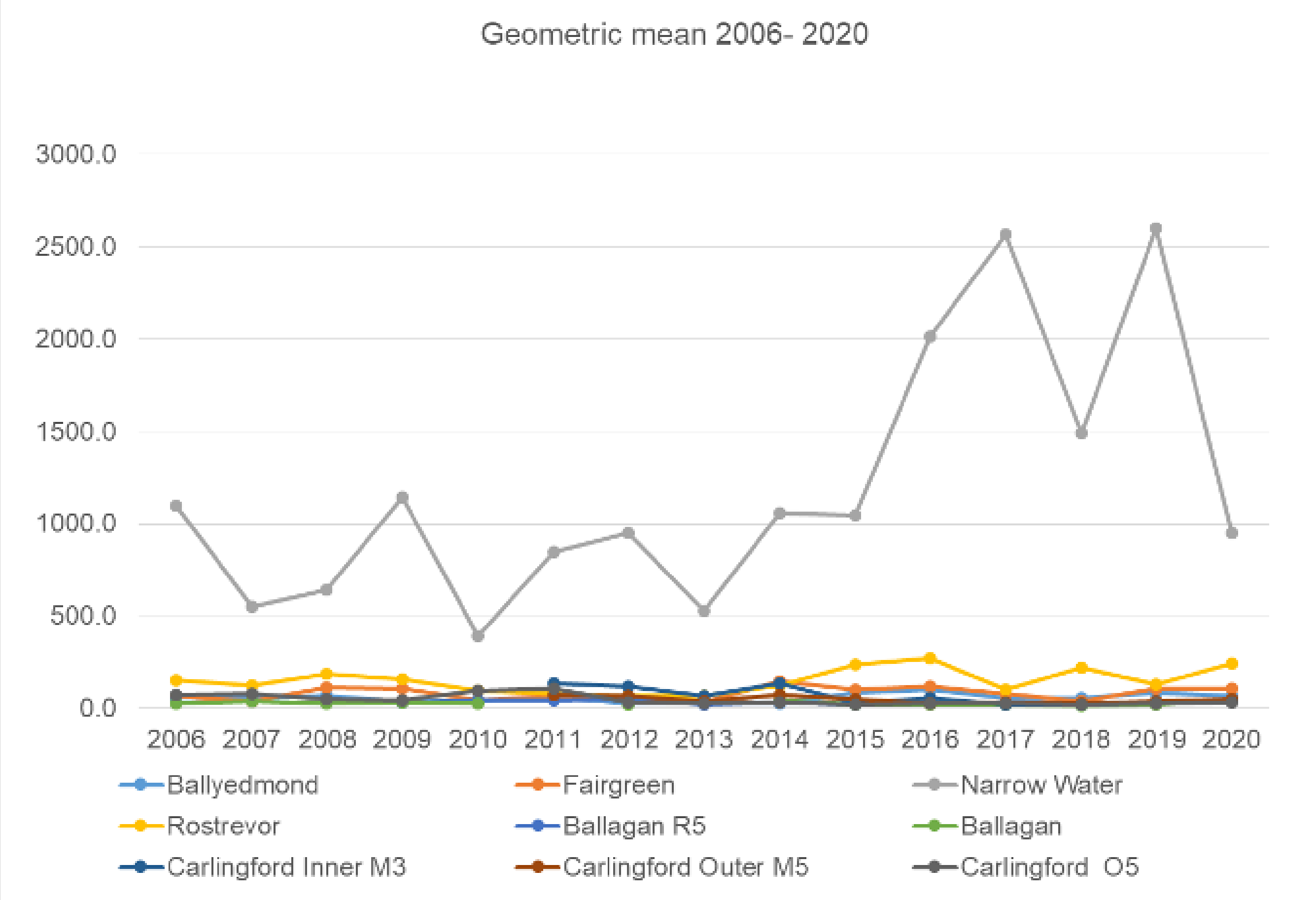
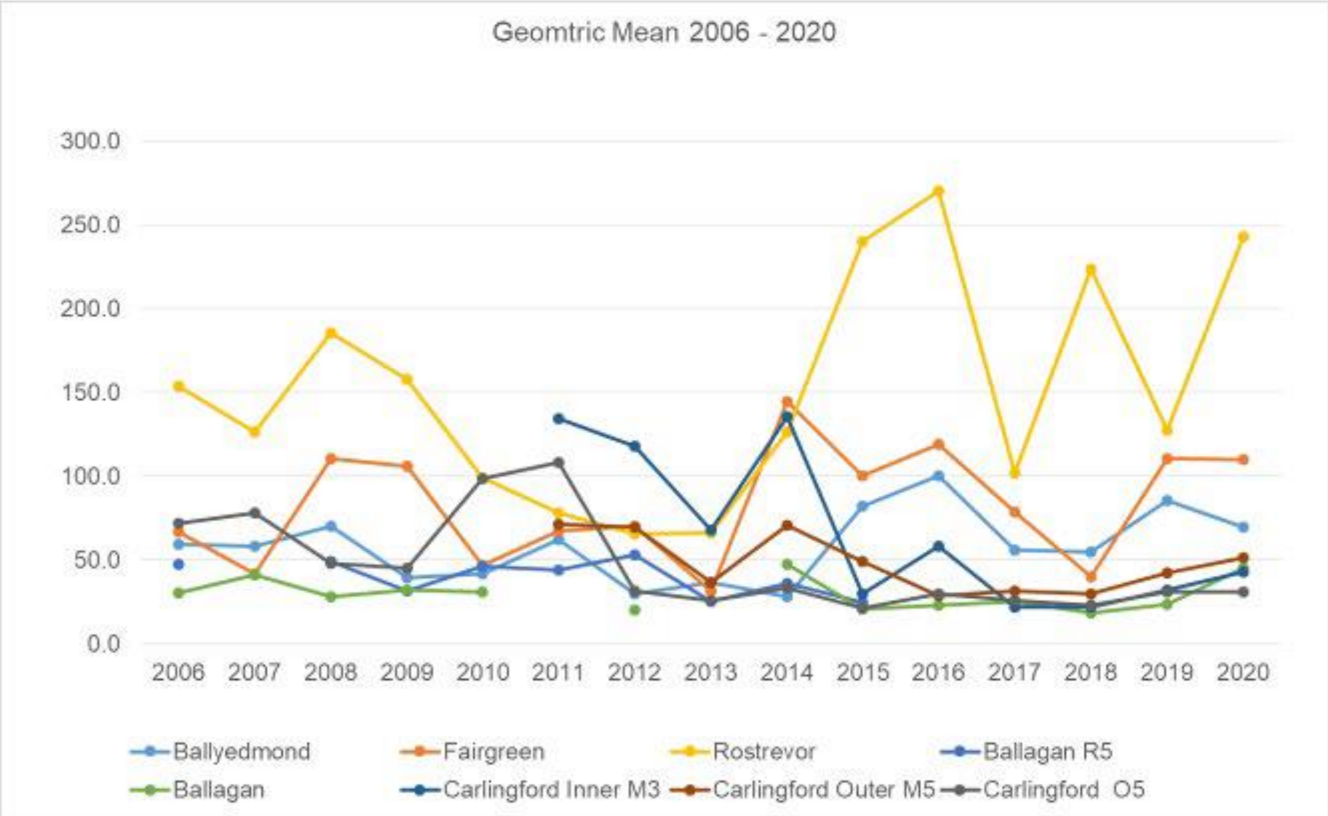


Figure 5.81: Trend in geometric mean of *E. coli* levels from 2006 to 2020 for all beds excluding NW Narrow Water mussels.



In order to identify any significant differences in *E. coli* levels based on location, a one-way analysis of variance (ANOVA) was performed on all *E. coli* results from shellfish flesh from the various harvesting beds. The sites monitored by FSA in NI and SFPA were analysed separately. The sites were further subdivided based on species. Only one site is monitored for razor clams and so stats could not be carried out on location. The FSA in NI monitor two sites for oyster (C7 Ballyedmond and C11 Fairgreen) and two for mussels (NW Narrow Water and C1 Rostrevor). Oysters from the C11 Fairgreen monitoring site had significantly higher *E. coli* levels than at the C7 Ballyedmond site. While *E. coli* levels in mussels at the NW Narrow Water site were significantly higher than at the C1 Rostrevor site. The SFPA monitor two sites for oyster (Ballagan and Carlingford) and two for mussels (Carlingford inner and outer). *E. coli* results for oysters were found to be significantly higher at Carlingford monitoring site than at the Ballagan site. No statistically significant difference was found between the Carlingford Inner and Outer monitoring sites for mussels.

A one-way ANOVA was also carried out to look for differences between years for each harvesting bed and species. Both the monitoring points at Carlingford Inner (mussels) and

Carlingford (Oysters) were found to have a significant difference between years all other sites had no significant difference. Figure 5.13 show the boxplots for each year of results at Carlingford Inner monitoring point for mussels. The *E. coli* levels at this site have decreased in recent years with 2015 and 2017 to 2020 recording lower results over the year than previous years. Figure 5.14 show the boxplots for each year of results at Carlingford monitoring point for oysters. It can be clearly seen that the results from 2012 onwards are lower than the preceding years. This monitoring point was moved approximately 80m southwest after the 2011 sanitary survey. This appears to have moved the monitoring point to an area of better water quality.

A one-way ANOVA was also carried out on the seasonal *E. coli* counts for each harvesting location and species. This analysis found that there was no significant difference between seasons for C7 Ballyedmond oysters, Inner Carlingford mussels, Outer Carlingford mussels or oyster and Ballagan razor clams or oysters. A significant difference was found between seasons for C11 Fairgreen oysters, NW Narrow Water mussels and C1 Rostrevor mussels. Refer to Section 4.1.2 ‘Tourism’ for further details on the seasonal data.

Figure 5.82: Boxplot for Carlingford Inner mussel monitoring site.

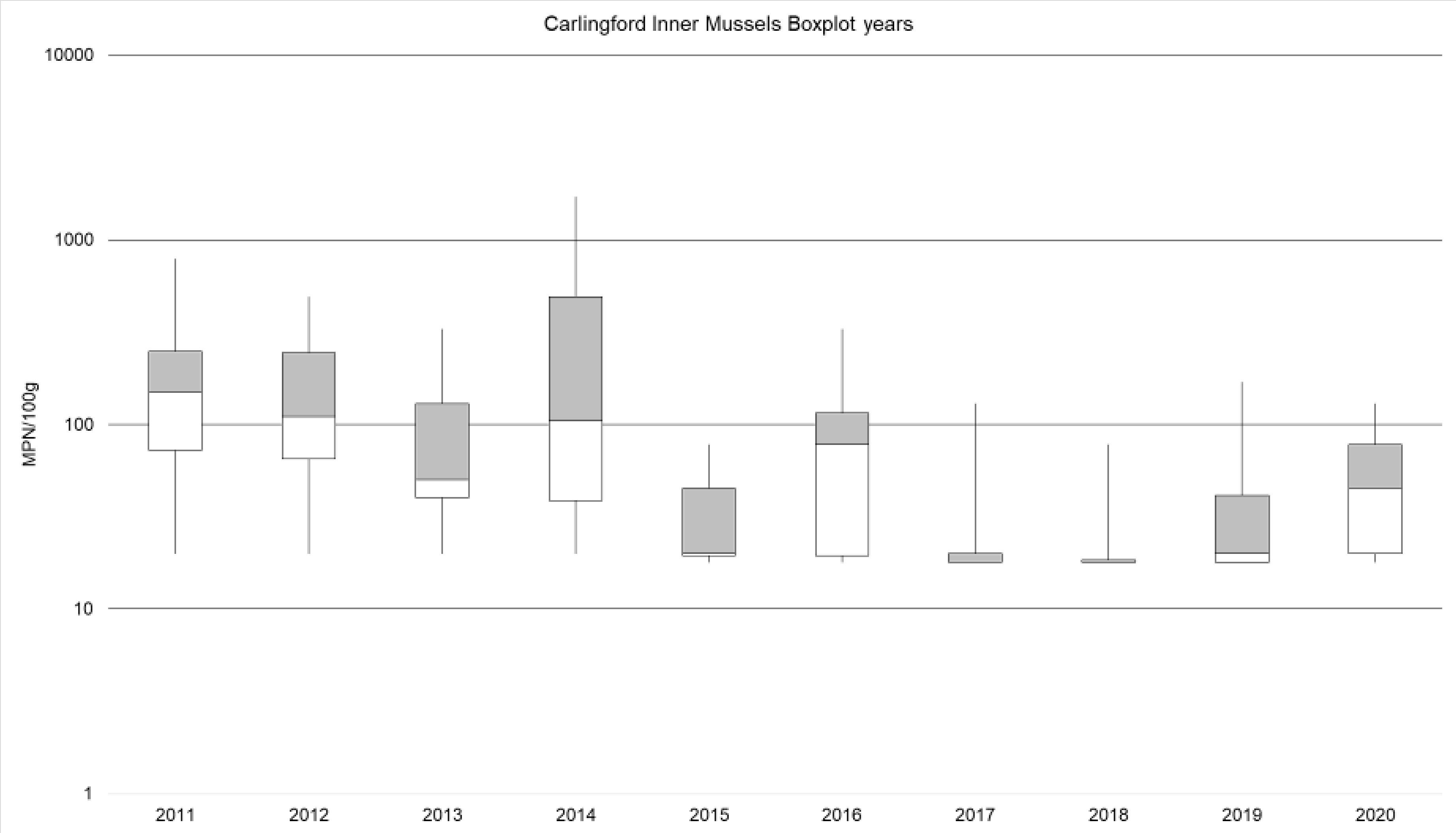
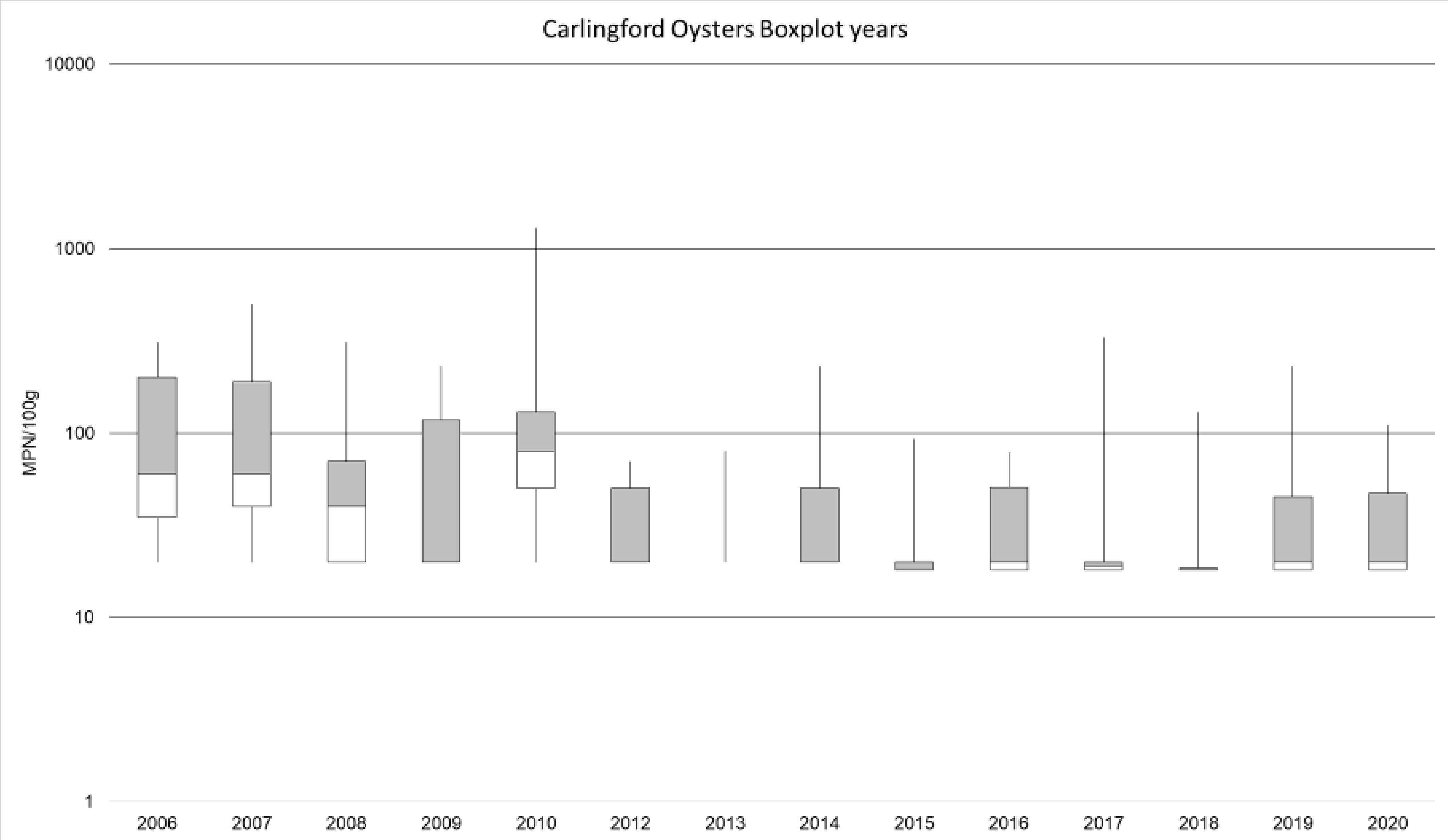


