Sanitary Survey Report
and
Sampling Plan
for Strangford Lough

Produced by

AQUAFACT International Services Ltd

On behalf of

The Food Standards Agency in Northern Ireland

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Glossary

Adduct	To move or draw toward the axis of the body or one of its parts
AFBI	Agri-Food and Biosciences Institute
ANOVA	Analysis Of Variance
APP	Average Physical Product
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-pelagic 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 & Aquaculture Science
CEH	Centre for Ecology & Hydrology
C-Mar	Centre for Marine Resources and Mariculture
CSO	Combined Sewer Overflow
Cultch	Shell clumps, shells, and shell fragments without attached live oysters or boxes
DANI	Department of Agriculture for Northern Ireland
DARD	Department of Agriculture and Rural Development
Depuration	The process of purification or removal of 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
EC	European Communities
E. coli	*Escherichia coli*
EMS	Environmental Monitoring Stations

Epifauna	Animals living on the surface of marine or freshwater sediments
Epiflora	Plants living on the surface of marine or freshwater sediments
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 Turbidity Unit
Gamete	A reproductive cell that fuses with another gamete to produce a zygote, which develops into a new individual
Gametogenesis	The formation or production of gametes or reproductive cells
Genotype	The genetic makeup of an organism
Geometric Mean	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
Heterozygosity	Having two different alleles of the same gene
Hydrodynamic	Forces in or motions of liquids
Hydrography	The description and analysis of the physical conditions, boundaries, flows and related characteristics of water bodies
INAB	Irish National Accreditation Board
Interspecific Competition	Competition for resources between different species
Intraspecific competition	Competition for resources between members of the same species
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.
Metamorphosis	The transformation from the larval to the adult form that occurs in the life cycle of many invertebrates and amphibians
MPN	Most Probable Number
MSD	Marine Sanitation Device
Multilocus	Occurring at more than one position or locus on a chromosome

NAP	Nitrates Action Programme
ND	Not Detectable
NH_4	Ammonium
NIEA	Northern Ireland Environment Agency
NISFCo	Northern Ireland Scallop Fishermen's Co-op
NISRA	Northern Ireland Statistics and Research Agency
NITB	Northern Ireland Tourist Board
NI Water	Northern Ireland Water
NO_2	Nitrite
NO_3	Nitrate
NR	Nature Reserve
NRFA	National River Flow Archive
NRL	National Reference Laboratory
Ordnance Datum	OD
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	Material rejected by suspension or deposit feeders as potential food before entering 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 (EC) 854/2004	REGULATION (EC) No 854/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption
RIB	Rigid Inflatable Boat

RMP	Representative Monitoring Point
SAC	Special Area of Conservation
SLLP	Strangford Lough and Lecale Partnership
SMILE	Sustainable Mariculture in northern Irish Lough Ecosystems
SOA	Super Output Areas or ward
SPA	Special Protection Area
SPS	Sewage Pumping Station
SS	Suspended Solids
Suspension feeders	Animals that feed on small particles suspended 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 (EC) 854/2004, 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 inform the sampling plan for the Official Control Microbiological Monitoring Programme, the results of which determine the annual classification for bivalve mollusc production areas. Other wider benefits of sanitary surveys include the potential to improve the identification of pollution events and the sources of those events so that in the future remedial action can be taken to the benefit of the fisheries in the area.

Strangford Lough is a large marine lough located south of Newtownards and northeast of Downpatrick, Northern Ireland. The lough is 24km long, 8km wide and 59m in depth at its deepest point, however much of the lough is less than 20m deep. The main freshwater sources to Strangford Lough are the Comber River in the northwest and the Quoile River in the southwest. The lough connects to the Irish Sea through an inlet known as 'The Narrows'. The Narrows are relatively deep (30m) and are subjected to strong tidal currents of over 3.6m/s while conversely some sheltered inlets on the western shores have virtually still water. Many islands, reefs and rocks are distributed throughout the lough and the shore is approximately 240km in length and is highly indented. The lough supports populations of blue mussels (*Mytilus edulis*), native oysters (*Ostrea edulis*), Pacific oysters (*Crassostrea gigas*) and scallops (*Pecten maximus*), 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 Strangford Lough come from continuous and intermitttent sewage discharges into the lough and its tributary rivers and from non-point sources related to agricultural land-use in the wider area. There are also seasonal variations in the contribution of microbiological sources of contamination from wildfowl (birds), boats (shipping and recreational activity) and tourism.

The eastern section of the lough is less vulnerable to pollution due to the deeper depths and stronger current speeds compared with shallower depths and weaker currents along the western shoreline. It was on the basis of hydrodynamic and spatial features (i.e. areas of similar depth, tidal currents, suspended sediment levels, freshwater influence and historical classifications) that resulted in the lough been divided into 5 production areas. Representative Monitoring Points (RMPs) were selected from currently licenced beds within the active Production Areas for a number of species i.e. mussel, oyster and scallop. In total there are 3 RMPs in the lough, to be sampled monthly.

2. Overview of the Fishery/Production Area

2.1. Location/Extent of Growing/Harvesting Area

The shellfish designated waters in Strangford Lough cover an area of approximately 8.35km^2 at Paddy's Point and Reagh Bay and can be seen in Figure 2.1 (DOENI, 2009). Pacific oysters, native oysters, mussels and scallops are cultivated in Strangford Lough.

Figure 2.1: Shellfish designated waters within Strangford Lough (Source: DOENI, 2009).

Figure 2.2 shows the current locations of licenced harvesting areas within Strangford Lough. Strangford Lough is currently licenced for mussels, native oysters, Pacific oysters, native clams and scallops covering an area of

$3km^2$. Some sites are licenced for only one species while others are licenced for multiple species. Mussels occupy $0.41km^2$, scallops occupy $2.04km^2$, native oysters occupy $0.19km^2$, scallops and mussels occupy $0.08km^2$, Pacific oysters and native oysters occupy $0.19km^2$ and Pacific oysters, native oysters and native clams occupy $0.09km^2$. Table 2.1 shows the details of each of these sites.

Table 2.1: Details on DARD licenced sites in Strangford Lough

Map ID	Name	Species	Area
1	Dunsy Island	Mussels	0.02
2	South Buckley Rock	Mussels	0.06
3	North Buckley Rock	Mussels	0.05
4	East of Bird Island Passage	Mussels	0.03
5	Skartrock Pladdy	Mussels	0.04
6	South Dougherty Rock	Mussels	0.05
7	West Dougherty Rock	Mussels	0.11
8	Paddy's Point	Pacific Oysters, Native Oysters	0.19
9	Marfield Bay	Scallops, Mussels	0.02
10	Skate Rock	Scallops, Mussels	0.06
11	Salt Island	Native Oysters	0.19
12	Reagh Bay	Pacific Oysters, Native Oysters, Native Clams	0.09
13	West of Sheelahs Island	Scallops	0.39
14	Bullock Pladdies	Mussels	0.05
15	East of Sheelahs Island	Scallops	1.65

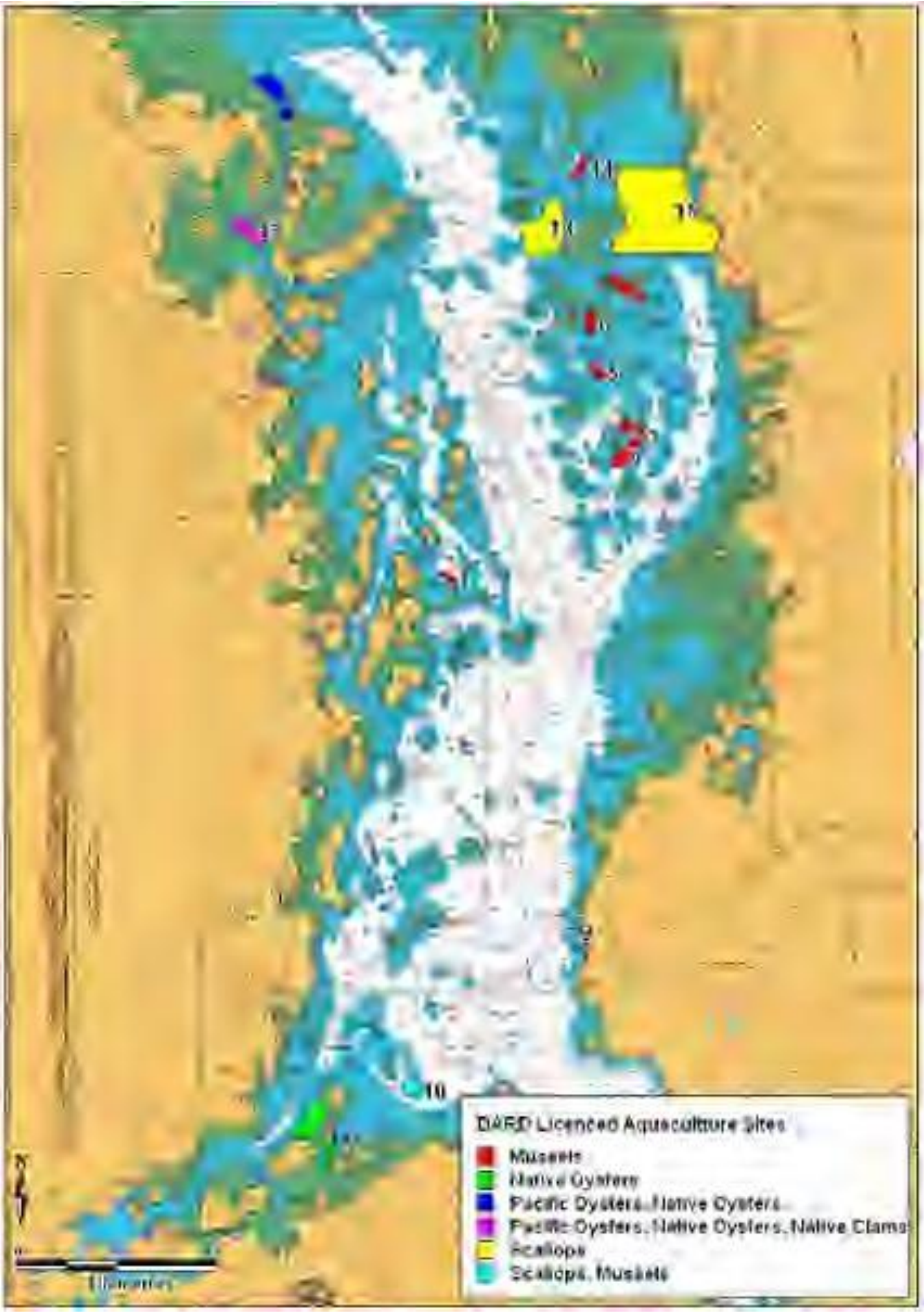

Figure 2.2: Licenced harvesting areas located within Strangford Lough (Source: DARD).

2.2. Description of the Area

Strangford Lough is a large marine lough located south of Newtownards and northeast of Downpatrick, Northern Ireland (See Figure 2.3). The lough is 24km long, 8km wide and 59m in depth at its deepest point, however much of the lough is less than 20m deep. It covers an area of approximately 150km^2 and has a volume of 1537 x 106m^3. The main freshwater sources to Strangford Lough are the Comber River in the northwest and the Quoile River in the southwest. The lough connects to the Irish Sea through an inlet known as 'The Narrows', approximately 8km in length and less than 1km wide. The Narrows are relatively deep (>10m to 60m) and are subjected to strong tidal currents of over 3.6 m/s while conversely some sheltered inlets on the western shores have virtually still water. Many islands, reefs and rocks are distributed throughout the lough and the shore is approximately 240km in length and is highly indented. The exit channel consists of patches of bedrock and extensive beds of coarse gravel.

Strangford Lough is designated as a Special Area of Conservation (SAC), a Special Protection Area (SPA) and a Ramsar Site. It is a Marine Nature Reserve and contains six marine related Nature Reserves. Strangford Lough contains 4 Annex I habitats[1], which are the primary reason for the designation of this site: mudflats and sandflats not covered by seawater at low tide, coastal lagoons, large shallow inlets and bays and reefs. It also contains the following Annex I habitats as qualifying features of the site: Annual vegetation of drift lines, Perennial vegetation of stoney banks, *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*). Also the common seal, which is an Annex II species[1] is present as a qualifying feature of the site.

Strangford Lough holds 7 bird species of international importance: light-bellied Brent goose, red knot, shelduck, common redshank, black-tailed godwit, whooper swan and mute swan. It also holds populations of 24 nationally important bird species.

Strangford Lough on the east coast of Northern Ireland is an outstanding example of a large, enclosed fjordic sea lough. Sea water enters the lough through a narrow entrance, expanding into a broad, mostly shallow basin that has a central deep channel (30-60m deep), which carries rapid currents and causes great turbulence

[1] The EU Habitats Directive (Directive 92/43/EEC, amended by Directive 97/62/EC) aims to protect some 220 habitats and approximately 1,000 species listed in the directive's Annexes. Annex I covers habitats, Annex II species requiring designation of Special Areas of Conservation, Annex IV species in need of strict protection, and Annex V species whose taking from the wild can be restricted by European law. These are species and habitats which are considered to be of European interest, following criteria given in the directive.

in some parts, particularly the Narrows. With a wide range of tidal stream strengths and depths, there is a remarkable marine fauna within Strangford Lough and it is one of the most diverse sea loughs in the UK. The faunal assemblages' present range from the very rich high-energy communities near the mouth, which depend on rapid tidal streams, to communities in extreme shelter where fine muds support burrowing brittlestars, Dublin Bay prawn *Nephrops norvegicus*, and a rich community associated with horse mussels *Modiolus modiolus*.