Figure 5.83: Boxplot for Carlingford oysters monitoring site.



5.2 Current data

5.2.1 Sampling sites and methodology

Eleven shellfish sampling points and 23 water sampling points were sampled within Carlingford Lough on the 7th March 2022. Due to bad weather one of the shellfish samples could not be taken (M5) and no mussels could be collected at M3. All water samples were collected, however, due to the bad weather the outer part of the bay could not be safely accessed by boat. The stations in the outer part of the Lough were instead taken from the closest shoreline location. The weather on the day of sampling was dry and windy (19kt southwesterly) with 100% cloud cover.

The predicted low water level on the 7th March was at 08:38am at Warrenpoint (0.55m) and at 08:00am at Carlingford (1.01m).

The 11 shellfish sampling points were made up of four mussel sites and seven Pacific oyster sites. Eight of these sites were from the existing monitoring points and three were chosen for the purpose of relocating the monitoring point in production areas 4 and 6. Unfortunately a sample could not be retrieved from M3 and the M5 monitoring point was inaccessible due to rough weather.

Of the 23 water samples collected, 6 were taken from river/stream outflows, 5 were taken from discharge pipes/runoff and the remainder were taken from throughout the Lough.

All water samples were collected on the same day (7/03/2022). Figure 5.15 shows the shellfish sampling sites and Figure 5.16 shows the water sampling sites. The coordinates of these stations can be seen in Table 5.5 and Table 5.6.

Figure 5.84: Location of shellfish sampling stations.

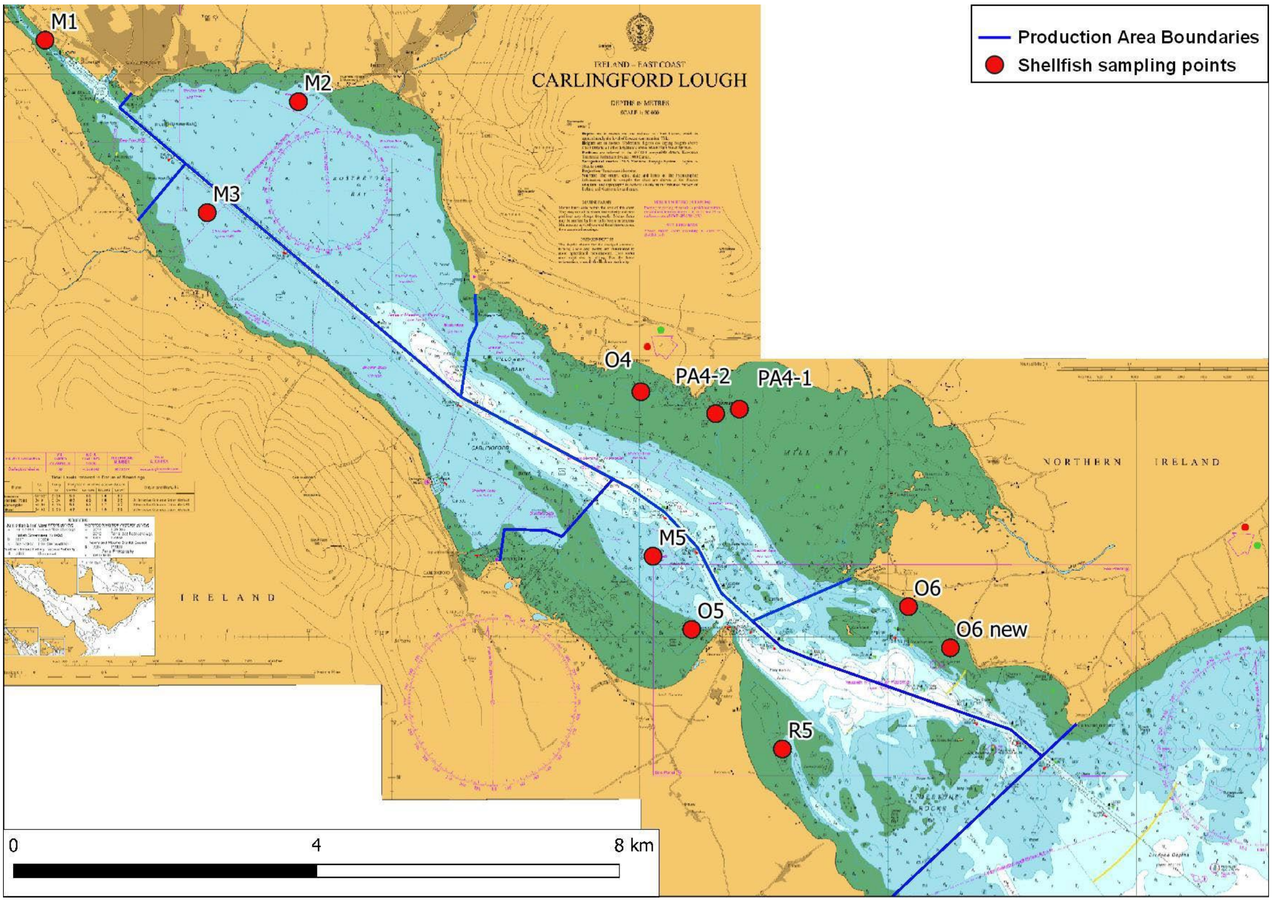


Figure 5.85: Location of water sampling stations.

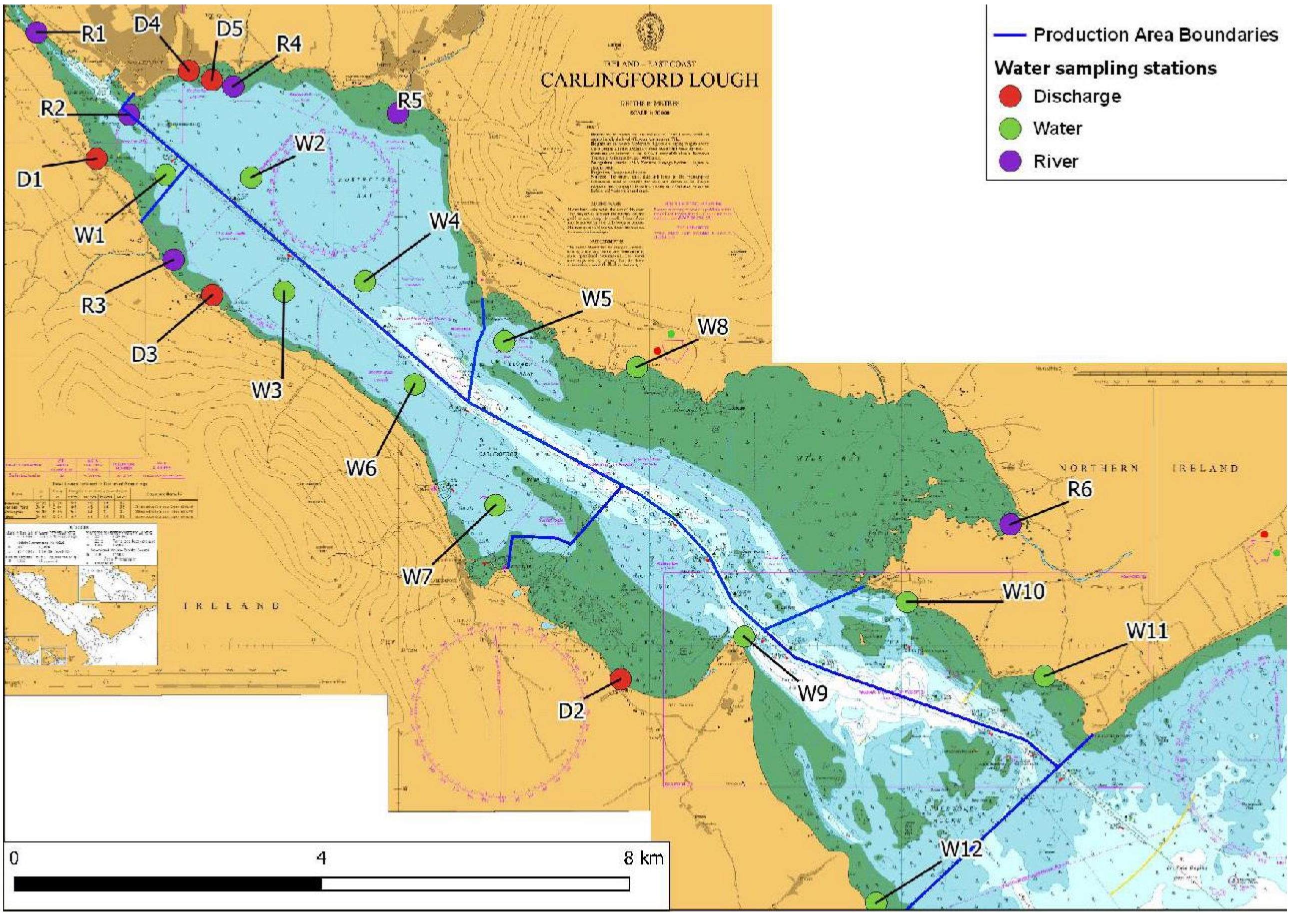


Table 5.21: Shellfish sampling coordinates.

Station	Latitude	Longitude	Easting	Northing
M1	54.1040	-6.2697	313227.7	318589.6
M2	54.0967	-6.2187	316587.6	317861.7
M3	54.0836	-6.2371	315421.7	316367.7
M5	54.0428	-6.1473	321416.6	311985.2
O4	54.0623	-6.1497	321200.2	314151.7
O5	54.0341	-6.1395	321952.3	311031.8
O6	54.0368	-6.0958	324804.8	311408.5
O6 new	54.0320	-6.0874	325373.2	310879.5
PA4-1	54.0603	-6.1299	322504.8	313956.7
PA4-2	54.0597	-6.1346	322193.4	313888.0
R5	54.0200	-6.1212	323191.9	309485.2

Table 5.22: Water sampling coordinates.