The intertidal mudflats and sandflats in the north of Strangford Lough represent the largest single continuous area of mud/sandflats in Northern Ireland. There are very extensive areas of muddy sand from Newtownards to Ardmillan Bay in the west and to Greyabbey in the east. The habitat also occurs in the southwest reaches of the lough along the northern shore of Lecale. The northern flats support luxuriant beds of the eelgrasses *Zostera noltei* and *Z. angustifolia*. Common eelgrass *Z. marina* and tasselled pondweed *Ruppia maritima* are also present, the latter being widespread but quite local in its distribution. Such extensive beds are rare in the British Isles. The green algae *Enteromorpha* spp. and *Ulva lactuca* tend to occur where there is seepage of nutrient-enriched freshwater. Many of the invertebrate species present in muds also occur in muddy sand. However, lugworm *Arenicola marina* and nereid worms are generally dominant, along with bivalve molluscs such as the thin tellin *Angulus tenuis*, the solf shell clam *Mya arenaria* and the common cockle *Cerastoderma edule*.

The 'Dorn' is a silled lagoon on the eastern side of Strangford Lough in Northern Ireland. The Dorn, from the Gaelic word for 'narrow channel', refers specifically to the channel which connects several exceptionally sheltered bays to the main area of the lough. Near the mouth, rock barriers or sills hold back water as the tide falls, creating saltwater rapids, unique in Ireland. In the area of the Dorn rapids, abundant growths of sea anemones, sponges and ascidians clothe the rock and boulders. Several of the animals found in the area of the rapids normally occur in relatively deep water. These include the featherstar *Antedon bifida*, purple sun-star *Solaster endeca*, sting winkle *Ocenebra erinacea*, king scallop *Pecten maximus* and light-bulb sea-squirt *Clavelina lepadiformis*. The main trough of the Dorn supports a dense forest of sugar kelp *Laminaria saccharina* and sea-oak *Halidrys siliquosa*. The gravelly-sand bottom has unusually dense colonies of peacock worm *Sabella pavonina* and sand gaper *Mya arenaria*, with occasional native oysters *Ostrea edulis* and *P. maximus*. The channel immediately above the sill has fast tidal streams without turbulence, enabling sponges to grow to exceptional proportions. The sheltered marine 'ponds' feeding the Dorn feature beds of common eelgrass *Zostera marina* and the green alga *Codium fragile* ssp. *tomentosoides*.

Reefs in Strangford Lough vary from tide-swept bedrock and large boulders in the main channel of the

Narrows, through sand-scoured bedrock and boulders at either end of the channel, to more sheltered bedrock and boulders in the main central portion of the lough and in parts of the intertidal. Beds of horse mussels *Modiolus modiolus* form extensive biogenic reefs within the central portion of the lough. Tide-swept bedrock is restricted to the Strangford Narrows, where rock surfaces are entirely clothed in suspension-feeding species, notably the soft coral dead-men's fingers *Alcyonium digitatum*, sponges, especially *Pachymatisma johnstonia* and the rock-boring *Cliona celata* (which reaches massive proportions), ascidians, particularly *Dendrodoa grossularia* and *Corella parallelogramma*, and sea-anemones including *Metridium senile*. Very large boulders strew much of the bed of the Narrows, and are subject to strong tidal streams. These boulders are clothed with encrusting sponges, such as *Myxilla incrustans* and *Myxilla fimbriata*, with abundant hydroids, especially *Tubularia indivisa*, and sea anemones, including *Sagartia elegans*, *Corynactis viridis* and *Actinothoe sphyrodeta*. Coarse sand scours rock surfaces at the sides and either end of the Narrows. Here the characteristic species is the bryozoan *Flustra foliacea*. Though most of the intertidal zone is clothed in sediments, glaciated or sea-worn bedrock outcrops are found at many locations. Massive boulders (glacial erratics or the cores of eroded drumlins) occur on the shore and form rocky islands known as 'pladdies'. Whilst Silurian rocks predominate, there is sandstone at Mountstewart and limestone at Limestone Rock. The fauna and flora associated with these outcrops are dependent on the rock type, the angle of bedding-plane and degree of weathering, the position on the shore, and the degree of exposure to currents and waves. Full development of the climax biotope associated with the *M. modiolus* beds depends on the very sheltered, plankton-rich waters of extremely low turbidity found in the central to northern area. *M. modiolus* rarely occurs in such still waters. The mussels and dead mussel shells provide a hard surface in an otherwise soft- sediment environment on which numerous other species (up to 100) depend. Many mobile suspension- feeders also occur, particularly the scallop *Chlamys varia* which is co-dominant with *M. modiolus*. A similar biotope, also dominated by *M. modiolus*, but with brittlestars *Ophiothrix fragilis* and *Ophiocomina nigra* replacing *C. varia* as co-dominant, occurs in the central to south-western area where water movement is slightly greater.

Figure 2.3: Location of Strangford Lough.

Strangford Lough supports a wide diversity of species, including shellfish. The designated shellfish area within the lough is 8.35km^2 and the licenced shellfish sites cover an area of 3km^2. Mussels, Pacific oysters, native oysters and scallops are cultivation in the lough.

Land use in the catchment area is made up of approximately 90% agricultural land (pastures, complex cultivation patterns and agriculture/natural vegetation). The main freshwater sources to the lough are the Comber River (through Comber town) in the northwest and the Quoile River (through Downpatrick) in the south west.

The population of the catchment is approximately 150,000[2]. The main settlements are Newtownards with a population of 28,437[3] and Downpatrick with a population of 10,737[2]. The smaller coastal centres are villages/intermediate settlements with populations ranging from 1,037[2] (Greyabbey) to 3,028[2] (Killyleagh).

There are a number of shellfish fisheries within the lough. Current (i.e. over the last 25-30 years) commercial fishing and shore harvesting has largely focused on shellfish although angling for finfish continues (Roberts *et al.,* 2004a*)*. Exploited shellfish include scallops (*Pecten maximus* and *Aequipecten opercularis*); oysters (*Ostrea edulis*); whelks (*Buccinum undatum*); periwinkles (*Littorina littorea*); crabs (*Cancer pagurus*, *Necora puber*); lobsters (*Homarus gammarus*, *Nephrops norvegicus* [Dublin Bay prawns]) and squat lobsters (*Galathea* sp. & *Munida* sp.) although the latter are largely by-catch species in pots. Fishing involves the use of mobile gear for scallops and Dublin Bay prawns (which are also taken in pots); all other species are taken in baited pots.

Strangford Lough has numerous functions and processes, which are listed below:

- Dispersal of water quality characteristics brought about by the movement of water masses;
- Nutrient exchange;
- Bioturbation;
- Gas exchange;
- Primary and secondary production;
- Provision of habitats and ecosystems;
- Supports plankton populations, benthic infauna, epifauna, fish populations, bird populations;
- Propagule (e.g. seed stock/larvae) dispersion brought about by the movement of water masses;

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[2] Calculation explained in Section 4.1.1

[3] Source: Northern Ireland Statistics website: www.nisra.gov.uk. Crown copyright material is reproduced with the permission of the Controller of HMSO. 2008 Data

- Fishing activities;
- Navigation;
- Aquaculture activities;
- Socio-economic activities; and
- Recreational activities.

Oyster beds themselves perform important ecological functions including supporting oyster populations, providing refuge for fish and invertebrates that retreat from exposed intertidal flats and estuarine marshes at low tide, and serving as spawning and nursery areas for numerous species of aquatic animals. Oysters are an important food source for many other animals including starfish, crabs, fishes, and waterfowl.

Beds of mussels provide substratum for epiflora and epifauna, while the mussel matrix provides interstices and refuges for a diverse community of organisms. The buildup of mussel muds under the bed supports infaunal species, and in sedimentary habitats, the underlying sediment may support an enriched infauna. The diversity and species richness increases with the size and age of the mussel bed. In sedimentary habitats, mussel beds stablise and modify the substratum, and mussel beds have a higher biodiversity than surrounding mudflats. Mussel beds may also form biogenic reefs and *Mytilus edulis* is considered to be a habitat engineer (Holt *et al*, 1998; Hild & Günther, 1999).

In addition, larval production represents a significant contribution to the zooplankton, forming an important food source for herring larvae and carnivorous zooplankton (Seed & Suchanek, 1992). Dense beds of bivalve suspension feeders increase turnover of nutrients and organic carbon in estuarine (and presumably coastal) environments by effectively transferring pelagic phytoplanktonic primary production to secondary production (pelagic-benthic coupling) (Dame, 1996).

Ferreira *et al.* (2007) produced a carrying capacity assessment of Strangford Lough as part of the SMILE (Sustainable Mariculture in northern Irish Lough Ecosystems) Project. The approach used in the SMILE Project combined field data acquisition, experimental work on shellfish feeding behaviour, database and GIS and the implementation and coupling of various types of dynamic models. The concept of carrying capacity of an ecosystem for natural populations is derived from the logistic growth curve in population ecology, and defined as the maximum standing stock that can be supported by a given ecosystem for a given time. Carrying capacity estimates in terms of aquaculture (production) may be defined as the stocking density at which production levels are maximised without having a negative impact on growth. Subsequently, carrying capacity for shellfish culture has been further defined as the standing stock at which the annual production of the marketable cohort is maximised. This will differ substantially from the ecological carrying capacity and is termed the sustainable aquaculture carrying capacity.

For bivalve suspension feeders, the dominant factors determining the sustainable carrying capacity at the ecosystem scale are primary production, detrital inputs and exchange with adjacent ecosystems. At the local scale, carrying capacity depends on physical constraints such as substrate, shelter and food transported by tidal currents, and density-dependent food depletion. Mortality is a critical factor, and high seed mortality due to sub-optimal seed deployment, particularly in bottom culture, is a key factor in reducing production yield and economic competitiveness.

Table 2.1 shows the summary of SMILE model results for Strangford Lough. The average physical product (APP) is defined as the ratio between harvested biomass (total physical product – TPP) and seed biomass, and is a measure of ecological and economic efficiency. The total production per unit of area is also shown, and varies within the system depending on the location of the aquaculture.

Table 2.2: Summary of SMILE model results for Strangford Lough (Source: Ferreira *et al.* 2007).

Ecosystem and Species		Aquaculture Area (ha)	TPP (tons)	APP	TPP per ha
Strangford Lough	Blue Mussel	6	9		1.5
	Pacific Oyster	24	223	8	9.5

2.3. *Description of Species*

2.3.1. Blue Mussels (*Mytilus edulis*)

2.3.1.1. General Biology

Mytilus edulis is a filter feeding marine bivalve. It occurs from the high intertidal to the shallow subtidal attached by fibrous byssus threads to suitable substrata. It is found on the rocky shores of open coasts attached to the rock surface and in crevices, and on rocks and piers in sheltered harbours and estuaries, often occurring as dense masses. They are a gregarious species and at high densities form dense beds of one or more (up to 5 or 6) layers, with individuals bound together by their byssus threads. Young mussels colonise spaces within the bed increasing the spatial complexity, and the bed provides numerous niches for other organisms. Overcrowding results in mortality as underlying mussels are starved or suffocated by the accumulation of silt, faeces and pseudofaeces, especially in rapidly growing populations (Richardson & Seed, 1990). Death of underlying individuals may detach the mussel bed from the substratum, leaving the bed vulnerable to tidal scour and wave action (Seed & Suchanek, 1992).

Growth rates in *Mytilus* spp. are highly variable. Part of this variation is explained by genotype and multilocus heterozygosity (Gosling, 1992) but the majority of variation is probably environmentally determined. The following factors affect growth rates in *Mytilus* species: temperature, salinity, food availability, tidal exposure, intraspecific competition for space and food and parasitism.

Several factors may work together, depending on location and environmental conditions (Seed & Suchanek, 1992) or the presence of contaminants (e.g. Thompson *et al.*, 2000). For example, in optimal conditions *Mytilus edulis* can grow to 60-80mm in length within 2 years but in the high intertidal growth is significantly lower, and mussels may take 15-20 years to reach 20-30mm in length (Seed & Suchanek, 1992). Bayne *et al.* (1976) demonstrated that between 10-20°C water temperature had little effect on scope for growth and Carter & Seed (1998) showed that latitudinal variations in temperature influences shell structure in *Mytilus* species.

Several factors contribute to mortality and the dynamics of *Mytilus edulis* populations e.g. temperature, desiccation, storms and wave action, siltation and biodeposits and intra- and interspecific competition, but predation is the single most important source of mortality. Many predators target specific sizes of mussels and, therefore, influence population size structure. The vulnerability of mussels decreases as they grow, since they can grow larger than their predators preferred size. *Mytilus* sp. may be preyed upon by neogastropods such as *Nucella lapillus*, starfish such as *Asterias rubens*, the sea urchin *Paracentrotus lividus*, crabs such as *Carcinus maenas* and *Cancer pagurus*, fish such as *Platichthys flesus* (plaice), *Pleuronectes platessa* (flounder) and *Limanda limanda* (dab), and birds such as oystercatcher, eider, scooter, sandpiper, knot, turnstone, gulls and crows (Seed & Suchanek, 1992; Seed, 1993).

Fouling organisms, e.g. barnacles and seaweeds, can also increase mussel mortality by increasing weight and drag, resulting in an increased risk of removal by wave action and tidal scour. Fouling organisms may also restrict feeding currents and lower the fitness of individual mussels. However, *Mytilus edulis* is able to sweep its prehensile foot over the dorsal part of the shell (Thiesen, 1972, Seed & Suchanek, 1992). Fouling by ascidians can be a problem in rope-cultured mussels (Seed & Suchanek, 1992).

In addition, the polychaete *Polydora ciliata* may burrow into the shell of *Mytilus edulis*, which weakens the shell leaving individuals more susceptible to predation by birds and shore crabs resulting in significant mortality, especially in mussels >6 cm (Holt *et al.*, 1998).

Longevity is dependent on locality and habitat. On the lower shore, few individuals probably survive more than 2-3 years due to intense predation as discussed above, whereas high shore populations are composed of numerous year classes (Seed, 1969a). Specimens have been reported to reach 18-24 years of age (Thiesen, 1973).