Station	Latitude	Longitude	Easting	Northing
D1	54.0901	-6.2597	313920.2	317059.0
D2	54.0294	-6.1557	320900.1	310476.1
D3	54.0742	-6.2368	315467.9	315326.7
D4	54.1003	-6.2414	315091.2	318227.9
D5	54.0993	-6.2368	315393.5	318114.6
R1	54.1048	-6.2716	313104.3	318676.0
R2	54.0952	-6.2533	314327.6	317637.0
R3	54.0783	-6.2445	314949.9	315770.4
R4	54.0985	-6.2326	315672.5	318038.0
R5	54.0954	-6.2000	317816.4	317746.8
R6	54.0475	-6.0784	325915.2	312620.2
W1	54.0882	-6.2460	314823.1	316869.8
W2	54.0879	-6.2291	315933.0	316864.0
W3	54.0746	-6.2225	316397.5	315394.5
W4	54.0758	-6.2065	317444.6	315554.6
W5	54.0688	-6.1788	319276.9	314821.9
W6	54.0638	-6.1966	318124.6	314235.5
W7	54.0497	-6.1806	319216.4	312693.2
W8	54.0658	-6.1525	321006.5	314533.8
W9	54.0344	-6.1312	322493.4	311069.2
W10	54.0384	-6.0989	324596.7	311578.5
W11	54.0297	-6.0716	326412.0	310660.9
W12	54.0033	-6.1050	324301.1	307657.0

All mussel samples were collected using a 0.025m2 grab sampler. All Pacific oyster samples were hand-picked. Only individuals within the normal commercial size range were selected. All shellfish samples were stored in food grade plastic bags and stored in a cool box (containing freezer packs). All water samples were collected in sterile plastic water bottles. All samples were delivered to AQUALAB within 24hrs of collection. AQUALAB is an INAB (Irish National Accreditation Board) certified laboratory.

5.2.2 Microbial Analysis results

Table 5.7 shows the results of the shellfish *E. coli* analysis (Refer to Appendix 2 for result certificates). Figure 5.17 shows this data in graphical form for 2010 and Figure 5.18 shows the 2022 results. Similar to 2010 all sites, Pacific oyster and mussels had an *E. coli* level of <230 *E. coli* per 100g flesh with the exception of the mussel sites M1 (Narrow Water – 330MPN/100g which was the same as 2010). The recent results for M2 were significantly lower than in 2010.

The RMP in production area 4 is only accessible at spring low tides. Which can mean that during the winter a suitable tide does not occur during daylight hours for some months. A serious health and safety risk is caused by the presence of deeper channels in this area which could lead to samplers becoming stranded. As such two extra locations were sampled to aid in the relocation of the RMP. The three locations sampled had similar *E. coli* levels with one having slightly higher (PA4-2). Therefore PA4-2 is the most suitable RMP from a bacteriological standpoint.

An access issue was also identified in production area 6. Access to the licensed area is located at the eastern end of the beach. The RMP is located at the western end. Due to the presence of soft sand on the beach samplers need to make a 2km round trip on foot to collect the samples. A shellfish sample was taken at either end of the licensed area. There was very little difference in the result from either sample and both results were significantly below the A classification limit. As such it is considered suitable to relocate the RMP to the eastern end of the licensed area.

Table 5.23: Shellfish E. coli results for Carlingford Lough.

Station	Species	2010: MPN/100g	2022: MPN/100g
M1	Blue Mussel	330	330
M2	Blue Mussel	1300	230
M3	Blue Mussel	50	N/A
M5	Blue Mussel		N/A
O4	Pacific Oyster	<20	45
PA4-1	Pacific Oyster		40
PA4-2	Pacific Oyster		68
O5	Pacific Oyster	<20	<18
O6	Pacific Oyster		45
O6 new	Pacific Oyster		40
R5	Pacific Oyster	<20	<18

Figure 5.86: Shellfish *E. coli* results from Carlingford Lough (sampled on 19th October 2010).

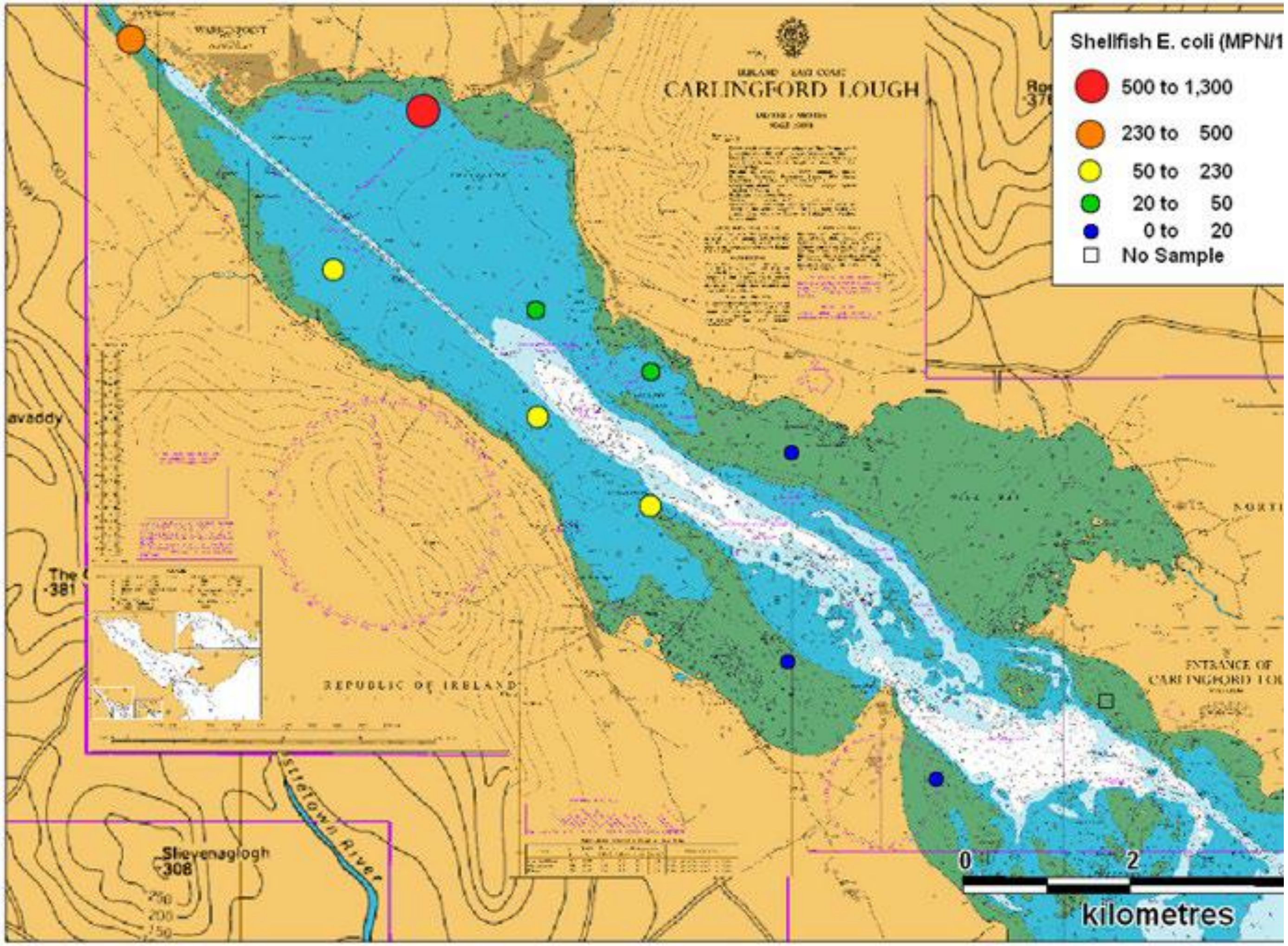


Figure 5.87: Shellfish *E. coli* results from Carlingford Lough (sampled on 7th March 2022).

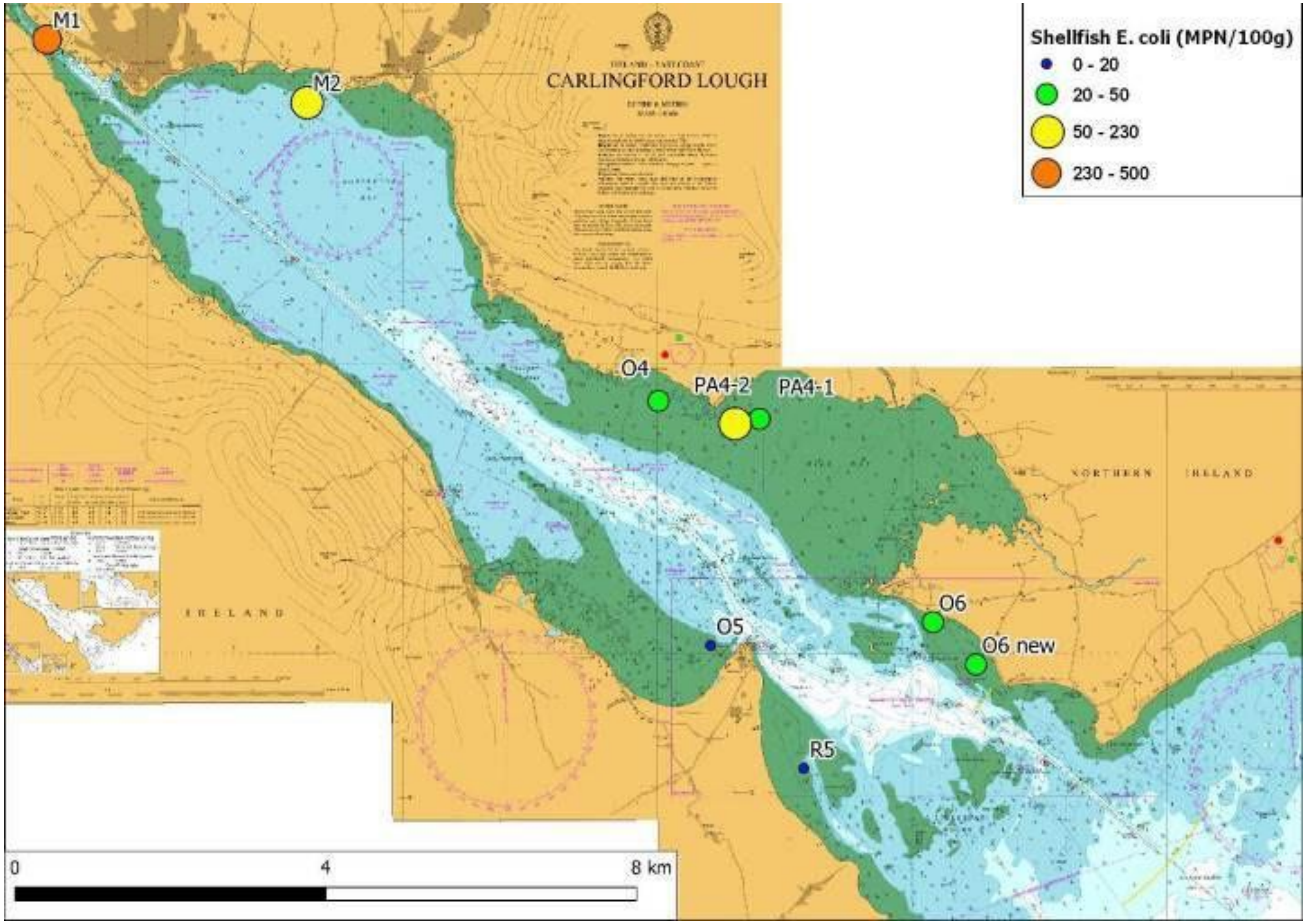


Table 5.8 shows the water sample analysis results (Refer to Appendix 2 for result certificates). Figure 5.19 shows this data in graphical form for 2010 and Figure 5.20 shows the 2022 results. The water quality patterns in the Lough have not changed with the highest *E. coli* levels recorded in the inner part of the lough near Warrenpoint and Omeath. In general, *E. coli* levels were lower for the current survey. However, there had been no significant rainfall in the week prior to the survey. The reduction is likely to be due to this rather than a significant change in the water quality in the lough.

Station D1 recorded a higher *E. coli* result than in 2010, this may be related to the increase in population in Omeath. Stations R6 and W12 also recorded higher results than 2010, however, the original sampling locations could not be sampled due to a combination of weather and tide. Station R6 was sampled in the River White Water before it enters the bay. As such there is no dilution of the river at this point and so is likely to have higher *E. coli* levels. W12 was taken from the shore and is more susceptible to contamination than the original location in open water. The land adjoining this location is farmland, horses and goats were observed grassing close to the shore.

Table 5.24: Water *E. coli* results for Carlingford Lough.

Station	2011: *E. coli* MPN/100ml	2022: *E. coli* cfu/100ml
W1	32	5
W2	6	25
W3	4	5
W4	2	<1
W5	0	<1
W6	0	<1
W7	0	<1
W8	10	15
W9	0	10
W10	0	5
W11	2	<1
W12	0	130
R1	72	55
R2	56	20
R3	18	54
R4	8	325
R5	6	29
R6	0	380
D1	2200	4000
D2	0	<1
D3	120	185
D4	5,300	175
D5	4	330

Figure 5.88: Water *E. coli* results from across Carlingford Lough 2010.