Spawning is protracted in many populations, with a peak of spawning in spring and summer. Resting gonads begin to develop from October to November, gametogenesis occurring throughout winter so that gonads are ripe in early spring. A partial spawning in spring is followed by rapid gametogenesis, gonads ripening by early summer, resulting in a less intensive secondary spawning in summer to late August or September (Seed, 1969b). Mantle tissues store nutrient reserves between August and October, ready for gametogenesis in winter when food is scarce (Seed & Suchanek, 1992). Larvae spawned in spring can take advantage of the phytoplankton bloom. The secondary spawning is opportunistic, depending on favourable environmental conditions and food availability. Reproductive strategies in *Mytilus edulis* probably vary depending on environmental conditions (Newell *et al.*, 1982). Fertilization is external and can occur successfully between 5- 22°C and at salinities of 15-40psu (Bayne, 1965; Lutz & Kennish, 1992).

Fecundity and reproductive effort increase with age and size, young mussels diverting energy to rapid growth rather than reproduction. Reproductive output is influenced by temperature, food availability and tidal exposure and can therefore vary from year to year. An individual female (ca 7mm) can produce 7-8 million eggs, while larger individuals may produce as many as 40 million eggs (Thompson, 1979).

In optimal conditions larval development may be complete in less than 20 days but growth and metamorphosis in the plankton between spring and early summer, at ca. 10 °C, usually takes 1 month. However, it is not unusual for planktonic life to extend beyond 2 months in the absence of suitable substrata or optimal conditions (Bayne, 1965; Bayne, 1976). Pediveligers (the third and final free swimming larval stage, prior to settlement or attachment to a substrate) can delay metamorphosis for up to 40 days at 10 °C (Lutz & Kennish, 1992) or for up to 6 months in some cases (Lane *et al.*, 1985). The duration of the delay is mainly determined by temperature, with longer delays at low temperature (Strathmann, 1987). Larvae become less selective of substrata the longer metamorphosis is delayed. In many populations *Mytilus edulis* exhibits a two stage settlement, the pediveliger settling on filamentous substrates such as, bryozoans, hydroids, filamentous algae such as *Polysiphonia* sp., *Corallina* sp. and *Mastocarpus* sp., or the byssus threads of previously settled adults and then moving on to suitable adult substrata by bysso-pelagic drifting. Post-larvae may remain on their primary attachment until 1-2mm in size (sometimes larger), and many late post-larvae over-winter on algae, moving to adult substrata in spring, although many will leave the algae earlier due to winter storms or death of the algae (Seed & Suchanek, 1992). Newly settled mussels are termed 'spat'.

Dispersal is dependent on the duration of planktonic life. Maintenance of their position in the water column by active swimming ensures that larvae can be potentially dispersed over great distances by currents. In addition, post-larvae can become bysso-pelagic up to 2-2.5 mm in size, which may take ca. 2 months to achieve, during which time they may be transported significant distances by currents. Recruitment is dependent on larval supply and settlement, together with larval and post-settlement mortality. Larval mortality is probably due to adverse environmental conditions, especially temperature, inadequate food supply (fluctuations in phytoplankton populations), inhalation by suspension feeding adult mytillids, difficulty in finding suitable substrata and predation (Lutz & Kennish, 1992). Recruitment in many *Mytilus* sp. populations is sporadic, with unpredictable pulses of recruitment, possibly from the pool of young mussels on filamentous algae (Seed & Suchanek, 1992). *Mytilus* sp. is highly gregarious and final settlement often occurs around or in between individual mussels of established populations (AQUAFACT, 2007). Competition with surrounding adults may suppress growth of the young mussels settling within the mussel bed, due to competition for food and space, until larger mussels are lost (Seed & Suchanek, 1992). Persistent mussel beds can be maintained by relatively low levels of recruitment.

Mytilus edulis is a filter feeding organism, which collects algae, detritus and organic material for food but also filters out other contaminants in the process. Shumway (1992) noted that mussels are likely to serve as vectors for any water-borne disease or contaminant. Mussels have been reported to accumulate faecal and pathogenic bacteria and viruses, and toxins from toxic algal blooms. Bacteria may be removed or significantly reduced by depuration (placing contaminated mussels into clean water) although outbreaks of diseases have resulted from poor depuration and all viruses may not be removed by depuration. Recent improvements in waste water treatment and shellfish water quality regulations may reduce the risk of bacterial and viral contamination. The accumulation of toxins, by the mussels, from toxic algal blooms may result in paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP) or amnesic shellfish poisoning (ASP). These toxins are not destroyed by cooking. Shumway (1992) suggested that mussels should only be collected from areas routinely monitored by public health agencies, or obtained from approved sources and never harvested from waters contaminated with raw sewerage.

Mytilus edulis is not listed as threatened or endangered; however, intertidal *Mytilus edulis* beds are listed as threatened or in decline in the OSPAR [Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)] List of Threatened and/or Declining Species and Habitats (OSPAR, 2008).

2.3.1.2. Distribution

Figure 2.4 shows the currently licenced mussel harvesting areas within Strangford Lough. This covers an area

0.49km^2 (approximately 16% of the entire licenced area). The majority of these sites are located in the northeastern region of the lough between Gransha Point and Chapel Island.

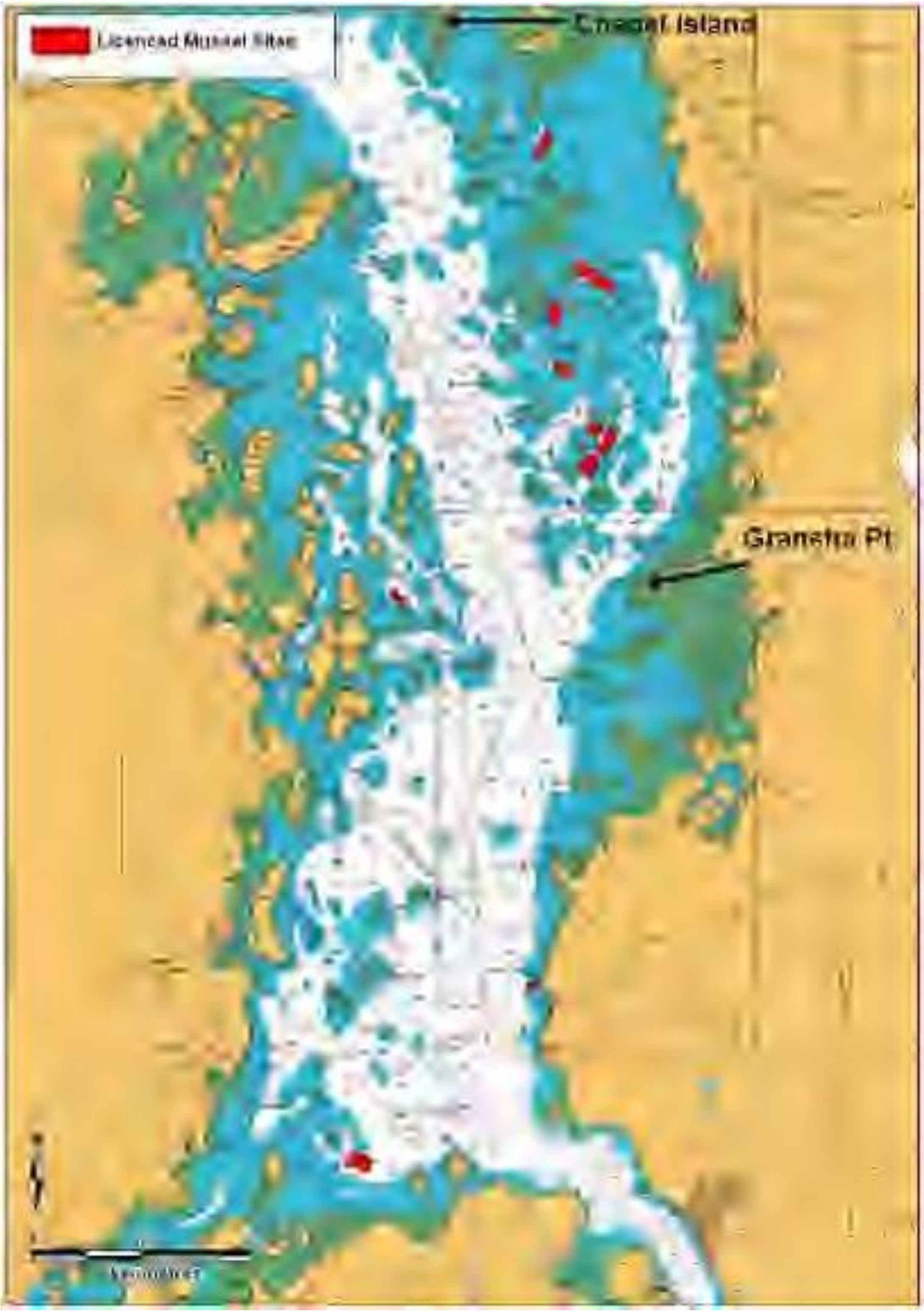


Figure 2.4: Mussel licenced sites in Strangford Lough (Source: DARD).

2.3.1.3. Fishery

In Strangford Lough mussels are cultivated by suspended mussel culture systems which involve the collection and wrapping of seed mussels on ropes or similar material, which are hung from rafts or floats (Roberts *et al.,* 2004b). The mussels are typically collected *in situ* by settlement from the plankton and grown on the collecting ropes. As the mussels develop, they are stripped from the ropes, graded for size, tubed (mesh) and resuspended in the watewr column. Suspended mussel culture systems have a number of advantages, the main one being to avoid predation. Suspended mussels are usually of a superior quality with higher meat yields (between 30 and 35%, compared to 20-30% for bottom cultured, dredged mussels), better shell quality and no sand/grit in the meat (O'Sullivan, 1997). Harvesting usually occurs 18-30 months from settlement. Because the suspended mussel culture utilises more of the water column, production of the area is significantly enhanced (Dore, 1991), however there may be increased competition with other wild (non farmed/indigenous stock) filter feeders for available plankton (Roberts *et al.,* 2004b). Such competition would probably only become a problem in areas of poor water exchange, with a poor supply of phytoplankton, and is unlikely to occur in Strangford Lough (Kelso & Service, 2000).

Figure 2.5 shows the total mussel production in Strangford Lough from 2004 to 2010 (Source: Department of Agriculture and Rural Development [DARD]). Output increased from a low of 15 tonnes in 2004 to 50 tonnes in 2007 follwed by a decrease to 41 tonnes in 2008 and a slight increase to 45 tonnes in 2009. The highest output was in 2010, 51 tonnes. Values increased from a low of £21,000 in 2004 to £75,000 in 2007, decreasing steadily to £70,000 in 2009 and increasing to £82,022 in 2010. Input levels were greatest in 2005 (54 tonnes).

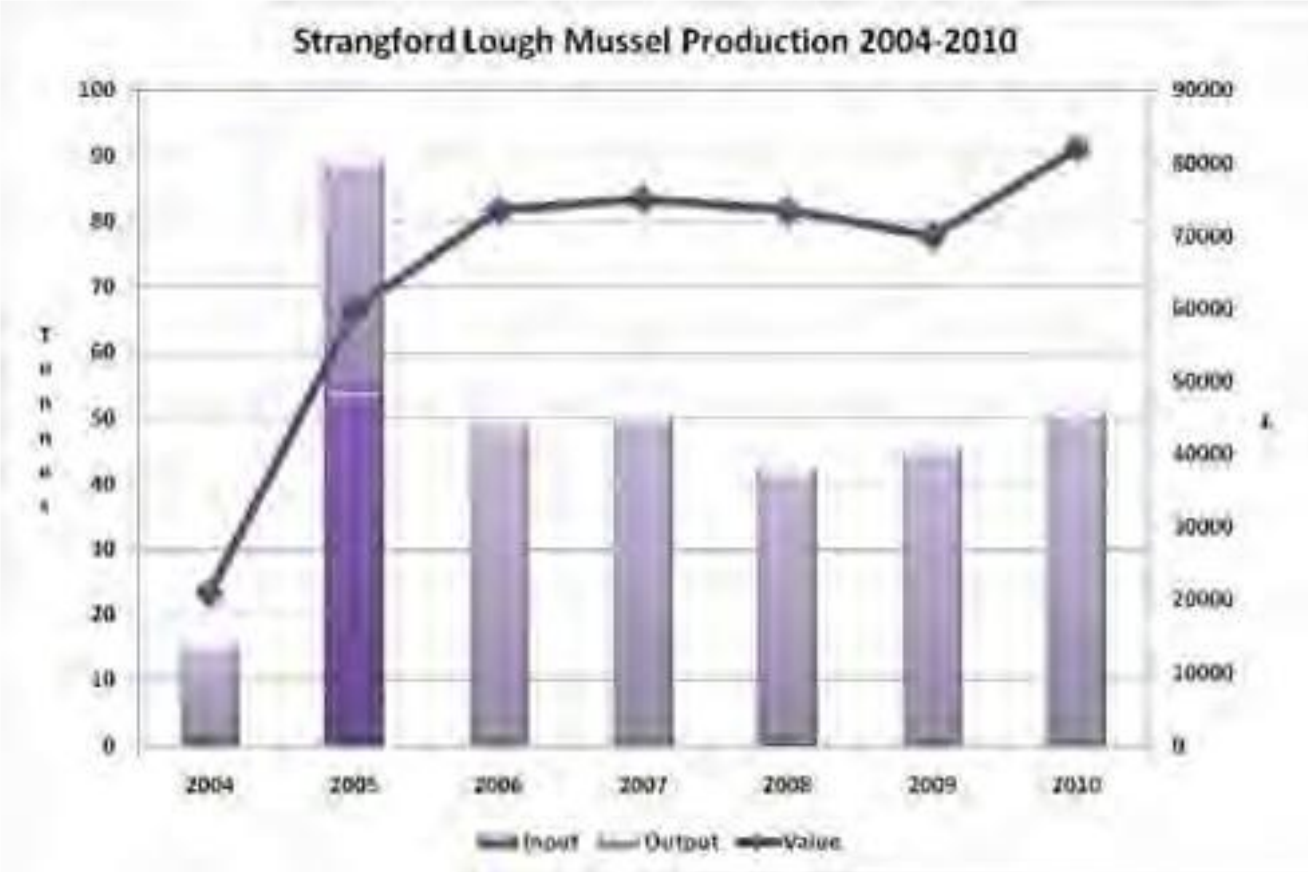


Figure 2.5: Mussel production in Strangford from 2004-2010 (Source: DARD)

2.3.2. Native Oysters (*Ostrea edulis)*

2.3.2.1. General Biology

The European flat oyster is the only indigenous species of true oyster found around the British Isles (Yonge, 1966). *Ostrea edulis* is a potentially long-lived member of the sessile epibenthic macrofauna, often forming extensive beds in lower intertidal and sublittoral areas down to 30m in depth (Hayward & Ryland, 1995). Sheltered locations such as loughs or estuaries exhibiting a variety of bottom types (stiff mud, sandy mud, fine gravel or shells with a mixture of mud, sand or gravel) can provide optimal grounds for flat oyster survival (Cole, 1956).

Ostrea edulis is dioecious and has been defined as an alternate, continuous hermaphrodite (Korringa, 1952). On reproductive maturity oysters tend to function as males (Rothschild *et al.*, 1994) before entering a cycle of alternation between sexes, which continues throughout life (Kennedy, 1999). The number of sex changes expressed annually depends on the length of the breeding season, which is itself determined by the ambient temperature regime (Loosanoff, 1962). Consequently flat oysters tend to exhibit a greater number of sexual episodes in any one year in the warmer southern regions of their range (Yonge, 1966).

Functional female flat oysters are larviparous and retain up to 1 million eggs within the mantle cavity (Utting *et al.*, 1991). During the spawning period the functional male oysters release sperm into the water column; which is then taken up by the female to fertilise the eggs inside the pallial cavity (Cole, 1941, Yonge, 1966). Developing larvae remain inside the pallial cavity for a period of 8-10 days, before being released as shelled veligers into the water column to undergo a short planktotrophic stage which lasts for approximately 10-14 days depending on ambient conditions (Knight-Jones, 1952, Walne, 1964). The planktonic veligers develop into pediveligers, which are capable of attaching to suitable substrata before undergoing metamorphoses into the final benthic stage of the lifecycle (Carriker, 1961). When the larvae are fully developed they settle on to the surface of suitable material (cultch); this is often another oyster shell but may be many other substances. Flat oysters are reported to exceed 12 years of age and to reach sizes of 15 x 15.4cm (Roberts *et al.,* 2004b).

Flat oysters exhibit slower growth rates than *Crassostrea* and reach market size within 5-6 years. Kennedy (1983) noted that overfishing could generate potential problems for protandrous hermaphroditic species like *Ostrea edulis*. In such species, larger individuals exhibit a greater capacity to function as females; the larger size categories of the stock therefore contribute most significantly to egg production. As fishing effort increases, the mean size and age of the population decreases as larger individuals are preferentially removed. This leaves an oyster bed with a lower proportion of productive females and thus the production of eggs per unit biomass of the stock may plummet as the sex ratio changes. In effect, the population suffers recruitment overfishing, in which the spawning stock biomass produces less than the average potential recruitment (Rothschild *et al.*, 1994).To achieve the best fertilisation rates the distance between male and female oysters must be kept to a minimum to effect good transfer of sperm. As the population density falls, due to increased fishing effort, the fertilisation rate declines as the mean distance between compatible individuals increases. Dilution of sperm results in incomplete fertilisation of females and wastage of reproductive effort (Galtsoff *et al*., 1930).

In addition to overfishing, oyster stocks are threatened by disease, particularly the flat oyster disease (Bonamiasis) caused by infection with the protozoan parasite *Bonamia ostreae* (Pichot *et al*., 1979, cited in Spencer, 1990). Bonamiasis has progressively destroyed the flat oyster fisheries of mainland Europe and has had a serious impact on fisheries in Britain and Ireland (Hawkins *et al.*, 1992).

In Strangford Lough, the traditional native oyster fishery collapsed around 1903, possibly as a result of overfishing. The decline of natural oyster beds, such as those in Strangford Lough and elsewhere in Europe, together with a failure of natural spatfalls to replenish stock, stimulated the search for hatchery techniques for the production of oyster seed under a fully controlled environment at the Fisheries Laboratory, Conwy.

2.3.2.2. Distribution

Figure 2.6 shows the locations of licenced native oyster sites in Strangford Lough. These farmed sites cover an area of 0.47km^2 (approximately 16% of the total licenced area). The three sites in Strangford are located in Reagh Bay and Paddy's Point in the northwestern region of the lough and close to Salt Island in the southwestern region of the lough. There is also a unlicenced (yet classified) site, known as The Dorn, which acts as a hardening off are at the foot of the depuration plant where oysters go for depuration.

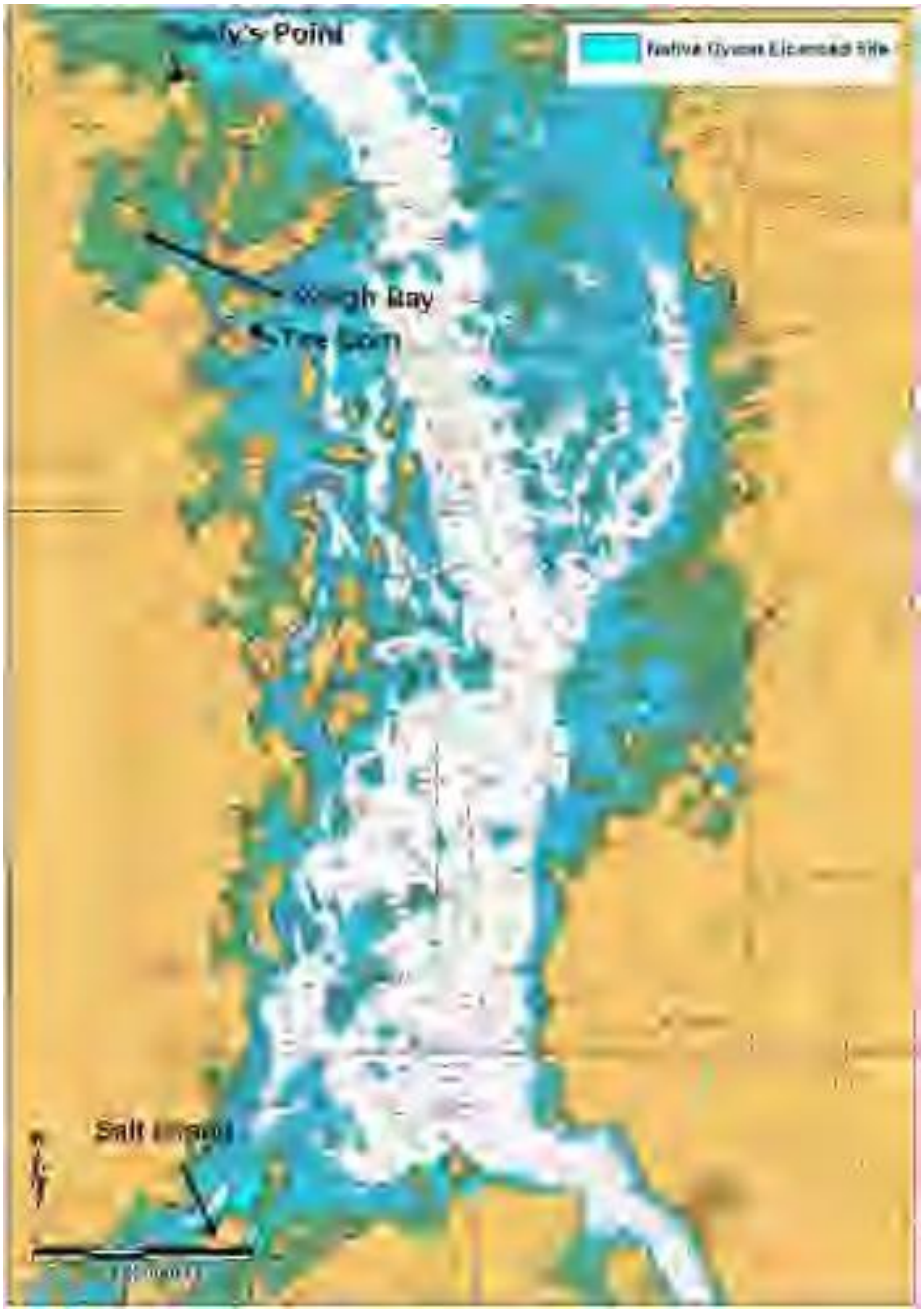


Figure 2.6: Licenced native oyster harvesting sites in Strangford Lough (Source: DARD).

2.3.2.3. *Fishery*

The start of attempts to re-establish *Ostrea edulis* in Strangford Lough dates back to observation of oyster spat at various sites in the north of the lough in the early 1990s; the spat were most probably derived from spawning commercial stocks of native oysters held in high densities on mats in the low intertidal zone (Roberts *et al.,* 2004b). These observations resulted in trials, led by Strangford Lough Shellfishermen's Cooperative, to initiate extensive culture and a sustainable fishery for native oysters in the lough. Shell cultch, native oyster seed and broodstock were placed on three licensed sites during 1998 under section 14 permits. In parallel with commercial trials, Kennedy (1999) investigated oyster distribution, larval production and spatfall. Kennedy (1999) noted significant larval flux from the part of the lough with commercial oyster beds, supporting the idea that most spatfall could be attributed to this source. Sites surveyed by Kennedy in 1998 were resurveyed by Smyth in 2003 and 2004 (Smyth, 2005) and point to significant oyster settlement over the previous four to five years and widespread, unregulated harvesting which resulted in the first significant harvest of native oysters from Strangford Lough for over 100 years. Native oysters are cultivated by bottom cultivation in Strangford Lough (Roberts *et al.,* 2004b).

Figure 2.7 shows the total native oyster production in Strangford Lough from 2004 to 2010 (Source: DARD). Output decreased from 3.14 tonnes in 2004 to 0.16 tonnes the following year and there has been no output since. There was an input of 5 tonnes in 2007 which should result in some output in 2012/2013. Values in 2004 were approximately £17,000.

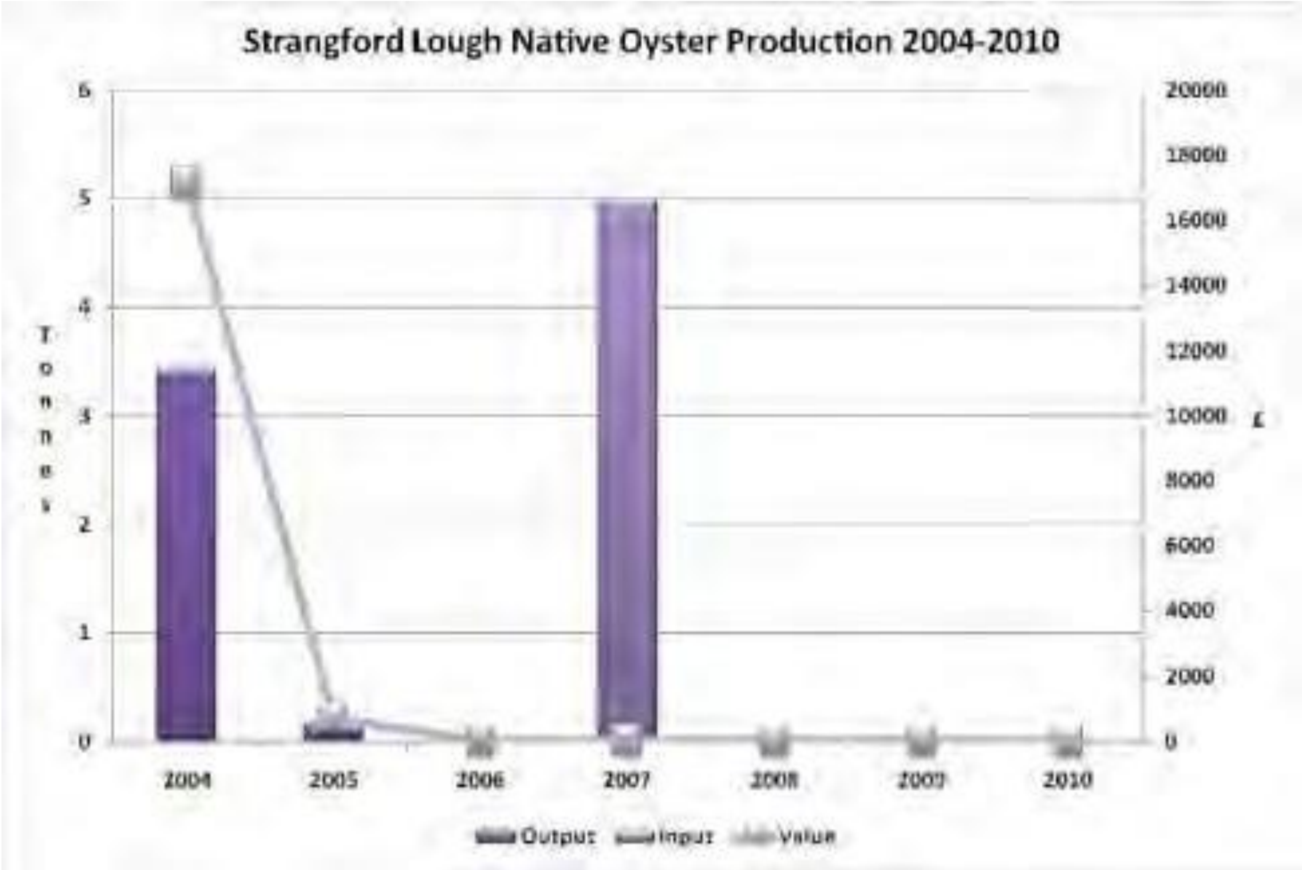


Figure 2.7: Native oyster production in Strangford from 2004-2010 (Source: DARD)

2.3.3. Pacific Oysters (*Crassostrea gigas*)

2.3.3.1. General Biology

Pacific oysters are not native to Irish waters; they were introduced from the Pacific coasts of Asia. They are large cupped oysters with a deep, elongated shell, which is often very irregular. They can be found in intertidal and subtidal zones. They prefer to attach to hard or rocky surfaces in shallow or sheltered waters but have been known to attach to muddy or sandy areas when the preferred habitat is scarce. They can also be found on the shells of other animals. They can grow to approximately 30cm but is normally harvested at less than 15cm (Roberts *et al.,* 2004b).