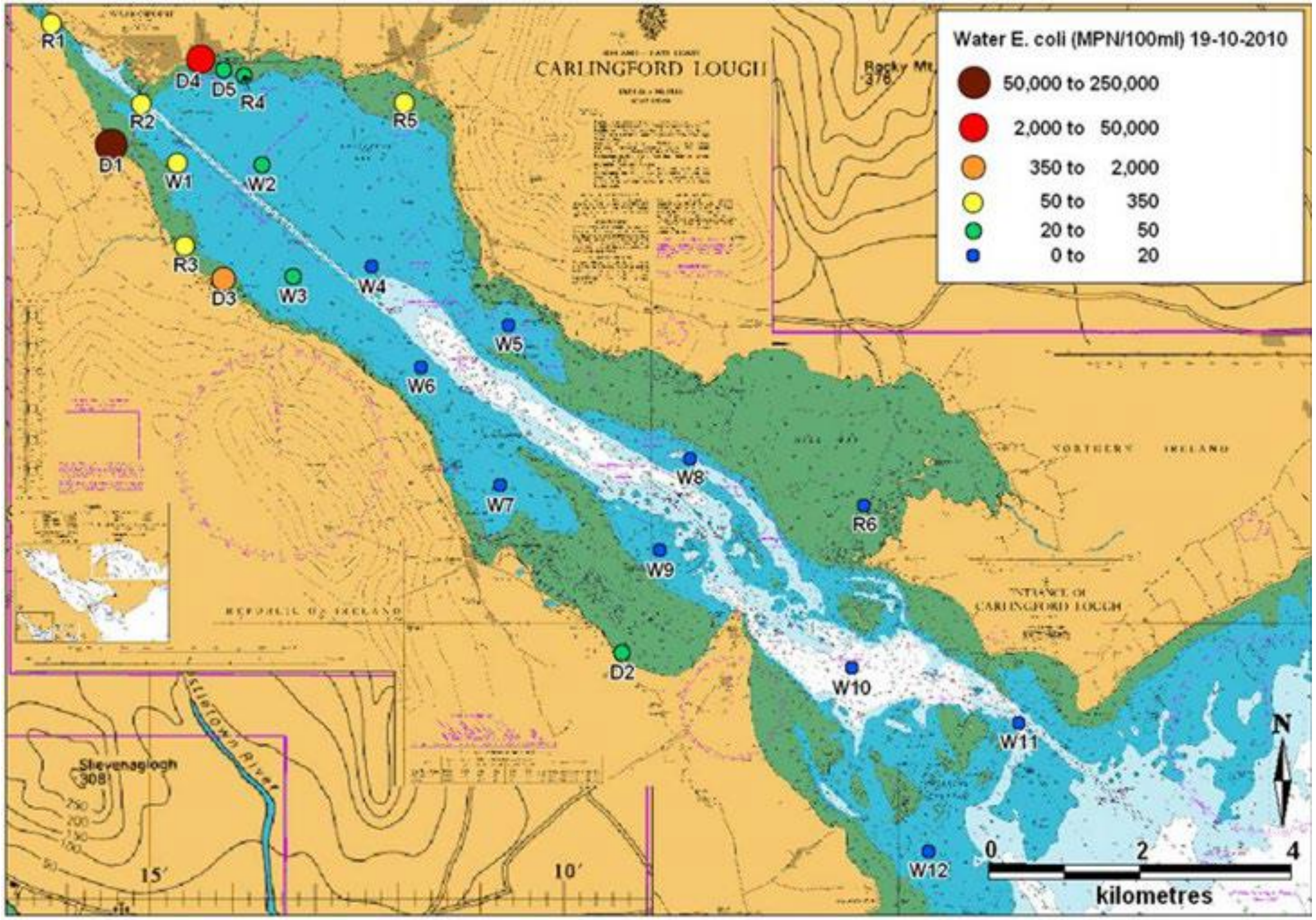
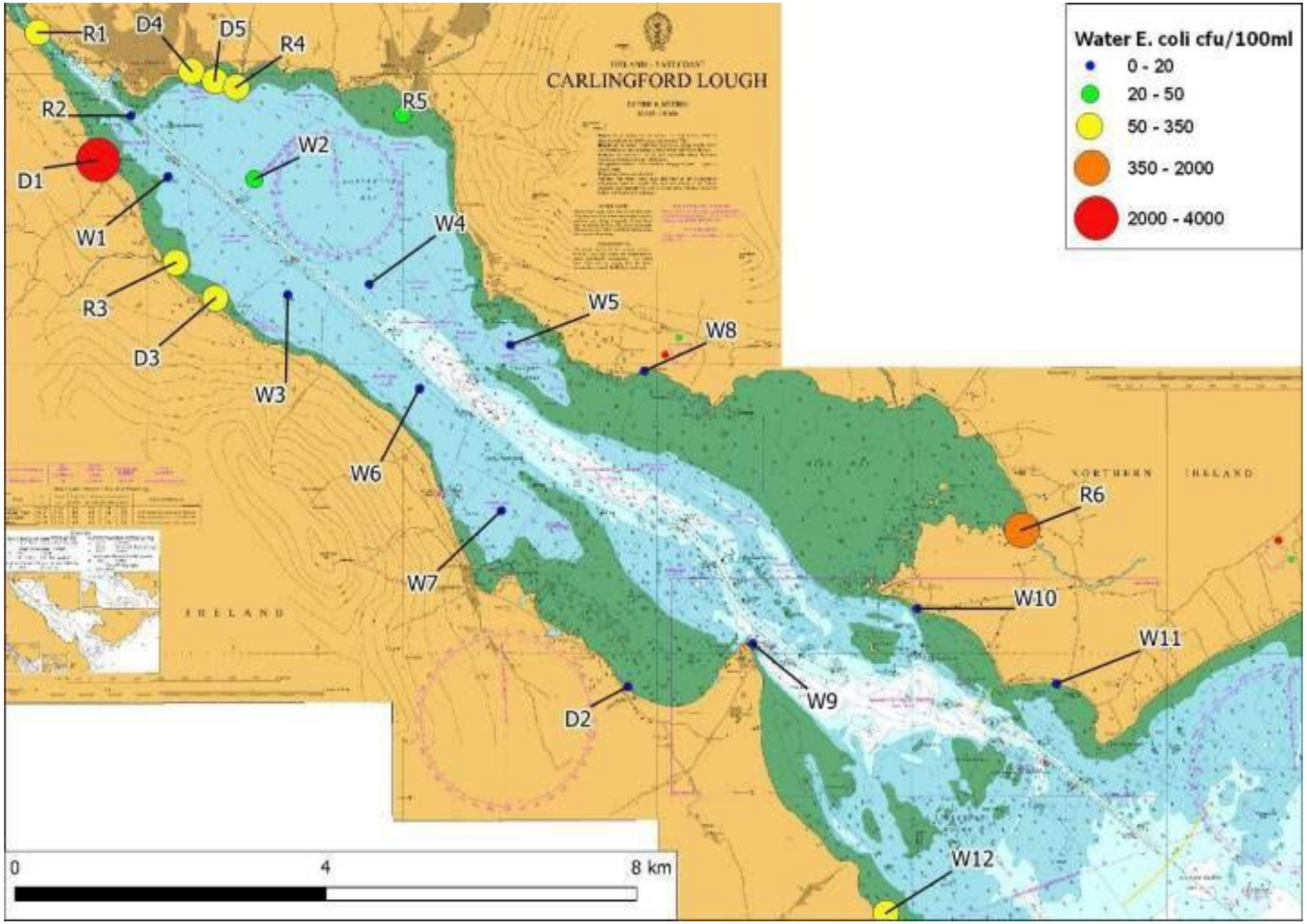


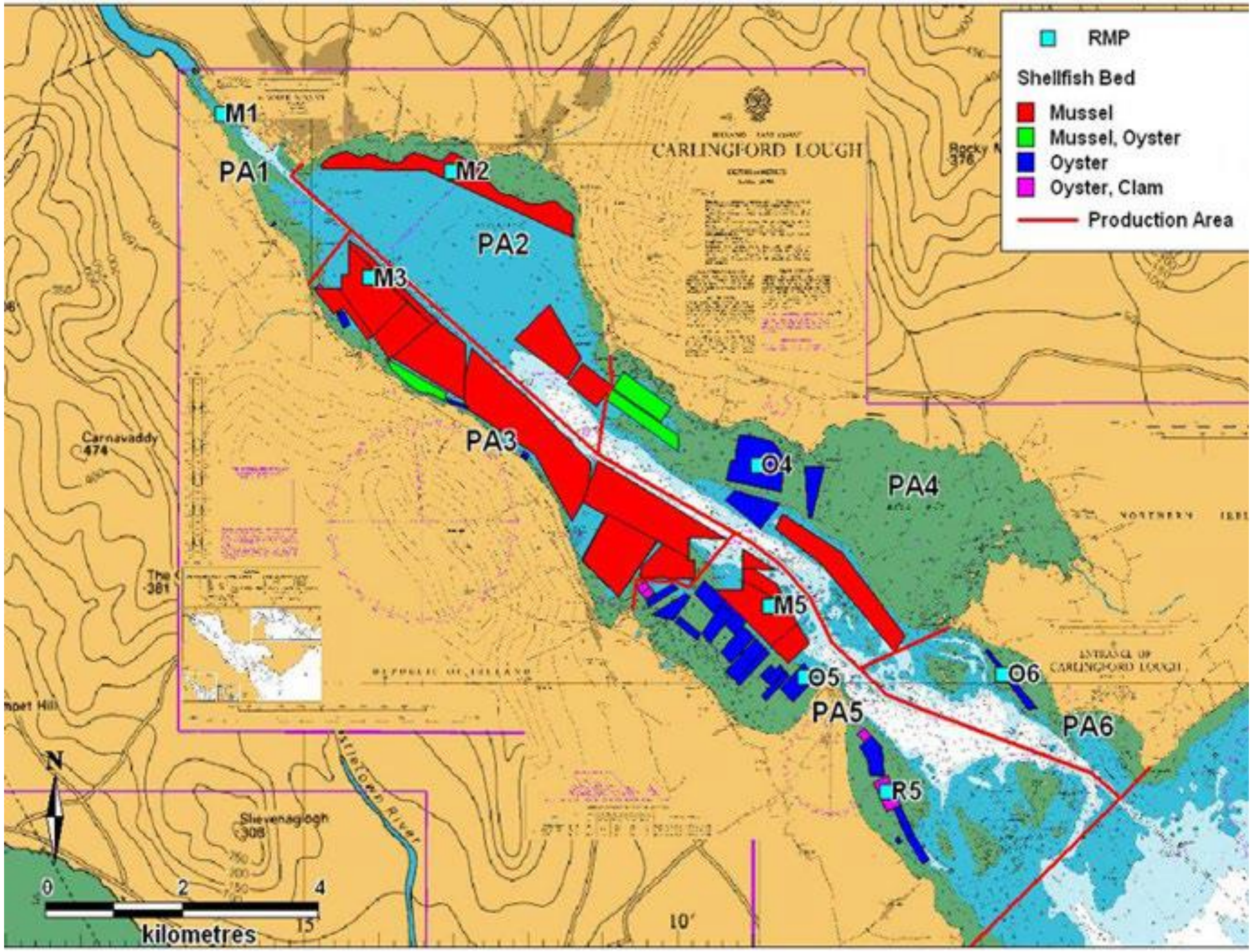
Figure 5.89: Water *E. coli* results from across Carlingford Lough 2022



6. Production Areas for Monitoring

The 2011 sanitary survey proposed production areas based on hydrographical and spatial features *i.e.*, areas of similar depth, tidal currents, residence times, suspended sediment levels and freshwater influence as well as the results from the shellfish and water sampling. These six production areas and RMPs can be seen in Figure 6.1.

Figure 6.90: Production Areas and RMPs from 2011 sanitary survey.



7. Discussion/Conclusion

The monthly and seasonal wind patterns for the Carlingford Lough catchment area have remained constant over time. Winter experienced the strongest wind speeds, while summer experienced the weakest winds. The rainfall patterns for the catchment area have also remained the same with February to May being the driest period and, rainfall increasing through summer to the wettest period between August and January.

The total population of the SOA which overlap Carlingford Lough Catchment is 100,472 people up 12.8% from the 2011 sanitary survey. However, much of the SOAs only partially overlap the catchment. Therefore, an effort was made to estimate the population within the catchment based on the percentage of the SOAs within it. Based on this, the total population within the Carlingford Lough catchment is estimated at approximately 69,000 people which is an increase of 13.6% on the 2011 sanitary survey. Newry (26,893 0.3%) and Warrenpoint (8,721 +14.7%) are the largest population centres, located at the western end of the lough. Rostrevor (2,788 +9.1%) and Rathfriland (2,472, -4%) are the next largest centres. The two remaining settlements are Omeath (603, +37.4%) and Carlingford (1,445, +132%) located in the Republic of Ireland.

Tourism in Northern Ireland since the 2011 sanitary survey has increased significantly by 46.5%. Carlingford Lough Catchment overlaps four Local Government Districts for tourism numbers Newry /Mourne /Down and Armagh City, Banbridge Craigavon. The Northern Ireland LGD boundaries were changed since the 2011 sanitary survey and so tourism statistics cannot be directly compared. These two LGDs received 638,504 tourists in 2018. As the tourism numbers in Northern Ireland have increased by 46.5% it is likely that the tourism numbers in the Carlingford Lough area have also increased. The catchment also partially overlaps County Louth. County Louth received 172,000 overseas tourists in 2017, an increase of 93.3% from 2011. There is however no way of estimating the number of tourists who visited the Carlingford Catchment area during their stay.

Statistical analysis was carried out on *E. coli* data for the active shellfish beds to ascertain if there are any seasonal patterns. This analysis found that there was no significant difference between seasons for C7 Ballyedmond oysters, Inner Carlingford mussels, Outer Carlingford mussels or oyster and Ballagan razor clams or oysters. A significant difference was found between seasons for C11 Fairgreen oysters, NW Narrow Water mussels and C1 Rostrevor mussels.

C11 Fairgreen oysters had significantly higher *E.coli* results in summer and autumn when compared to winter. The *E. coli* levels for autumn were also higher than spring results. High results can occur in late summer and autumn due to increase rainfall after the drier spring period. High levels of faecal contamination from livestock can build up on farmland over spring and enter the bay in run-off when rain levels increase in summer and particularly autumn. The spreading of slurry will also add to this. At the C11 Fairgreen monitoring site *E. coli* levels drop significantly in winter. This is likely due to a number of factors. High rainfall during this period will dilute the faecal content in land run-off and some livestock will be over wintered indoors. The location of this monitoring point at the mouth of the lough will mean that it will experience higher dilution and dispersion due to wind and wave action.

NW Narrow Water mussels had significantly higher results in winter than in summer and autumn. The results for spring and autumn where also significantly higher than summer results. Similar to the other station in the bay *E. coli* levels increase in autumn due to increased rainfall. However, unlike C11 Fairgreen monitoring point the *E. coli* levels continue to increase into winter. This is due to the sheltered nature of this area and its location in the inner extent of the lough. There is reduced dispersion and dilution due to wave action and the residence time is significantly higher than further out in the lough. Another significant factor is the lower salinity which will allow *E. coli* to survive for longer. As such *E. coli* levels remained high into spring.

C1 Rostrevor mussels had significantly higher *E. coli* results for winter than spring and summer. Autumn also had significantly higher results than summer. Similarly to the NW Narrow water site *E. coli* levels increased in autumn through to winter.

However, *E. coli* level began to drop in spring. This is likely due to C1 Rostrevor being less sheltered, having a slightly shorter residence time and a higher salinity than Narrow Water.

The trend at all of these sites appears to be linked to rainfall levels and run-off from land. As such tourism does not appear to have a significant effect on the shellfish quality in the bay.

There are 24 Waste Water Treatment Works (WWTWs) in the Carlingford Lough catchment, serving a population of approximately 93,185 p.e. Since the 2011 sanitary survey 3 septic tanks have been upgrade and are now listed as WWTW. All three treatment facilities were upgraded to rotational biological contactors. The major works are those at Newry, Warrenpoint, Cranfield, Rathfriland and Carlingford, these five works together account for 96.7% of the total population equivalent of the catchment. Of the 24 WWTWs 15 are below capacity, 6 are over capacity and 1 had no design p.e. information available. The six plants that are over capacity account for 8.9% of the load on the WWTW in the catchment. Importantly Newry WWTW which accounts for 68.2% of the load on the WWTW in the catchment is operating at just over half its capacity.

The 2011 survey only listed industrial discharges along the shoreline. All industrial discharges within the catchment have now been identified. In total 39 discharges have been identified with most relating to site drainage.

Agriculture remains dominant, with Land use associated with agricultural activities (non-irrigated arable land, pastures, complex cultivation patterns and agriculture/natural vegetation) accounting for 78.9% of the Land use in the catchment and increase of 8.2% since 2011. Due to a change in the reporting boundaries for the agri-census between 2009 and 2018 farming densities could not be compared directly. As some of the wards (2018) or SOAs (2009) only partially overlap the catchment an attempt was made to account for this. The percentage of each division within the catchment was estimated in GIS. This percentage was then applied to the agri data to estimate the proportion within the catchment. Based on this, the area used for crops has increased by 0.08% (+2ha) and sheep numbers have increased by 2.3% (2,075). Cattle numbers have increased by 1,365 (2.3 %), pigs by 3,114 (24.7%) and poultry by 317,000 (91.8%). Although these appear to be relatively high increases the area of farmland within the catchment needs to be considered, which has also increased by 2,501ha (8%). When spread across all farmland within the catchment cattle have decreased by 0.1 per ha, sheep have decreased by 0.15 per ha, pigs have increased 0.06 per ha and poultry have increased 8.6 per ha. Jones and White (1984) estimated the potential daily load for different livestock. Based on this the change in stocking densities of the different species will lead to an estimated reduction in daily *E. coli* load by 0.59×10^{9} per ha.

There are two commercial ports in Carlingford Lough Warrenpoint and Greenore. Warrenpoint is the largest port and received 3,321,000 tonnes of cargo in 2019 which is an increase of 80% on 2009. There has been a further increase due to divergence from Dublin to Warrenpoint as it has become the point of entry. It is unclear if this is a temporary change or not. Cargo passing through Warrenpoint include Agricultural products (e.g. grain, soya), Coal, Crude oil, Forestry products, metal and other typical freight. No live animals on the hoof have passed through Warrenpoint since 2001. Greenore port received 1,188,000 tonnes of cargo in 2019 and increase of 204% since 2009. The types of cargo passing through Greenore port are not available for 2020. Live animals on the hoof do pass through the port although numbers or tonnage is not available. Feacal matter from live animals being shipped may enter the lough during transport and loading/unloading if management practices are not sufficient. There does not appear to be any change in boating facilities within the lough.

The available data for wetland birds show no significant change since the 2011 survey. The 5-year mean in 2009 was 10,360 and has only slightly increased to 10,584 in 2018.

FSA in NI currently sample shellfish flesh in the C7 Ballyedmond, C11 Fair Green, NW Narrow Water and C1 Rostrevor harvesting areas for classification purposes. SFPA currently sample shellfish flesh at Ballagan, Carlingford outer and Carlingford

Inner harvesting areas for classification purposes. Based on the geometric means for all available data the highest *E. coli* concentrations were recorded in the western end of the lough and to the northern extent. This follows the findings of the 2011 sanitary survey as residence times are higher further into the lough and the prevailing southwesterly winds blow bacteriological contamination to the northern extent of the lough, which is often higher in lower salinity surface waters.

Statistical analysis was carried out to assess whether or not the different RMPs for each species were significantly different to each other. The FSA in NI and SFPA monitoring sites were analysed separately. The FSA in NI monitor two sites for oyster (C7 Ballyedmond and C11 Fairgreen) and two for mussels (NW Narrow Water and C1 Rostrevor). Oysters from the C11 Fairgreen monitoring site had significantly higher *E. coli* levels than at the C7 Ballyedmond site. While E. coli levels in mussels at the NW Narrow Water site were significantly higher than at the C1 Rostrevor site. The SFPA monitor two sites for oyster (Ballagan and Carlingford) and two for mussels (Carlingford inner and outer). *E. coli* results for oysters were found to be significantly higher at Carlingford monitoring site than at the Ballagan site. No statistically significant difference was found between the Carlingford Inner and Outer monitoring sites for mussels. With the exception of the Carlingford Inner and Outer monitoring sites for mussels all monitoring sites were significantly different to each other justifying the choice of RMP locations in 2011. Although Carlingford Inner and Outer monitoring sites for mussels were not significantly different two RMPs are necessary due to the size of the area they cover.

Analysis was also carried out to identify if there were any differences between years at each monitoring site. Both the monitoring points at Carlingford Inner (mussels) and Carlingford (Oysters) were found to have a significant difference between years all other sites had no significant difference. The shellfish quality appears to have improved at the Carlingford Inner (Mussels) monitoring site since 2015. The shellfish quality at the Carlingford oyster site has improved since 2012. However, the location of the monitoring point was moved approximately 80m southwest after the 2011 sanitary survey. This appears to have moved the monitoring point to an area of better water quality. However, this has not affected the Classification awarded to this area as it was classified as A before and after 2011.

The changes since the 2011 survey that are of most importance for the faecal load of the lough are the increases to population, livestock numbers and shipping. The population has increased by 13.6%. Although this is a large increase there has been significant upgrades to a number of WWTW over the same period. The most significant of these is the upgrade to Newry WWTW which treats the waste for 40% of the catchment’s population. The facility is operating at just over half its capacity. Discharges from the Omeath (untreated) and Carlingford (over capacity) sewage schemes are of concern due to large population increases in both agglomerations. However, there has been no increase in the *E. coli* levels recorded at the monitoring sites. In fact, the *E. coli* levels have dropped in recent years. There are planned upgrades to both plants in the near future.

Agriculture is the dominant Land use is the catchment accounting for 78.9% of the land. The numbers of livestock have increased since they last survey, however, the area of land used for agriculture has also increased. Based on the daily faecal load for each type of livestock and the increase in land area the daily load per hectare due to livestock has decreased.

Although there has been an increase to shipping to both ports in the lough it is not expected to impact significantly on the faecal load of the lough. The increased shipping is mostly made up of large cargo ships which generally discharge their waste >12 nautical miles offshore.

The shoreline survey recorded 82 extra discharges along the shoreline of the lough compared to the 2010 survey. The extra discharges were mostly associated with the new greenway constructed along the southern shore and road runoff points between Warrenpoint and Rostrevor which were not noted in the last survey. Very few of the discharges and watercourses recorded during this survey showed any signs of nutrient enrichment or contamination. As such, the shoreline survey did not find sufficient evidence of change within the lough to require any alterations of the production area boundaries or monitoring points.

The bacteriological survey sampled water and shellfish samples throughout the lough for *E. coli* levels. The water quality patterns in the Lough have not changed with the highest *E. coli* levels recorded in the inner part of the lough near Warrenpoint and Omeath. In general, *E. coli* levels were lower for the current survey. However, there had been no significant rainfall in the week prior to the survey. The reduction is likely to be due to this rather than a significant change in the water quality in the catchment.

The shellfish results showed little change from the 2010 survey. The Rostrevor mussel (M2) result was significantly lower than in 2010, however, this may also be related to the dry period preceding the survey. Extra samples were taken at O4 (Ballyedmond) and O6 (Fairgreen) as the existing monitoring points were not considered suitable due to health and safety issues regarding safe access. Based on the bacteriological results new monitoring points were chosen for these production areas. See Table 7.1 for the new coordinates.

With the exception of O4, O5 and O6 RMP locations (Table 7.1) or monthly sampling frequency do not need to be adjusted. Since the 2010 sanitary survey production area 5 has been spilt into two production areas. Inside of Greenore Point remains production area 5, with the new production area 7 covering Greenore Point to Ballagan Point (See Figure 8.1 below). No futher alterations to the production area boundaries are required. It was decided to relocate the Carlingford oysters RMP (O5) as the existing monitoring point was not considered suitable due to health and safety issues regarding safe access. The new location was chosen as it is accessible on most low tides and sufficient stock is available for monitoring. The new RMP location will now be more likely to catch contamination from the Carlingford WWTP discharge to the west as well as the Greenore discharge.

Table 7.25: Carlingford Lough RMPS coordinates.

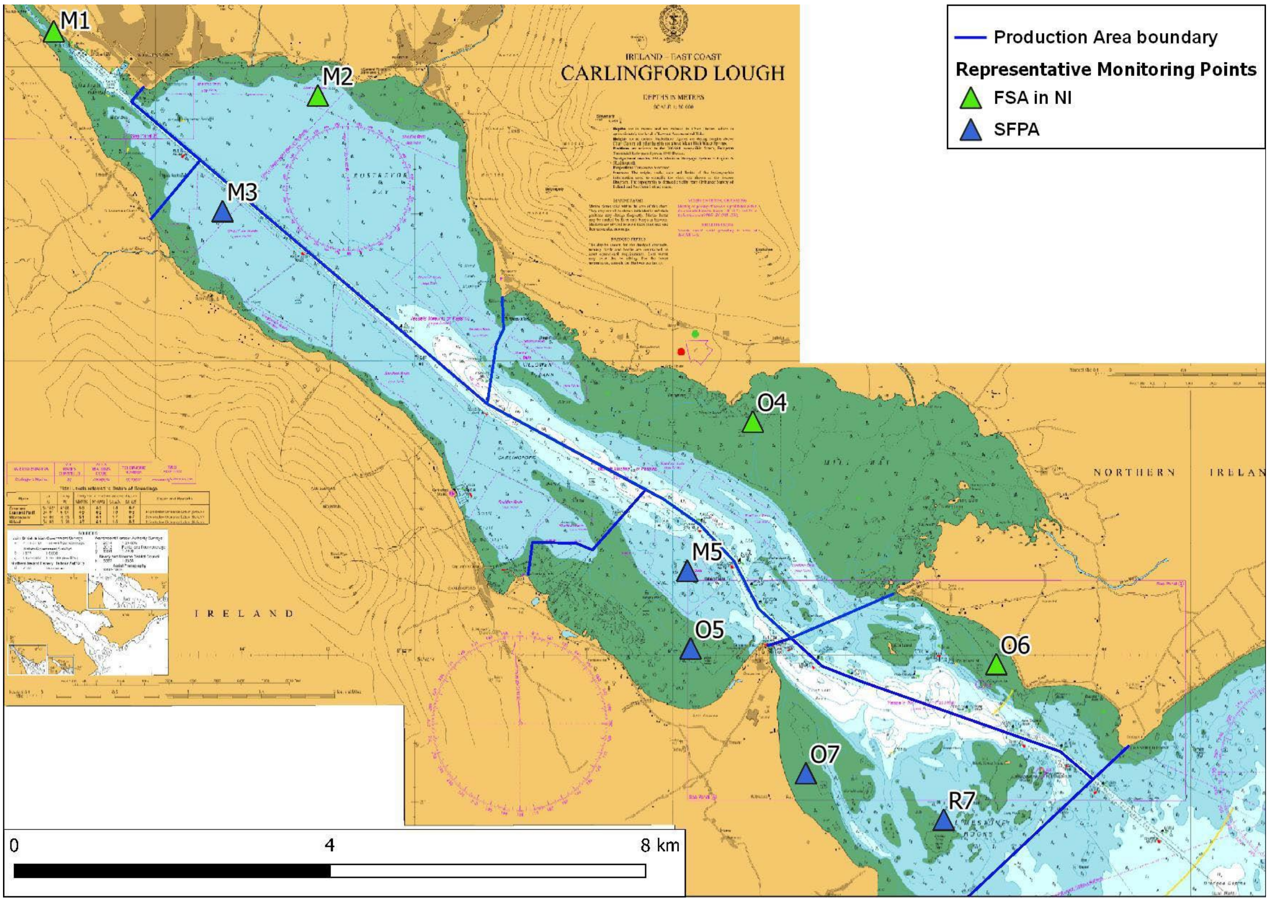
RMP	Name	SFPA code	Species	Longitude	Latitude	Easting	Northing
M1	NW Narrow Water		Mussels	-6.26978	54.10400	313227.7	318589.6
M2	C1 Rostrevor		Mussels	-6.21872	54.0967	316587.6	317861.7
M3	Carlingford Inner	LH-CL-M3	Mussels	-6.23710	54.08360	315418.9	316372.3
M5	Carlingford Outer	LH-CL-M5	Mussels	-6.14730	54.04280	321414	311981.8
O4	Ballyedmond		Oysters	6.13464	54.05973	322193.4	313888
O5	Carlingford	LH-CL-O5	Oysters	-6.13951	54.03410	321480.3	311000.5
O6	C11 Fairgreen		Oysters	-6.08760	54.03220	325356.5	310906.2
O7	Ballagan	LH-CL-BN-PO	Oysters	-6.12439	54.01980	322982.5	309461.4
R7	Ballagan	LH-CL-BN-RZ	Razor Clams	-6.09774	54.01453	324744.5	308922.5

8. Sampling Plan

8.1 Production Areas and Monitoring Points

Since 2010 production area 5 has been split into two production areas. Inside of Greenore Point remains production area 5, with the new production area 7 covering Greenore Point to Ballagan Point (See Figure 8.1). No other boundaries changes are required. The Representative Monitoring Points have also remained unchanged for the most part, except for the oyster monitoring points at O4, O5 and O6. The new locations for these RMPs can be seen in Figure 8.1 and the coordinates are shown in Table 7.1 above. The previous coordinates for Ballagan razor's RMP was incorrect. The correct location and coordinates can be seeing in Figure 8.1 and Table 7.1.