The sexes are separate, but as the oyster ages it may change sex with females being more numerous when conditions are favourable (Roberts *et al.,* 2004b). Females discharge millions of eggs into the water column, where fertilisation occurs. The larvae are planktonic and develop within a few hours, swim actively for about two or three weeks and then drop out of the plankton and settle on material on the bottom, at which point it is known as 'spat'. The larvae often settles on the shells of adults, and great masses of oysters can grow together to form oyster reefs. The larvae spend the first year attached as a male, before eventually becoming female.

C. gigas does not spawn at temperatures below 20°C. It is very unusual for Pacific oysters to spawn in Ireland. However, they will ripen even in an average summer, and the gonads will become 'milky' with eggs or sperm. Unharvested oysters can live up to 30 years. The conservation status of *Crassostrea gigas* is not listed.

2.3.3.2. Distribution

Figure 2.8 shows the locations of licenced intertidal farmed Pacific oyster sites in Strangford Lough. These farmed sites cover an area of $0.28km^2$ (approximately 9% of the total licenced area). The two farms in Strangford are located on the inter-tidal areas of foreshore in Reagh Bay and Paddy's Point in the northwestern region of the lough. There is also a unlicenced (yet classified) site, known as The Dorn, which acts as a hardening off are at the foot of the depuration plant where oysters go for depuration.

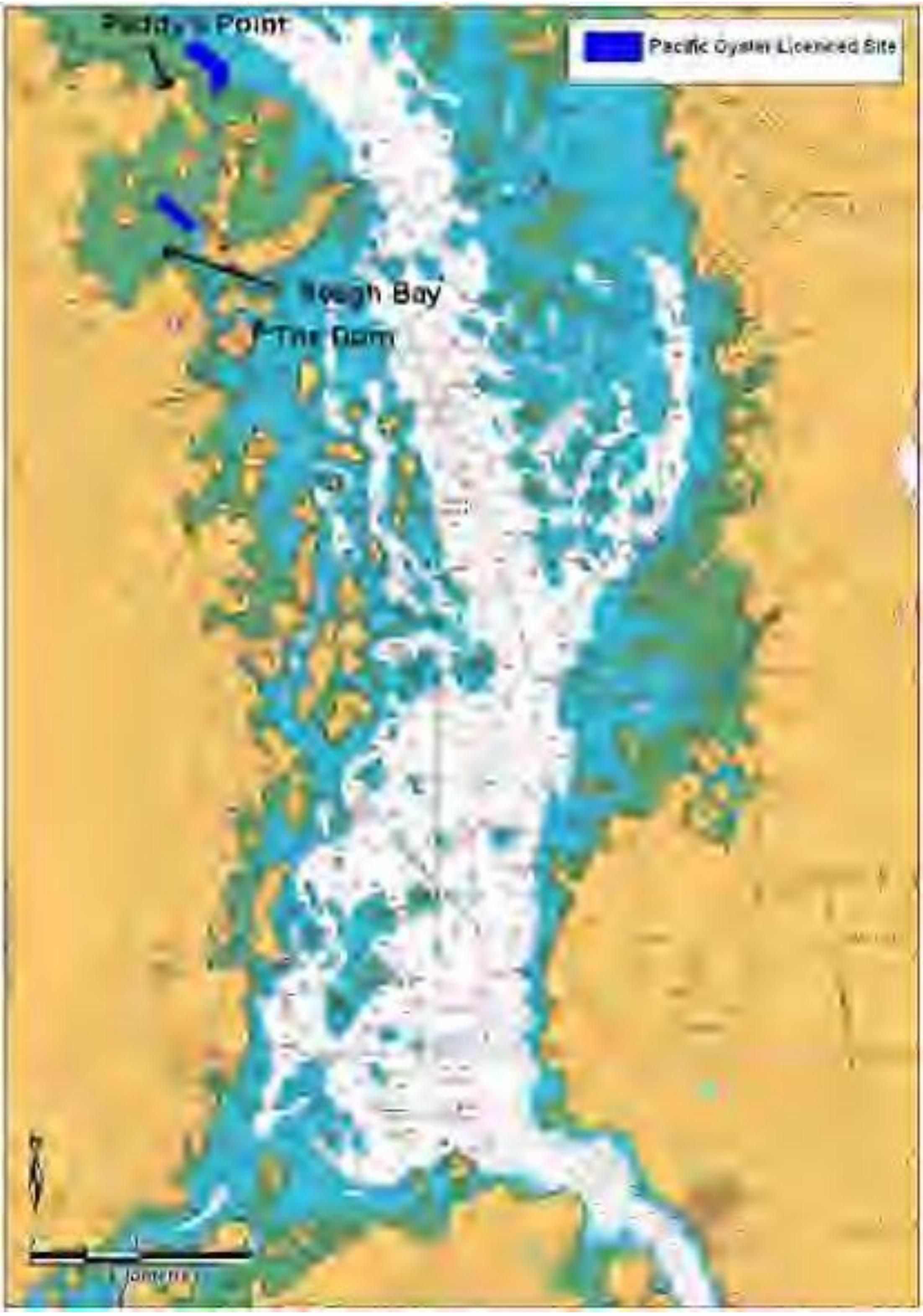


Figure 2.8: Licenced Pacific oyster harvesting sites in Strangford Lough (Source: DARD).

2.3.3.3. *Fishery*

Pacific oysters were trialled in Strangford Lough by DANI (Department of Agriculture for Northern Ireland[4]) in 1970. Since then production has expanded steadily (Spencer, 1990).

All Pacific oysters grown in Ireland come from hatchery produced seed. *Crassostrea gigas* is both faster growing (reaches market size in 3-4 years), shows greater tolerance to disease and is tolerant of a wider range of conditions than the native or flat oyster (*Ostrea edulis*) (Roberts *et al.,* 2004b). Seed can be purchased at a variety of sizes, small (G7) seed are placed in nursery trays until they reach a suitable size to be placed in bags (pouches) on trestles for on-growing (Roberts *et al.,* 2004b). Seed taken at a larger size may be placed directly into the bags but as seed size increases so does the price. The trestles are made of 16mm steel tube and are usually approximately 300mm high and are 2.5-3.0mlong by 1m wide. Each trestle can hold 5-6 oyster bags, which are held on by rubber bands and/or hooks. The bags vary in mesh size depending on the size of oyster being held. The bags and trestles are reusable and remain on the shore all year round. Oyster sites are accessed by farmers at low tide using a tractor and trailer. The farms are positioned between Mean Low Water Spring and Mean Low Water Neap, allowing 2.5-3.5 hrs exposure per day, depending on weather conditions. This in turn translates to approximately 15% visual exposure during day light hours over a typical month. When cultured off the bottom, oysters are protected from predators and tend to grow faster. Oysters grown in bags that are regularly turned are more evenly shaped and less bent and twisted than traditional bottom culture. If submerged for their full life-span oysters tend to have more fragile shells than those which have been 'hardened' by exposure to the air at major tides.

Figure 2.9 shows the total Pacific oyster production in Strangford Lough from 2004 to 2010 (Source: DARD). Output increased from 194 tonnes in 2004 to a high of 235.5 tonnes in 2007 followed by a steady decrease to a low of 80 tonnes in 2010. Values increased from approximately £506,500 in 2004 to a high of approximately £620,000 in 2007. This was followed by a decrease to a low of £288,000 in 2010. Input was 50 tonnes in 2007.

[4] Obsolete title, currently called Department of Agriculture and Rural Development [DARD}

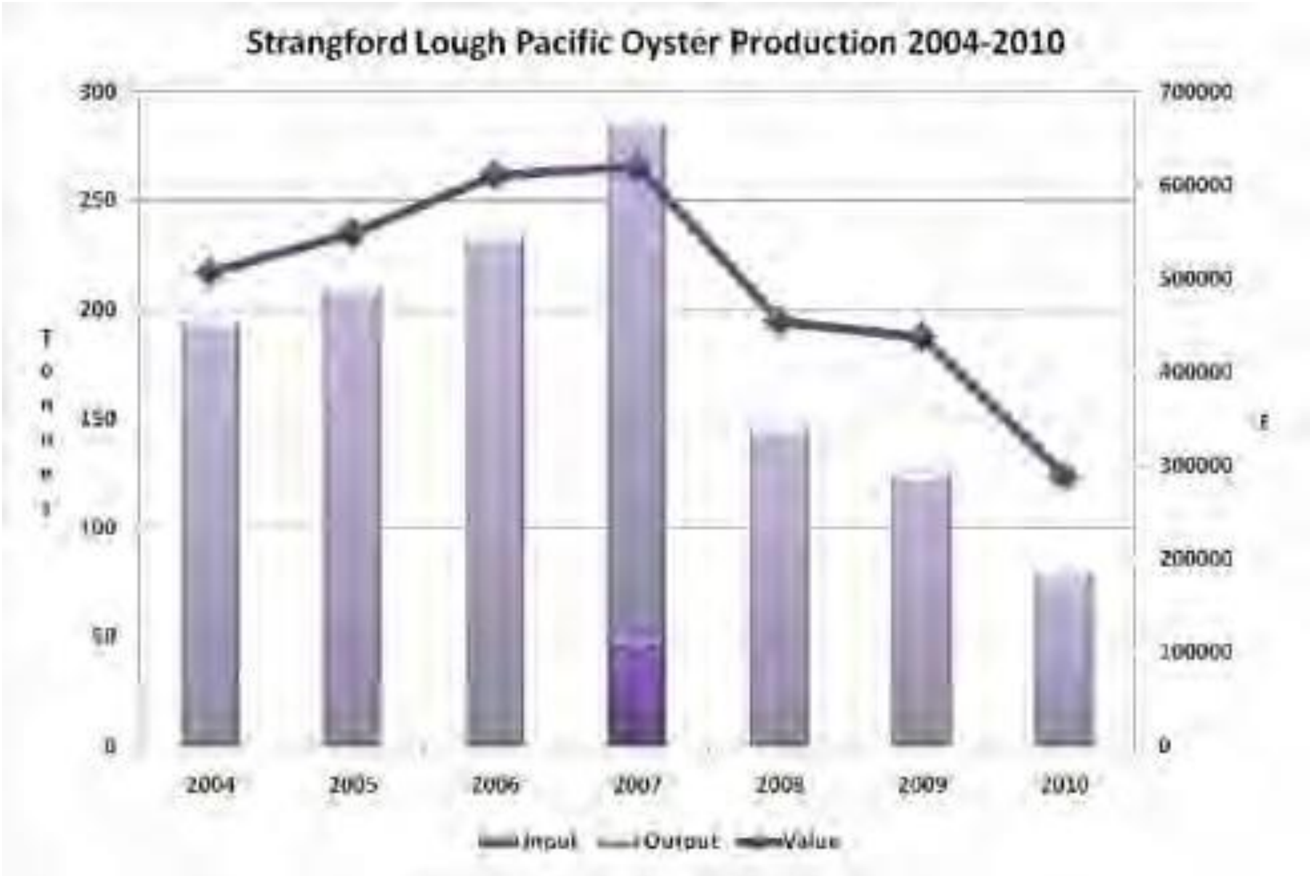


Figure 2.9: Pacific oyster production in Strangford from 2004-2010 (Source: DARD).

2.3.4. Scallops (*Pecten maximus*)

2.3.4.1. General Biology

The great scallop (*Pecten maximus*) is a large scallop, which in most areas can grow to a shell height of 150mm or more (Ansell *et al.,* 1991). Individuals can live for 20 years or more, but the average life-span is much lower than this, even in unexploited populations. Adult *Pecten maximus* prefer substrata of clean firm sand, fine gravel or sandy gravel and generally recess into the sediment so that the upper, flat valve is level with the seabed and often has a slight covering of sediment. If disturbed, these scallops can attempt to protect themselves by swimming or closing their valves.

Scallops are hermaphrodites, the male portion of the gonad being proximal (testis, creamy-white) and the female part distal (ovary, pink-orangered) (Roberts *et al.,* 2004b). Scallops undergo cycles of reproductive activity in which gametes are produced and spawned, fertilisation occurs, and larvae develop. Inshore scallops generally spawn between April and June and again from August to September. In deeper water there is often only one peak in summer June/July). Spawning cycles of *Pecten maximus* show interannual variability in

Strangford Lough with either protracted or bimodal patterns of spawning between July and August (McDonough, 1998). In general, scallops have a life-cycle very similar to other filter-feeding molluscs. Eggs and sperm mix in the water, and the hatched larvae metamorphose into scallops within a few weeks. They attach themselves when they first metamorphose, using byssal threads in a similar manner to mussels. However, after they have fully developed, they abandon their attachment and thereafter are capable of free swimming. Although they are capable of moving reasonable distances by adducting the valves, scallops only seem to move when disturbed or to escape predators. Owing to the availability of suitable substrate this species is essentially coastal, being most abundant just inside or away from strong tidal streams. Their distribution is patchy with beds often consisting of a single age group. Starfish and crabs are the main predators of scallops.

2.3.4.2. Distribution

Figure 2.10 shows the locations of licenced scallop sites in Strangford Lough. These farmed sites cover an area of 2.12km^2 (approximately 71% of the total licenced area). There are two licenced sites in the northeastern region of the lough south of South Island and 2 in the southern region of the lough south of Ringburr Point and east of Green Island.