Figure 8.91: Carlingford Lough shellfish production areas and RMPs 2022.



8.2 Sampling Plan

8.2.1 Methodology

All sampling for the FSA in NI should follow the UK NRL (National Reference Laboratory) Microbiological Sampling Protocol[1], which outlines the following:

All sampling for the SFPA should follow the Sea Fisheries Protection Authority's own Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas (SFPA, 2020). The guidance notes are found at Appendix 9.2 of that document.

8.2.2 Time of sampling

Sampling shall be undertaken, where practical, on as random a basis as possible with respect to likely influencing environmental factors e.g., tidal state, rainfall, wind etc to avoid introducing any bias to the results.

8.2.3 Frequency of Sampling

All sampling should be carried out on a monthly basis.

8.2.4 Sampling method

Wherever possible, species shall be sampled by the method normally used for commercial harvesting. The temperature of the surrounding seawater at the time of sampling should be recorded on the sample submission form.

8.2.5 Size of individual animals

Samples should only consist of animals that are within the normal commercial size range. In circumstances where less mature stock is being commercially harvested for human consumption then samples of these smaller bivalves may be gathered for analysis.

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[1] The UK NRL Microbiological Sampling Protocol remains compliant with Commission Regulation (EC) No 2073/2005 at the time of publication and should continue to be used. The Competent Authority will utilise the NI NRL for microbiology for future amendments.

8.2.6 Sample composition

The following sample sizes (in terms of number of individuals by species) are recommended for submission to the laboratory:

Oysters (Crassostrea gigas and Ostrea edulis)	12-18
Mussels (Mytilus spp.)	18-35

8.2.7 Preparation of samples

Any mud and sediment adhering to the shellfish should be removed. This is best achieved by rinsing/scrubbing with clean seawater or fresh water of potable quality. If these are unavailable the seawater from the immediate area of sampling may be used instead. Do not totally re-immerse the shellfish in water. Allow to drain before placing in a food grade plastic bag.

8.2.8 Sample transport

A cool box containing freezer packs should be delivered to the laboratory as soon as practicable but the maximum time between collection and commencement of the test should not exceed 24 hours. Samples should not be frozen and freezer packs should not come into direct contact with the samples.

The cool boxes used for such transport should be validated using appropriate temperature probes, to ensure that the recommended temperature is achieved and maintained for the appropriate period. The number and arrangement of freezer packs, and the sample packaging procedure, shown to be effective in the validation procedure should be followed during routine use. Where validation data already exists for a specific type of cool box, there is no need to take a local revalidation.

8.2.9 Sample Submission form

Sample point identification name, map co-ordinates, time and date of collection, species sampled, method of collection and seawater temperature should be recorded on the submission form. Any other information deemed relevant should also be recorded.

8.2.10 Delivery of samples

Samples should be properly labelled and accompanied by a completed sample submission form. Samples should be brought within 24 hours to the chosen accredited laboratory for analysis.

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Appendix 1: Statistical Analysis

Ballyedmond oysters v Fairgreen Oysters

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Ballyedmond	185	321.7298	1.73908	0.238391
Fairgreen	180	339.3055	1.88503	0.303915

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	1.943395	1	1.943395	7.17911	0.007712	3.867203
Within Groups	98.26459	363	0.270701	7.17911	0.007712	3.867203
Total	100.208	364	-	-	-	-

Narrow Water Mussels v Rostrevor Mussels

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Narrow Water	169	510.9414	3.023322	0.469751
Rostrevor	174	371.166	2.133138	0.503992

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	67.93619	1	67.93619	139.4643	3.25E-27	3.868873
Within Groups	166.1088	341	0.487122	139.4643	3.25E-27	3.868873
Total	234.045	342	-	-	-	-

Ballagan oysters v Carlingford Oysters

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Ballagan	135	197.0447	1.45959	0.15252
Carlingford	170	268.3256	1.578386	0.162708

ANOVA

Source of Variation	SS	df	MS	F	P-values	F-crit
Between Groups	1.061895	1	1.061895	6.71226	0.010038	3.87233
Within Groups	47.9353	303	0.158202	6.71226	0.010038	3.87233
Total	48.9972	304	-	-	-	-

Carlingford Inner Mussels v Carlinford Outer Mussels

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Carlingford Inner	121	212.1571	1.753365	0.275933
Carlingford Outer	98	160.4753	1.637503	0.265368

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	0.726853	1	0.726853	2.680039	0.103063	3.884669
Within Groups	58.85257	217	0.27121	2.680039	0.103063	3.884669
Total	59.57942	218	-	-	-	-

Ballyedmond oysters v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	12	21.3074	1.775617	0.321692
2007	11	19.42172	1.765611	0.273197
2008	12	22.13915	1.844929	0.305743
2009	14	22.39598	1.599713	0.239996
2010	11	17.8581	1.623464	0.231859
2011	12	21.54192	1.79516	0.143871
2012	12	17.73293	1.477744	0.141875
2013	12	18.75263	1.562719	0.125642
2014	13	18.80334	1.446411	0.068072
2015	13	24.89881	1.915293	0.249106
2016	13	26.02564	2.001972	0.212098
2017	13	22.74296	1.749458	0.36548
2018	12	20.86974	1.739145	0.263241
2019	13	25.13829	1.933714	0.24171
2020	12	22.10118	1.841765	0.262666

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	4.84375	14	0.345982	1.50735	0.112828	1.750351
Within Groups	39.02011	170	0.22953	1.50735	0.112828	1.750351
Total	43.86386	184	-	-	-	-

Fairgreen Oysters v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	9	16.4117	1.823522	0.283659118
2007	12	19.4607	1.621725	0.350548009
2008	12	24.5382	2.04485	0.614637384
2009	12	24.31691	2.026409	0.288295627
2010	11	18.40906	1.673551	0.292560353
2011	12	21.93571	1.827976	0.304170806
2012	12	22.16616	1.84718	0.33706742
2013	12	18.01703	1.501419	0.073852905
2014	13	28.0949	2.161146	0.192770328
2015	12	24.01014	2.000845	0.3038407
2016	13	27.00225	2.077096	0.385118584
2017	13	24.65639	1.896645	0.206890975
2018	12	19.21496	1.601247	0.127961054
2019	13	26.56804	2.043695	0.313223323
2020	12	24.50331	2.041942	0.243337697

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.948983	14	0.496356	1.725937138	0.05475	1.75214
Within Groups	47.45174	165	0.287586	1.725937138	0.05475	1.75214
Total	54.40073	179	-	-	-	-

Narrow Water Mussels v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2007	13	35.6237	2.740285	0.537633
2008	4	11.22453	2.806133	0.744591
2009	10	30.58706	3.058706	1.677257
2010	12	31.12755	2.593963	0.566894
2011	12	35.13074	2.927562	0.293869
2012	14	41.67874	2.977053	0.103571
2013	13	35.42003	2.724618	0.375595
2014	13	39.32852	3.025271	0.300176
2015	12	36.22348	3.018624	0.41275
2016	13	42.95316	3.304089	0.34808
2017	13	44.32317	3.409474	0.173986
2018	12	38.0696	3.172467	0.24184
2019	13	44.38799	3.414461	0.248245
2020	12	35.74499	2.978749	0.852077

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	9.997956	13	0.769074	1.706014	0.064726717	1.785042
Within Groups	68.52181	152	0.450801	1.706014	0.064726717	1.785042
Total	78.51977	165	-	-	-	-

Rostrevor Mussels v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	8	17.49146	2.186432	0.263410149
2007	11	23.12348	2.102135	0.370111564
2008	10	22.68415	2.268415	0.613443379
2009	12	26.37234	2.197695	0.275552336
2010	12	23.95069	1.995891	0.701394416
2011	11	20.8222	1.892927	0.184220744
2012	12	21.80418	1.817015	0.200457197
2013	12	21.85117	1.820931	0.596100181
2014	13	27.32183	2.101679	0.618080872
2015	13	30.94404	2.380311	0.681606885
2016	13	31.61499	2.431922	0.6163726
2017	13	26.12849	2.009884	0.321532032
2018	12	28.20087	2.350072	1.023236162
2019	13	27.38699	2.106691	0.2749143
2020	9	21.46912	2.385457	0.820044003

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.807866	14	0.486276	0.961871765	0.494773	1.754437
Within Groups	80.38276	159	0.505552	0.961871765	0.494773	1.754437
Total	87.19063	173	-	-	-	-

Ballagan Razors v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	6	10.04922	1.67487	0.14129
2008	11	18.61976	1.692706	0.284256
2010	4	6.662758	1.665689	0.25051
2011	8	13.15131	1.643914	0.169576
2012	4	6.894316	1.723579	0.435404
2013	8	11.20412	1.400515	0.033933
2014	14	21.79315	1.556654	0.329428
2015	9	12.52727	1.391919	0.076298

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.921216	7	0.131602	0.618045	0.738716	2.178156
Within Groups	11.92426	56	0.212933	0.618045	0.738716	2.178156
Total	12.84548	63	-	-	-	-

Ballagan Oysters v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	11	16.34676	1.486069	0.142688
2007	13	21.00681	1.615909	0.256584
2008	13	18.79988	1.446145	0.062636
2009	9	13.57997	1.508885	0.190015
2010	6	8.952308	1.492051	0.08791
2014	7	11.75348	1.679069	0.840241
2015	10	13.17572	1.317572	0.032943
2016	12	16.36564	1.363803	0.068765
2017	11	15.44967	1.404515	0.114387
2018	12	15.25516	1.271263	0.003068
2019	11	15.10497	1.373179	0.070884
2020	12	19.88647	1.657206	0.268269

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.013887	11	0.183081	1.160081	0.322611	1.872847
Within Groups	18.14897	115	0.157817	1.160081	0.322611	1.872847
Total	20.16286	126	-		-	-

Carlingford Inner Mussels v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2011	16	34.04757	2.127973	0.272844
2012	11	22.78129	2.071026	0.168866
2013	9	16.49934	1.833259	0.186071
2014	12	25.58413	2.132011	0.457365
2015	12	17.65418	1.471182	0.060253
2016	12	21.20973	1.767478	0.219817
2017	12	16.05921	1.338268	0.060085
2018	12	16.14379	1.345316	0.042609
2019	12	18.05335	1.504446	0.111733
2020	9	14.71831	1.635368	0.134459

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10.97675	9	1.219639	6.935638	7.93E08	1.968511
Within Groups	18.81606	107	0.175851	6.935638	7.93E08	1.968511
Total	29.79281	116	-	-	-	-

Carlingford Outer Mussels v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2011	4	7.414973	1.853743	0.741014
2012	11	20.25463	1.84133	0.16424
2013	9	14.08948	1.565498	0.473016
2014	12	22.21987	1.851656	0.410453
2015	12	20.28343	1.690286	0.277026
2016	12	17.5443	1.462025	0.102286
2017	12	17.95928	1.496606	0.186001
2018	12	17.67464	1.472886	0.175215
2019	11	17.90552	1.627775	0.287461

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.207934	8	0.275992	1.023736	0.424602	2.047958
Within Groups	23.18497	86	0.269593	1.023736	0.424602	2.047958
Total	25.39291	94	-	-	-	-

Carlingford Oysters v year

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
2006	12	22.29124	1.857604	0.203207
2007	14	26.49885	1.892775	0.187364
2008	13	21.8767	1.682823	0.168204
2009	10	16.52736	1.652736	0.221768
2010	9	17.94689	1.994098	0.251443
2011	13	19.44716	1.495935	0.049496
2012	9	12.70927	1.412141	0.051215
2013	11	16.71445	1.519495	0.151069
2014	12	15.95951	1.329959	0.040919
2015	12	17.73656	1.478047	0.069209
2016	12	16.90748	1.408957	0.134462
2017	12	16.36564	1.363803	0.068765
2018	12	17.853	1.48775	0.110301
2019	12	17.92493	1.493744	0.092922

ANOVA

Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	6.388336	13	0.49141	3.87539	2.13E-05	1.786361
Within Groups	18.89362	149	0.126803	3.87539	2.13E-05	1.786361
Total	25.28196	162	-	-		-

Ballyedmond Oysters v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	41	73.57357	1.794477	0.23762
Spring	48	79.12232	1.648382	0.223424
Summer	46	78.65671	1.709929	0.255277
Autumn	50	90.37721	1.807544	0.236256

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.794138	3	0.264713	1.112451	0.345414	2.654513
Within Groups	43.06973	181	0.237954	1.112451	0.345414	2.654513
Total	43.86386	184	-	-	-	-

Fairgreen Oysters v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	39	64.88108	1.663617	0.137793
Spring	48	88.67378	1.84737	0.310702
Summer	46	87.51885	1.902584	0.331725
Autumn	47	98.23174	2.090037	0.340533

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.969479	3	1.32316	4.617694	0.003897	2.655939
Within Groups	50.43125	176	0.286541	4.617694	0.003897	2.655939
Total	54.40073	179	-	-	-	-

Narrow Water Mussels v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	40	132.1982	3.304956	0.218629
Spring	41	126.2792	3.07998	0.527034
Summer	38	101.682	2.675843	0.346953
Autumn	50	150.7819	3.015638	0.583215