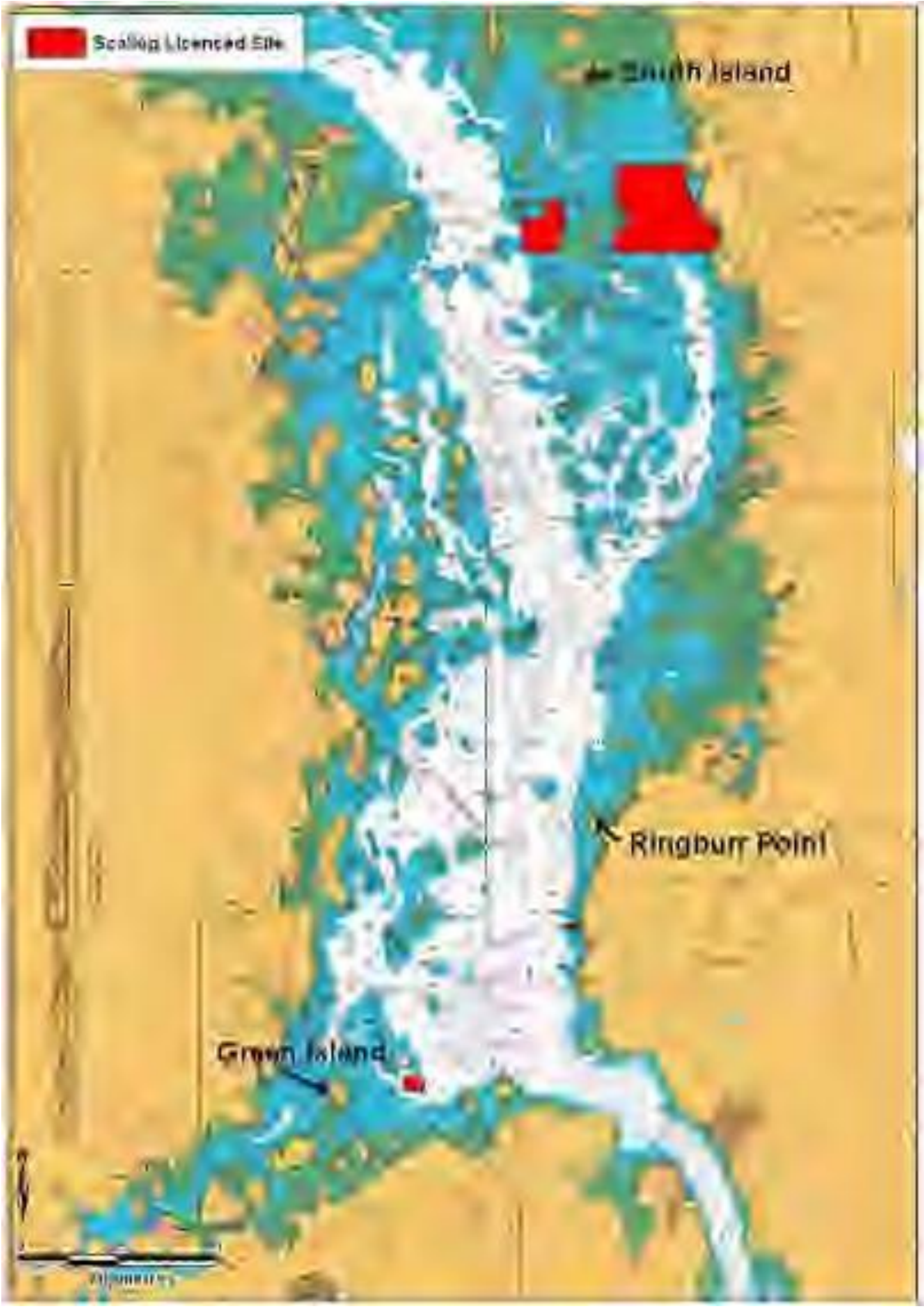


Figure 2.10: Licenced scallop harvesting sites in Strangford Lough (Source: DARD).

2.3.4.3. Fishery

Scallops are grown either by bottom cultivation or by suspended cultivation. In bottom cultivation, the scallops are introduced onto the site at 45-55mm and allowed to grow naturally (Roberts *et al.,* 2004b). Scallops grown on the seabed are usually harvested by divers after 2-3 years. Suspended cultivation requires flotation similar to that used in suspended mussel cultivation. Scallops can be eartagged, where a hole is drilled through the ear of the scallop and then it is attached directly to a vertical line suspended from a raft or long line. They can also be kept in lantern nets or stacked trays. The period from spat settlement to harvest will normally be approximately 4 -5 years (McDonough, 1998).

The cultivation of *P. maximus*, using scallop seed imported from Mulroy Bay, was conducted on a small scale at two sites in Strangford Lough since the 1980s. Investigations by C-Mar (Centre for Marine Resources and Mariculture) (Heath, 1995) and McDonough (1998) into the potential for collection of local scallop spat for growout in the lough revealed that settlement of *Pecten maximus* spat, which peaked in July (maximum densities = 14 per spat collector bag) was not commercially viable (minimum recommended 100 per spat collector bag [Wieland & Paul, 1983]).

In intermediate growth trials, growth rates were higher in the northern part of the lough (McDonough, 1998). Comparative studies of different cultivation equipment found that growth in lantern nets was commercially viable but survival was poor whereas the opposite was true for North-West Plastic trays. McDonough (1998) concluded that excessive fouling of both scallops and gear, poor survival and insufficient indigenous seed would limit the development of suspended cultivation of *P. maximus* in Strangford Lough.

More recently, 30,000 seed (56mm), also from Mulroy Bay, were relaid in an area of approximately 5,000m^2 in Scotts Hole as part of a scallop re-seeding exercise around the coast of Northern Ireland undertaken by Northern Ireland Scallop Fishermen's Co-op (NISFCo) in collaboration with North West Shellfish and C-Mar (Roberts *et al.,* 2004b). A main aim of the exercise was to increase spawning stock biomass in the relaid sites. In this trial, scallops recessed quickly in Strangford Lough after relaying and showed good growth and survival (>70% after 5months) (Heath, 1999).

Scallop production in Strangford Lough from 2004 to 2010 involved the input of seed in 2004 (0.1 tonnes), 2005 (20 tonnes) and 2007 (130,000 seed) and the output of 2 tonnes in 2006, 1 tonne in 2009 and 1 tonnes in 2010. The value of the 2006 output was £2,600 and £1,500 in 2010.

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). Strangford 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).

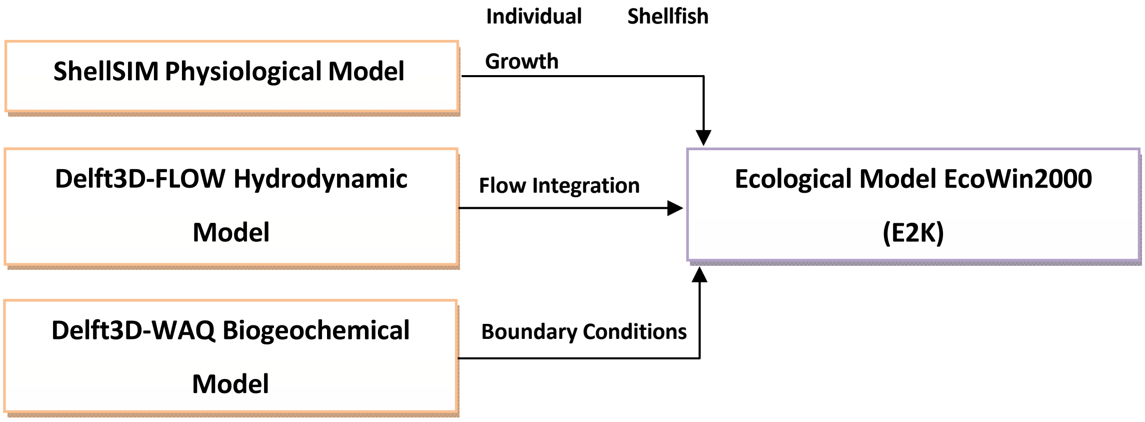


Figure 3.1: General modelling framework used in SMILE (Ferreira *et al.,* 2007).

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 upscaled from detailed hydrodynamic models.

3.2. Depth

Depths in Strangford Lough vary from approximately 62m in the inner most part of the Narrows (the narrow channel connecting the lough to the Irish Sea) between Audley's Point and Ballyhenry Bay to very shallow depths of 2-5m along the coastal parts of the lough and in particularly the inner reaches of the lough. Depths greater than 10m predominant in the Narrows and extend up along the centre of the lough before bifurcating into two main channels, one heading northeast to Kircubbin Bay and one northwest to beyond Mahee and Reagh Islands. Deeper pools of water, varying in depths from approximately 30 to 60m are found within this channel. Figure 3.2 shows a bathymetric map of Strangford Lough.

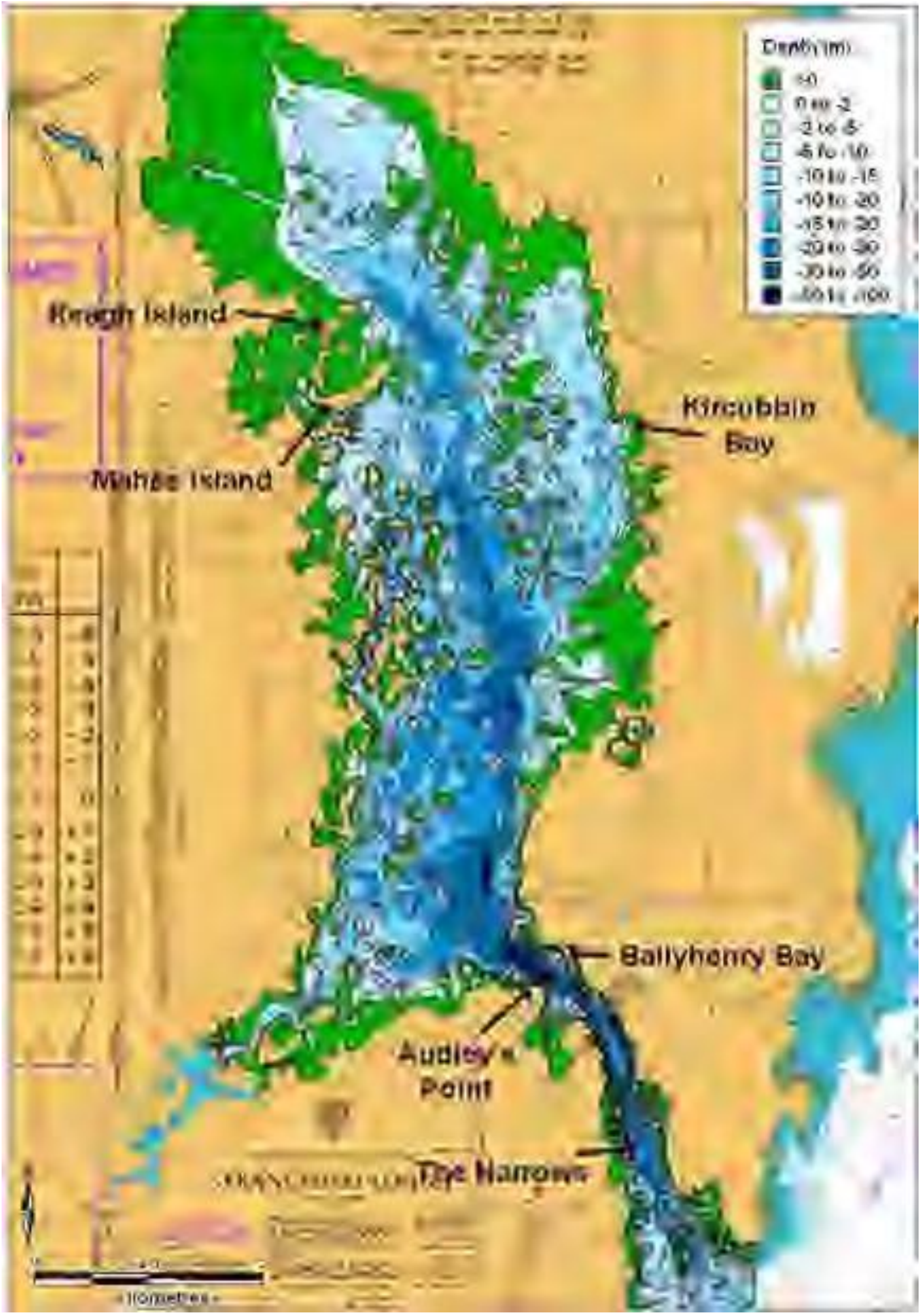


Figure 3.2: Depths in Strangford Lough (modified from The loughs Agency data).

3.3. Tides & Currents

The tidal cycle in Strangford Lough ranges from a mean high water of 4.5m to a mean low water of 0.3m during spring tides (UKHO, 1988; 2009). The characteristic tidal levels in Strangford Lough can be seen in Table 3.1. These are taken from the Admiralty Chart 2156-0 and 2156-1 (UKHO, 1988; 2009). Levels are presented in metres Chart Datum, which is approximately equal to Lowest Astronomical Tide (LAT). The tidal level locations can be seen in Figure 3.3.

Table 3.1: Strangford Lough tidal characteristics (Source: UKHO, 1988; 2009).

Admiralty Chart 2156-0/2156-1 Levels (m CD)	MHWS	MHWN	MLWN	MLWS	Datum & Remarks
Killard Point	4.5	3.8	1.2	0.5	3.14m below Ordnance Datum (Belfast)
Strangford	3.6	3.1	0.9	0.4	1.84m below Ordnance Datum (Belfast)
Quoile Barrier	3.7	3.2	0.8	0.3	1.86m below Ordnance Datum (Belfast)
Killyleagh	3.8	3.3	-	-	1.86m below Ordnance Datum (Belfast)

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 Strangford Lough (UKHO, 1988; 2009) and information was taken from Brown, (1997). The Narrows are subjected to strong tidal currents of over 3.6 m/s while conversely some sheltered inlets on the western shores have virtually still water.