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	7.895441	3	2.631814	6.114232	0.000572	2.659384
Within Groups	71.0227	165	0.430441	6.114232	0.000572	2.659384
Total	78.91814	168	-	-	-	-

Rostrevor Mussels v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	40	98.28926	2.457232	0.529251
Spring	42	81.55192	1.941712	0.546921
Summer	42	80.4897	1.916421	0.429295
Autumn	49	108.4734	2.213742	0.384193

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	8.031131805	3	2.677044	5.719099	0.000944	2.658079
Within Groups	79.10693888	169	0.468088	5.719009	0.000944	2.658079
Total	87.13807069	172	-	-	-	-

Ballagan Razors v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	16	716	44.75	2360.467
Spring	17	3154	185.5294	328275.8
Summer	19	1313	69.10526	14950.77
Autumn	12	1314	109.5	44331.73

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	192271.9596	3	64090.65	0.63618	0.594628	2.758078
Within Groups	6044582.025	60	100743	0.63618	0.594628	2.758078
Total	6236853.984	63	-	-	-	-

Ballagan Oysters v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	37	1719	46.45946	4585.644
Spring	31	749	24.16129	421.3398
Summer	33	1574	47.69697	9741.78
Autumn	31	7488	241.5484	927670

ANOVA

Source of Variation	SS	df	MS	F	P-value	FR crit
Between Groups	974621.9	3	324874	1.46838	0.22627	2.675387
Within Groups	28319560	128	221246.6	1.46838	0.22627	2.675387
Total	29294182	131	-	-	-	-

Carlingford Inner Mussels v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	32	4960	155	39914.52
Spring	28	1414	50.5	3990.926
Summer	27	3383	125.2963	36733.52
Autumn	30	4344	144.8	96925.89

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	193623.8	3	64541.26	1.426946	0.238646	2.684916
Within Groups	5111027	113	45230.33	1.426946	0.238646	2.684916
Total	5304651	116	-	-	-	-

Carlingford Outer Mussels v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	27	3591	133	65778.85
Spring	23	3215	139.7826	247023.8
Summer	24	4783	199.2917	248237.3
Autumn	24	1328	55.33333	3459.188

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	251159.1116	3	83719.7	0.608457	0.611149	2.701448
Within Groups	12933792.2	94	137593.5	0.608457	0.611149	2.701448
Total	13184951.32	97	-	-	-	-

Carlingford Oysters v Season

Anova: single factor

Summary

Groups	Count	Sum	Average	Variance
Winter	43	3162	73.53488	15721.64
Spring	41	1601	39.04878	3364.898
Summer	41	3771	91.97561	42413.07
Autumn	40	3057	76.425	10004.1

ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Between Groups	61255.46	3	20418.49	1.140821	0.33436	2.660755
Within Groups	2881587	161	17898.06	1.140821	0.33436	2.660755
Total	2942843	164	-	-	-	-

Appendix 2: Microbial results

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CERTIFICATE OF ANALYSIS

Customer:	**Aquafact Internati onal Services**	**Report no.:**	**22-01560**
	12 Kilkierrin Park	**No. of samples:**	12
	Lisbaun Estate	**Acceptance date:**	08/03/2022
	Galway	**Analysis date:**	08/03/2022
	H91 FW7V	**Date of issue:**	1Q/03/2022
		Contact:	Mark Costelloe

COflTIBlts
12 x S3mp es v,.ater

San-.,leID	San-.,le t)lle	Cliert reference	Teotmelhod	Test description	Result/Urns
22-01560-(01)	Seav,.ate-	W1	L/\!3423	E .mli	5 cfu/100ml
22-01560-(02)	Seav,.ate-	W2	L/\!3423	E .mli	25 cfu/100ml
22-01560-(03)	Seav,.ate-	W3	L/\!3423	E .mli	5 cfu/100ml
22-01560-(04)	Seav,.ate-	W4	L/\!3423	E.mli	<1cfu/100ml
22-01560-(05)	Seav,.ate-	W5	L/\!3423	E.mli	<1cfu/100ml
22-01560-(06)	Seav,.ate-	W6	L/\!3423	E.mli	<1cfu/100ml
22-01560-(07)	Seav,.ate-	W7	L/\!3423	E.mli	<1cfu/100ml
22-01560-(08)	Seav,.ate-	W8	L/\!3423	E.mli	15cfu/100ml
22-01560-(09)	Seav,.ate-	W9	L/\!3423	E.mli	10cfu/100ml
22-01560-(1 OJ	Seav,.ate-	W10	L/\!3423	E .mli	5 cfu/100ml
22-01560-(11)	Seav,.ate-	W11	L/\!3423	E .mli	<1cfu/100ml
22-01560-(12)	Seav,.ate	W12	L/\!3423	E .mli	130cfu/1OOm l

The re"-1lts in this electronically produced le st report have been ched<ed and approved. The le st report meets1he requirements of IS EN ISOEC 170252017 and is also valid w hout signature.

Report authorised by:

Erika Szunyog ova
Laboratory Manager

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CERTIFICATE OF ANALYSIS

Customer: **Aquafact Internati onal Services**
12 Kilkierrin Park
Lisbaun Estate
Galway
H91 FW7V

Report no.:	**22-01561**
No. of samples:	5
Acceptance date:	08/03/2022
Analysis date:	08/03/2022
Date of issue:	1Q/03/2022
Contact:	Mark Costelloe

COflTIBlts
5 x sampies \/\61er

San-.,leID	San-.,le t)lle	Cliert reference	Teotmelhod	Test description	Result/Urns
22-01561-(01)	Water	D1	L/\!3423	E .mli	4.0x10 3 ciu/100ml
22-01561 -(02)	Water	D2	L/\!3423	E .mli	<1 ciu/100ml
22-01561 -(03)	Water	D3	L/\!3423	E .mli	185 cfu/1OOm l
22-01561-(04)	Water	D4	L/\!3423	E.mli	175 cfu/1OOm l
22-01561-(05)	Water	D5	L/\!3423	E.mli	330 cfu/1OOm l

The reSJlts in this electronically produced le st report ha"" been che d<ed and appro""d. The le st report meets1h e requirements of IS EN ISOEC 170 25 2017 and is also valid without signature.

Report authorised by: ________________________

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CERTIFICATE OF ANALYSIS

Customer: **Aquafact Internati onal Services**
12 Kilkierrin Park
Lisbaun Estate
Galway
H91 FW7V

Report no.:	**22-01562**
No. of samples:	6
Acceptance date:	08/03/2022
Analysis date:	08/03/2022
Date of issue:	1Q/03/2022
Contact:	Mark Costelloe

COflTIBlts
6 x sampies \/\61er

San-.,leID	San-.,le t)lle	Cliert reference	Teotmelhod	Test description	Result/Urns
22-01562-(01)	Water	R'1	L/\!3423	E .mli	55 cfu/100ml
22-01562-(02)	Sea\/\61er	R'2	L/\!3423	E .mli	20 cfu/100ml
22-01562-(03)	Water	R'3	L/\!3423	E .mli	54 cfu/100ml
22-01562-(04)	Water	R'4	L/\!3423	E.mli	325 cfu/10em 1
22-01562-(05)	Water	R'5	L/\!3423	E.mli	29 cfu/100ml
22-01562-(06)	Water	R'6	L/\!3423	E.mli	380 cfu/10em 1

The reSJlts in this electronically produced le st report ha"' been che d<ed and appro""d. The le st report meets1he requirements of IS EN ISOEC 170 25 20 17 and is also valid without signature.

Report authorised by:

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CERTIFICATE OF ANALYSIS

Customer:	**Aquafact Internati onal Services**	**Report no.:**	**22-01563**
	12 Kilkierrin Park	**No. of samples:**	2
	Lisbaun Estate	**Acceptance date:**	08/03/2022
	Galway	**Analysis date:**	08/03/2022
	H91 FW7V	**Date of issue:**	1Q/03/2022
		Contact:	Mark Costelloe

COflTIBlts
2 x samples mus ls

San-.,leID	Sample type	Cliert reference	Teotmelhod	Test description	Result/Urns
22-01563-(01)	Mussels	M1	L/\!3431	E mli	330 MPN/100g
22-01563-(02)	Mussels	M2	L/\!3431	E mli	230 MPN/100g

The results in this electronically produced le st report have been che d<ed and approved. The le st report meets1h e requirements of IS EN ISO EC 170 25 20 17 and is also valid w hout signature.

Report authorised by: ___________________________

Erika Szunyog ova
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CERTIFICATE OF ANALYSIS

Customer:	**Aquafact Internati onal Services**	**Report no.:**	**22-01564**
	12 Kilkierrin Park	**No. of samples:**	7
	Lisbaun Estate	**Acceptance date:**	08/03/2022
	Galway	**Analysis date:**	08/03/2022
	H91 FW7V	**Date of issue:**	1Q/03/2022
		Contact:	Mark Costelloe

COfITIBIts
7 x sampies oys:ers

San-.,leID	San-.,le t)lle	Cliert reference	Teotmelhod	Test description	Result/Urns
22-01564-(01)	Oys:ers	R'5	L/\!3431	E mli	<18 MPN/100g
22-01564-(02)	Oys:ers	C7	L/\!3431	E mli	45 MPN/100g
22-01564-(03)	Oys:ers	C11	L/\!3431	E mli	45 MPN/100g
22-01564-(04)	Oys:ers	C11 new	L/\!3431	E .mli	40 MPN/100g
22-01564-(05)	Oys:ers	05	L/\!3431	E .mli	<18MPN/100g
22-01564-(06)	Oys:ers	C15	L/\!3431	E .mli	40 MPN/100g
22-01564-(07)	Oys:ers	PA4-2	L/\!3431	E .mli	68 MPN/100g

The reSJIts in this electronicallyproduced le st re port have been che d<ed and approved. The le st report meets111e requirements of IS EN ISOEC 170 25 20 17 and is also valid without signature.

Report authorised by: ______________________

Erika Szunyog ova
Laboratory Manager

Appendix 3: SFPA Site Specific

Carlingford Lough

Bivalve Mollusc Classified Production Area 3

Mussel Monitoring Information

Site Name: Carlingford Lough

Site Identifier: LH-CL-M3

Monitoring Point Coordinates

Latitude: 54.08360 **Longitude:** -6.23710

Species: *Mytilus Edulis*

Sample Depth: Seabed

Sample Frequency: Monthly

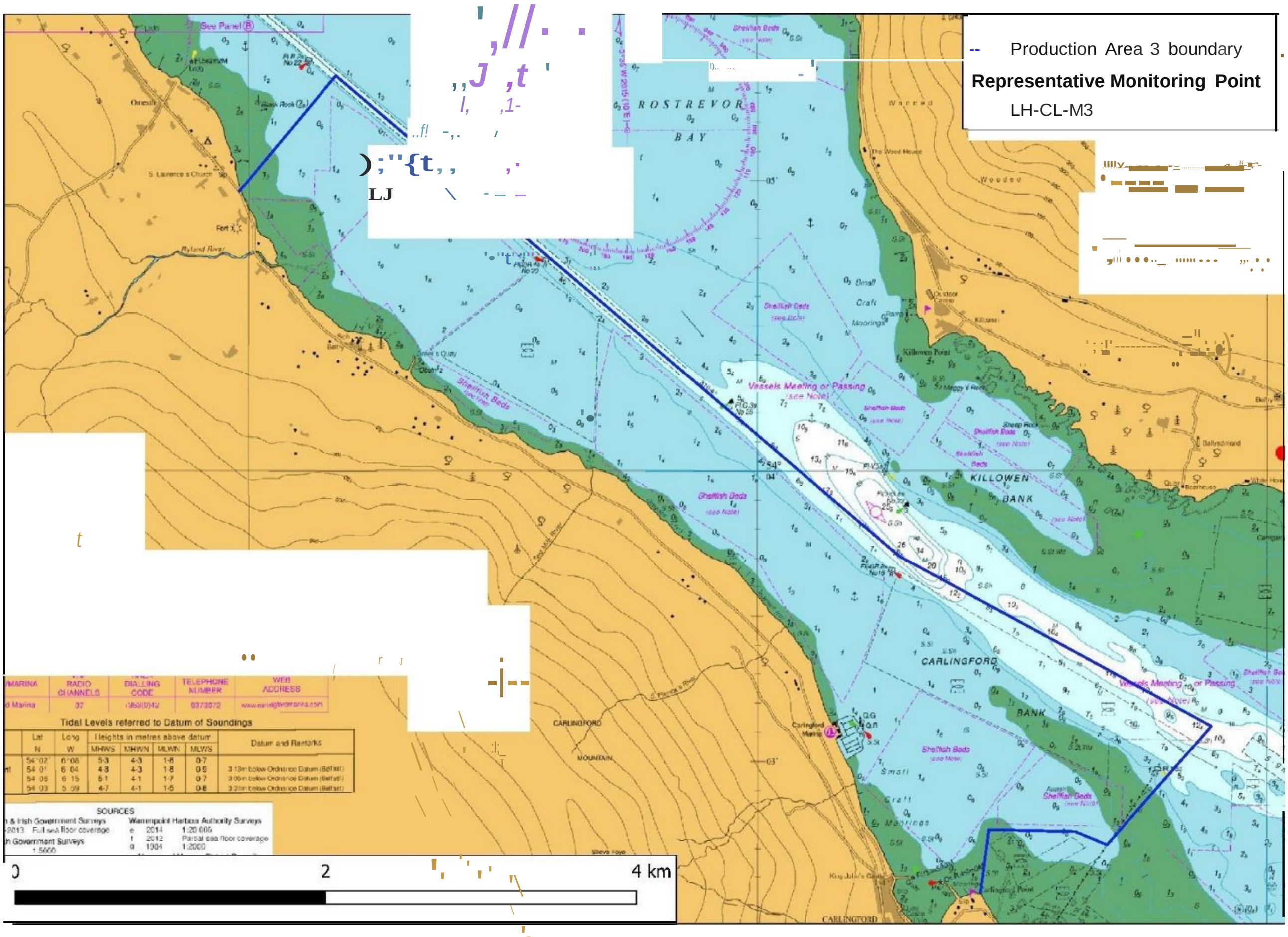
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Howth

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100m of the sampling point.