On a flooding spring tide, tidal flows reaching a mean spring rate of 1.29 m/s enter the Narrows around Killard Point and proceed into the West Channel maintaining their speeds up towards Kilchief Bay. In the East Channel, a mean spring rate of 2.52 m/s enters the Narrows east of Angus Rock. This flow weakens to imperceptible levels as it flows across the Narrows to Kilclief Point. A mean spring rate of 4.01 m/s is seen in the Narrows east of Black Islands, this decreases slightly to 3.34 m/s as the tide flows around Church Point, decreasing to 2.31 m/s around Audley's Point and decreases again to 1.03 m/s as the tide enters the main body of the lough. Mean spring rates of 0.51 m/s to 1.03 m/s are seen between Limestone Rock and Ringburr Point and the tide flows towards the upper reaches of the lough. From here, mean speeds of 1.03 m/s flow northeasterly up the main channel and speeds reduced to 0.51 m/s -0.77 m/s in the upper reaches of the lough. Inperceptible speeds flow in the southwestern region of the lough around Killyleagh and in the northeastern region of the lough towards Kircubbin Bay.

On the ebbing spring tide, the flow reaches a maximum of 0.51 m/s to 0.77 m/s as it leaves the inner reaches of the lough, increasing to 1.03 m/s north of Ringburr Point and decreasing to 0.51 m/s on approaches to Audley's Point. Once in the Narrows, speeds increase to 2.57 m/s around Church Point, increasing to 3.7 m/s east of Black Islands, decreasing to 2.83 m/s east of Kilclief Point and exiting through the East Channel at speeds of 3.91 m/s. There is an imperceptible flow across the Narrows just north of Angus Rock into the East Channel. There is a flow of 1.29 m/s out of Kilclief Bay, increasing to 2.06 m/s as the flow leaves the West Channel.

Outputs from the Delft3D-FLOW hydrodynamic model which was developed during the SMILE Project were provided by the Agri-Food and Biosciences Institute (AFBI). Figures 3.4 to 3.11 show the direction and magnitude of spring and neap tide surface and bottom ebb and flood flow currents.

Tidal movements in Strangford Lough are relatively simple entering in the southeast through the Narrows and moving in a northwesterly direction up through the lough. During a flooding spring tide, maximum velocities are seen in the Narrows between Dogtail Point and Strangford Point (3.2 – 4.1 m/s at the surface and 2.3 – 2.99 m/s at the bottom). At the surface, flows decrease to approximately 2.4 m/s around Ballyhenry Bay (1.8 m/s at the bottom) and decrease further to approximately 0.8 – 1.2 m/s (0.7 – 0.9 m/s at the bottom) as the flow moves around Ballyhenry Point and into the lough proper. This level of flow continues as far north as Ringburr Point. Between Ringburr Point and approximately Gransha Point, the flow is in the region of 0.5 – 1 m/s (0.4 – 0.7 m/s at the bottom) in the centre and eastern part of the channel with flows as low as 0.08 m/s (0.04 m/s at the bottom) in amongst the islands on the western coastline. Flows decrease to approximately 0.4 m/s (0.2-0.3 m/s at the bottom) between Gransha Point and a line drawn between Mahee Point and South Islands. Inside if this line, flows increase slightly and range between 0.4 to 0.7 m/s (0.5m/s at the bottom) in the central channel and in towards the Comber Estuary. Flows are lower (0.02 – 0.3 m/s) in the shallower coastal parts of the inner lough and in towards Newtownards.

On the ebbing tide, flows are highest in the Narrows between Dogtail Point and Strangford Point (3.49 – 4.12 m/s at the surface and 2.5 – 3.1 m/s at the bottom). Surface ebb flows within the lough proper range from 0.05 m/s in the inner reaches of the lough near Newtownards to 0.9 m/s off Ringburr Point. Bottom ebb flows in the same areas range from 0.04 m/s to 0.7 m/s.

The flow pattern described above is the same for neap tides with significantly lower velocities experienced. On a flooding neap tide, maximum bottom and surface speeds are found between Dogtail Point and Strangford Point (1.9 – 2.4 m/s at the surface and 1.4 -1.8 m/s at the bottom). On an ebbing neap tide, again maximum bottom and surface speeds are found between Dogtail Point and Strangford Point (1.9 – 2.3 m/s at the surface and 1.3 -1.7 m/s at the bottom).

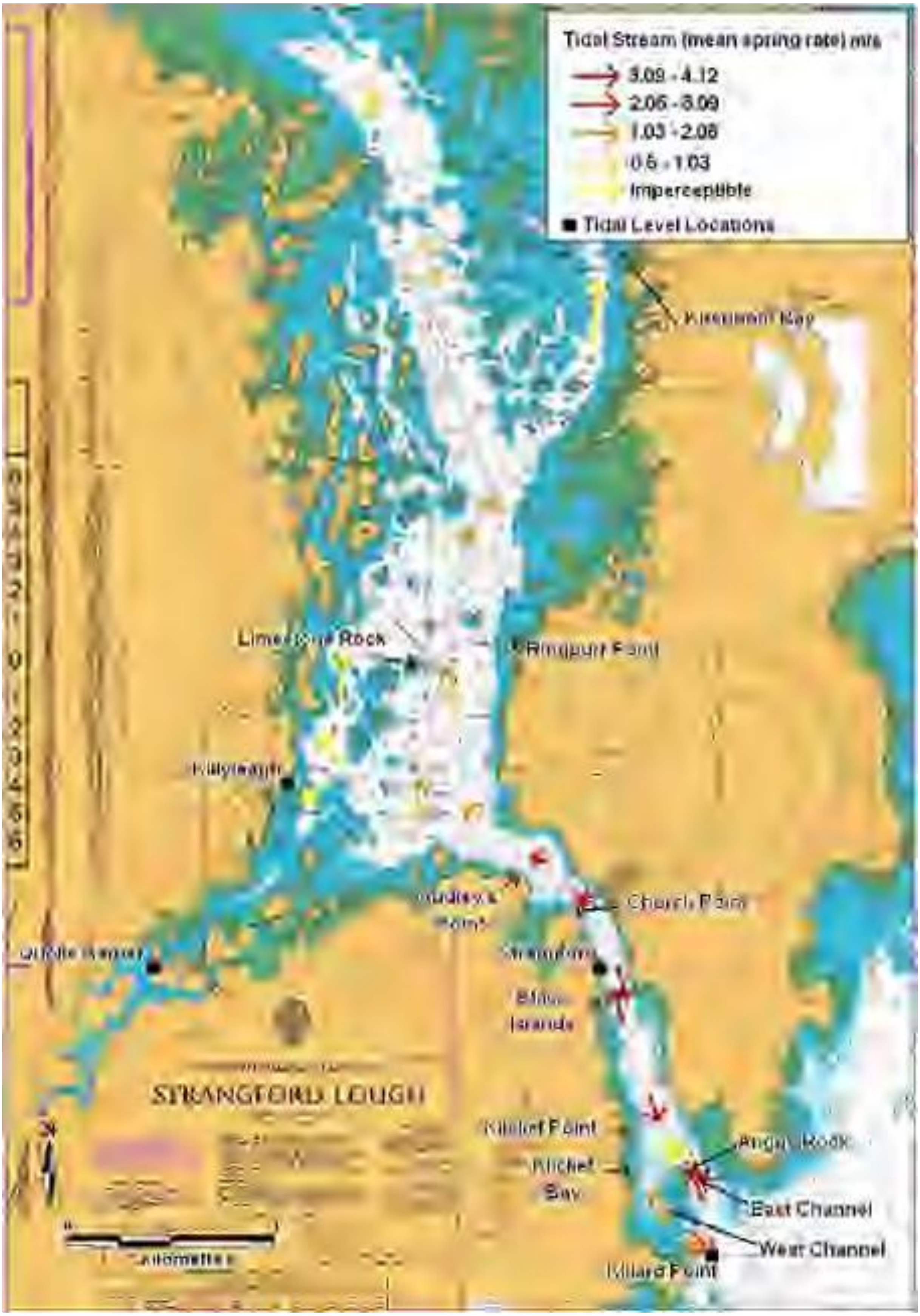


Figure 3.3: Tidal streams within Strangford Lough (UKHO, 1988; 2009; Brown, 1990).

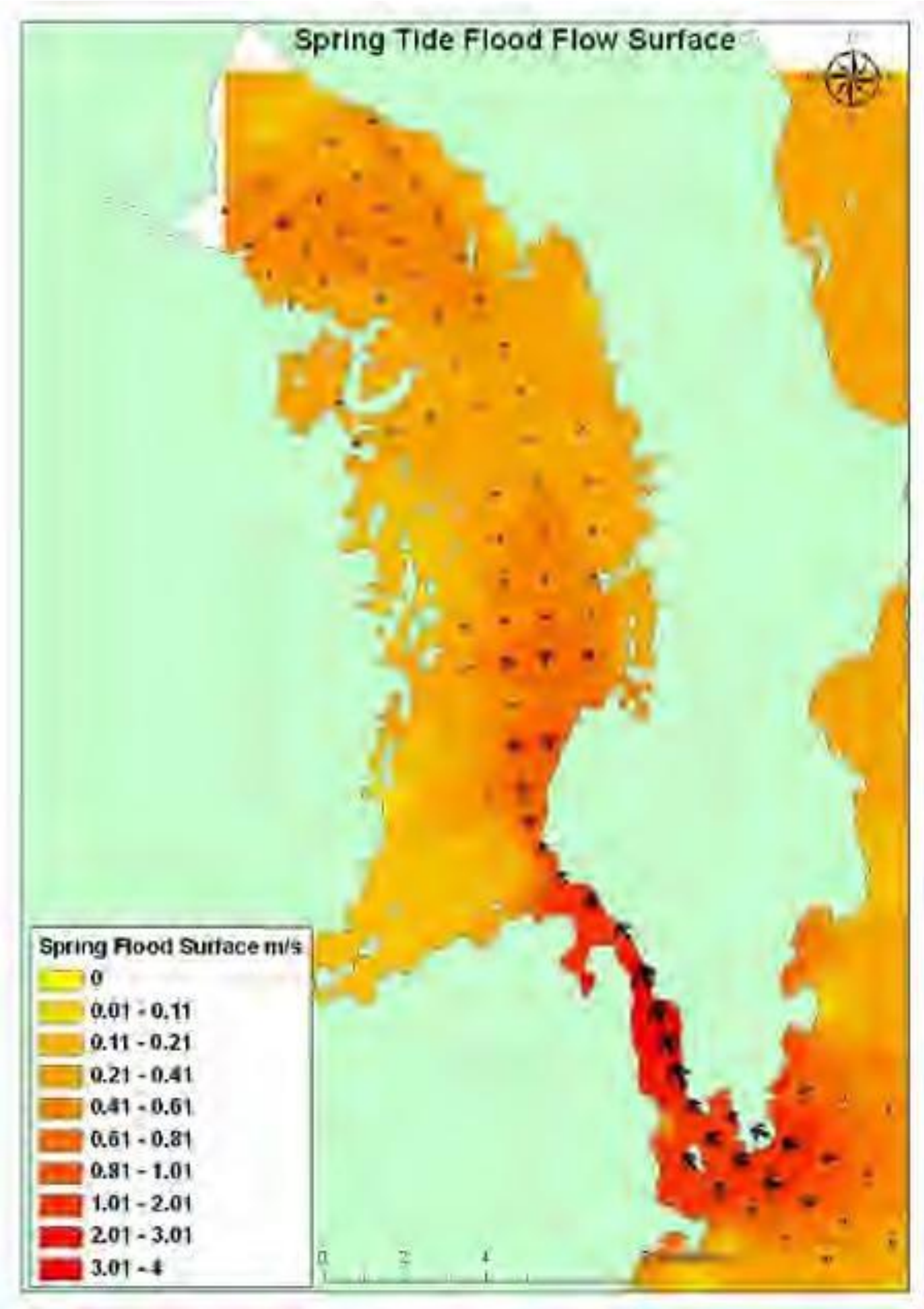


Figure 3.4: Surface current velocities and direction during a spring tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