Sampling Size: Minimum 15 market sized animals

Sampling Method: Taken at point


Production Area 3 boundary
Representative Monitoring Point
LH-CL-M3
ROSTREVOR
BAY
KILLOWEN
BANK
CARLINGFORD
Vessels Meeting or Passing
Shellfish Beds
Tidal Levels referred to Datum of Soundings
SOURCES
0
2
4 km

0

Carlingford Lough

Bivalve Mollusc Classified Production Area 5

Mussel Monitoring Information

Site Name: Carlingford Lough

Site Identifier: LH-CL-M5

Monitoring Point Coordinates

Latitude: 54.04280 **Longitude:** -6.14730

Species: *Mytilus Edulis*

Sample Depth: Seabed

Sample Frequency: Monthly

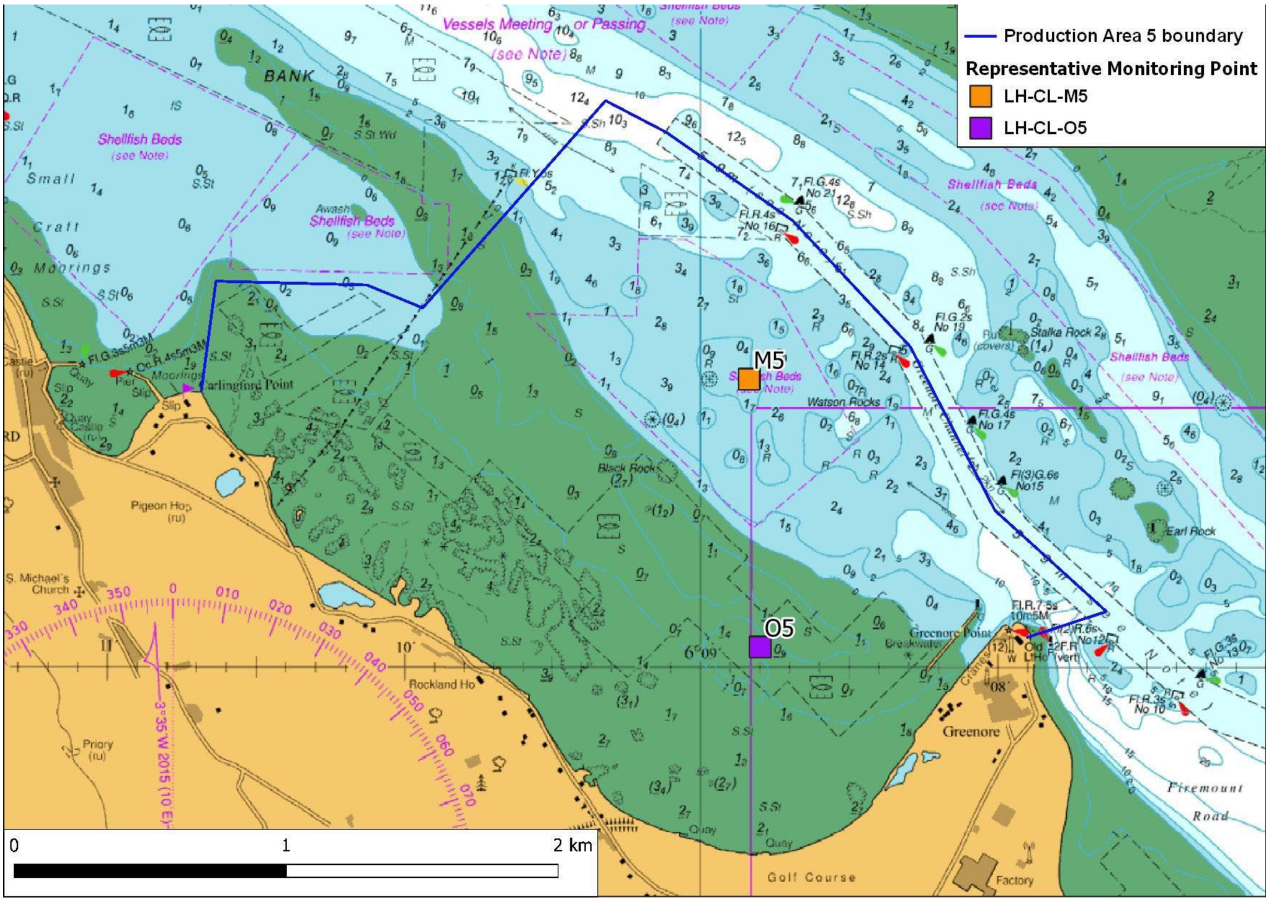
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Howth

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100m of the sampling point.

Sampling Size: Minimum 15 market sized animals

Sampling Method: Taken at point



Carlingford Lough

Bivalve Mollusc Classified Production Area 5

Pacific oysters Monitoring Information

Site Name: Carlingford Lough

Site Identifier: LH-CL-O5

Monitoring Point Coordinates

Latitude: 54.03410 **Longitude:** -6.13951

Species: *Crassostrea gigas*

Sample Depth: N/A

Sample Frequency: Monthly

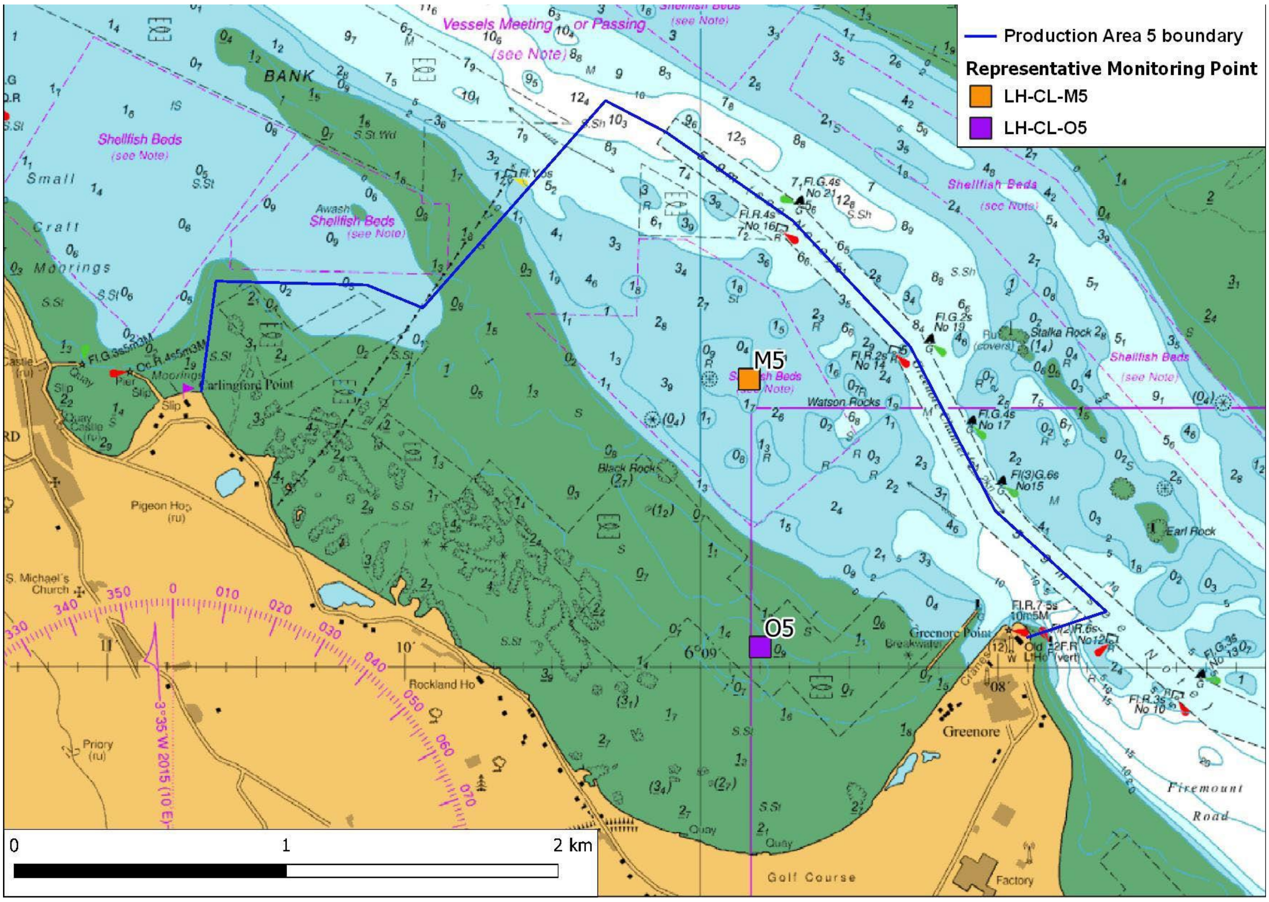
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Howth

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100m of the sampling point.

Sampling Size: Minimum 10 market sized animals

Sampling Method: Taken from trestles at point



Carlingford Lough

Bivalve Mollusc Classified Production Area 7

Pacific oysters Monitoring Information

Site Name: Carlingford Lough

Site Identifier: LH-CL-BN-PO

Monitoring Point Coordinates

Latitude: 54.01980 **Longitude:** -6.12439

Species: *Crassostrea gigas*

Sample Depth: N/A

Sample Frequency: Monthly

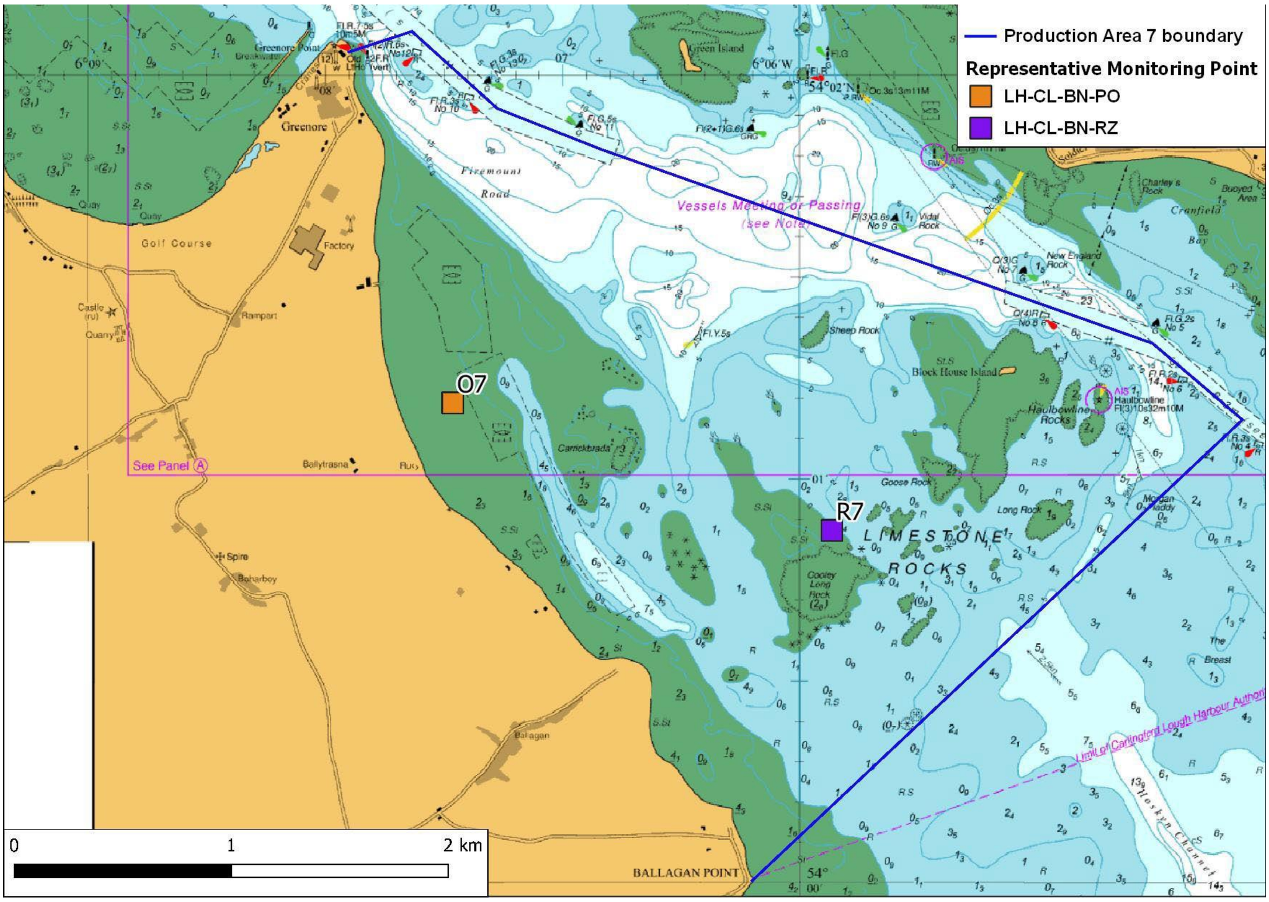
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Howth

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100m of the sampling point.

Sampling Size: Minimum 10 market sized animals

Sampling Method: Taken from trestles at point



Carlingford Lough

Bivalve Mollusc Classified Production Area 7

Razor Clam Monitoring Information

Site Name: Carlingford Lough

Site Identifier: LH-CL-BN-RZ

Monitoring Point Coordinates

Latitude: 54.01453 **Longitude:** -6.09774

Species: *Ensis spp.*

Sample Depth: Seabed

Sample Frequency: Frequency dependant on fishery opening

Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Howth

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100m of the sampling point.

Sampling Size: Minimum 10 market sized animals

Sampling Method: Taken from dredge at point