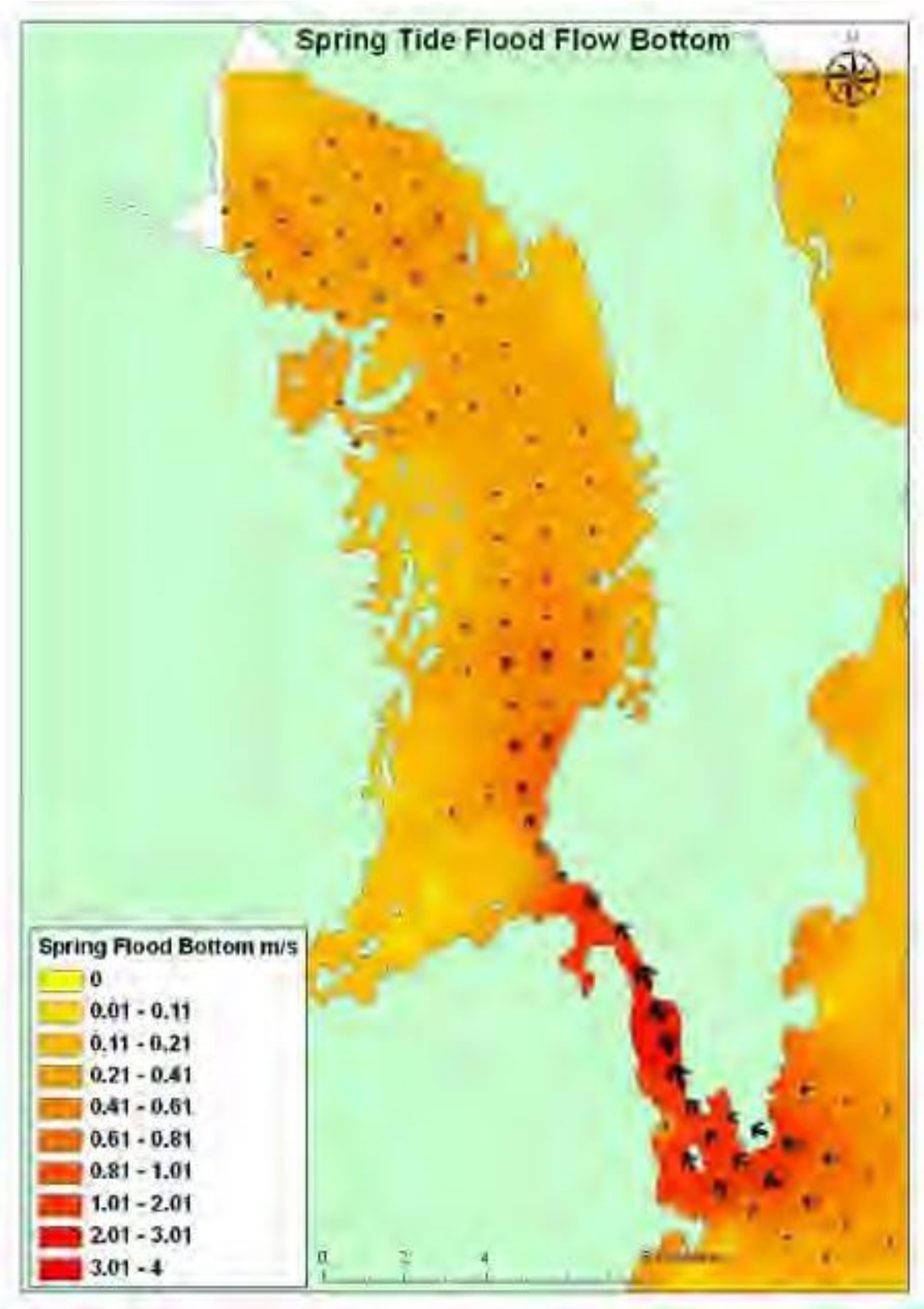


Figure 3.5: Bottom current velocities and direction during a spring tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

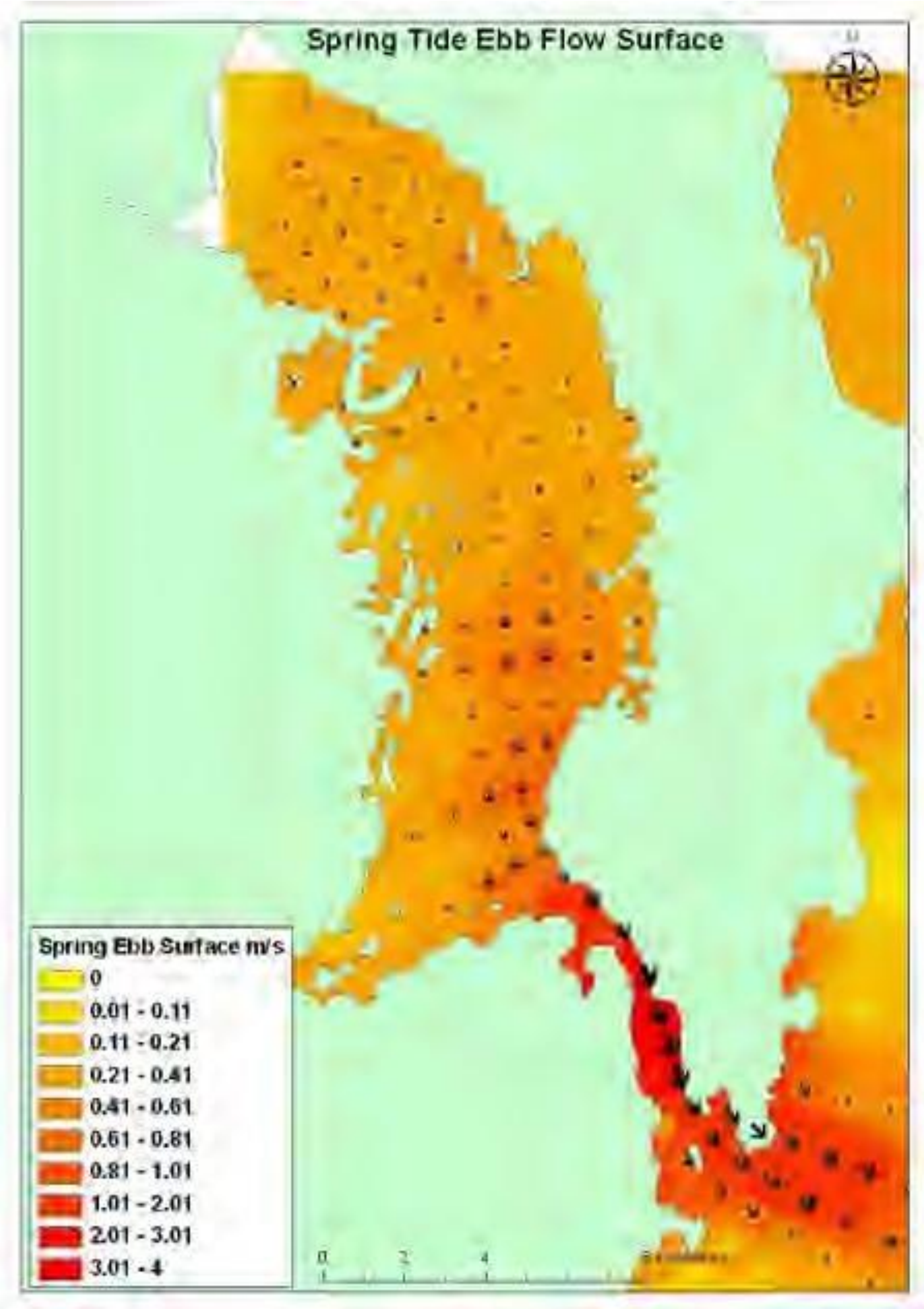


Figure 3.6: Surface current velocities and direction during a spring tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

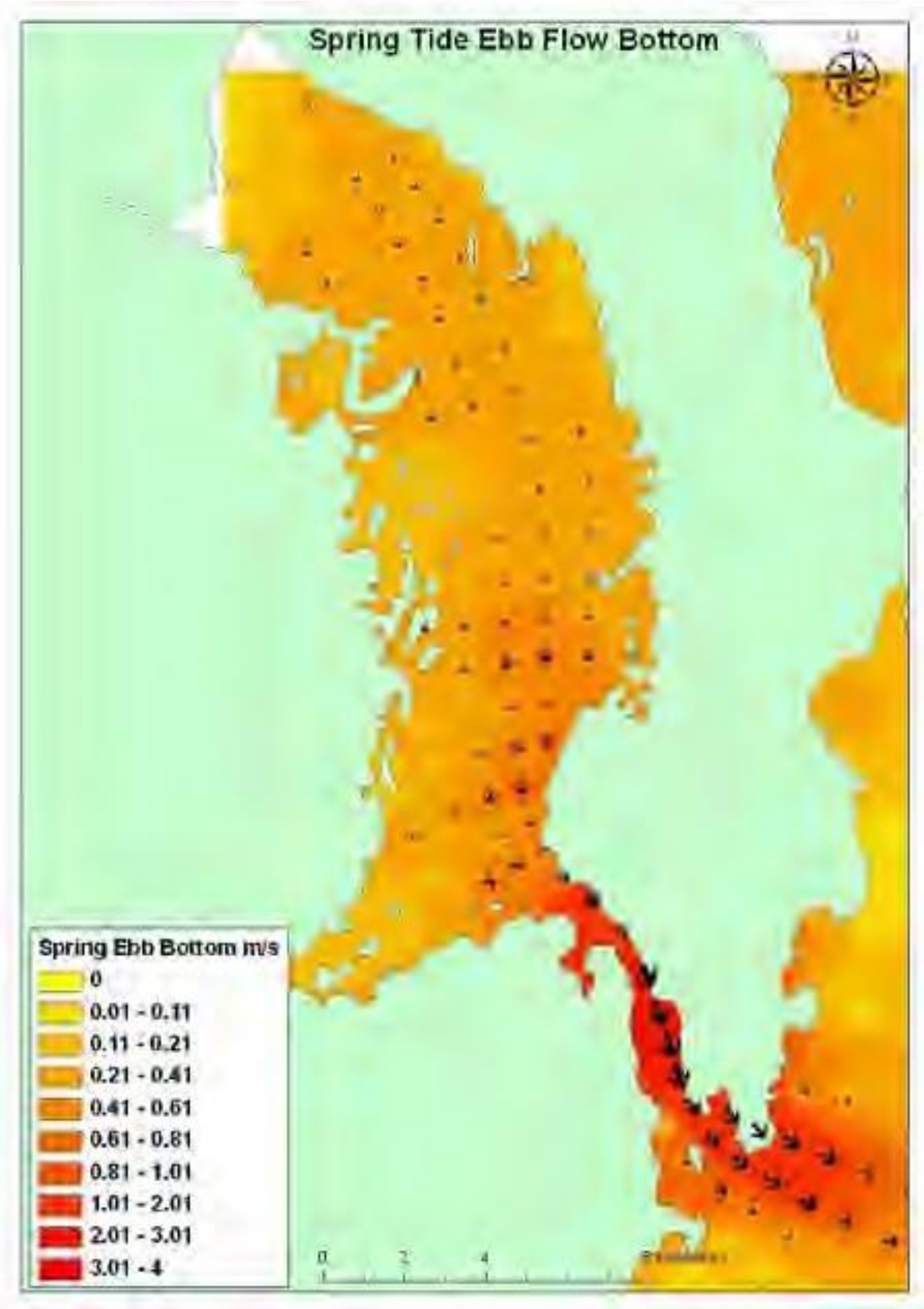


Figure 3.7: Bottom current velocities and direction during a spring tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

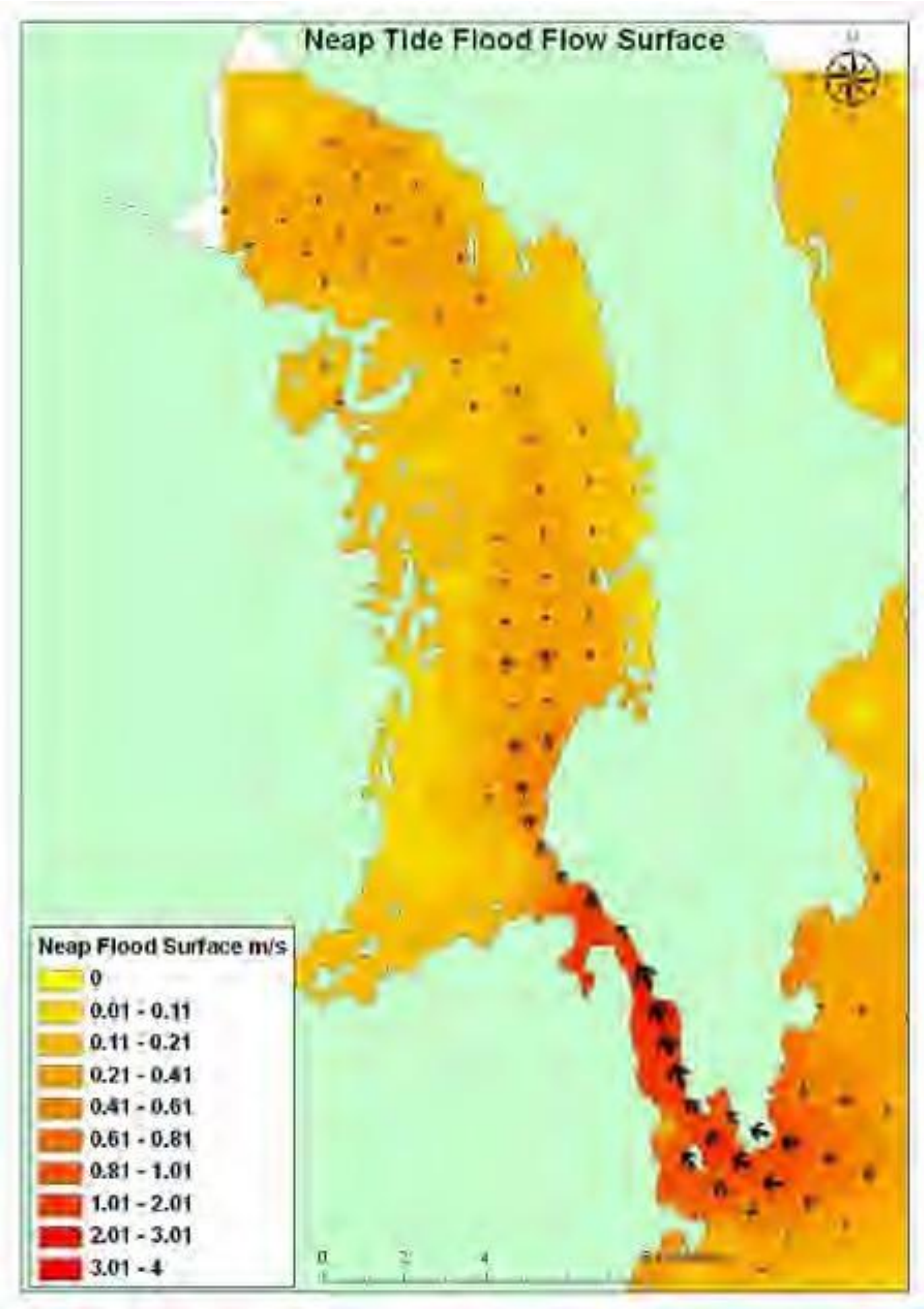


Figure 3.8: Surface current velocities and direction during a neap tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

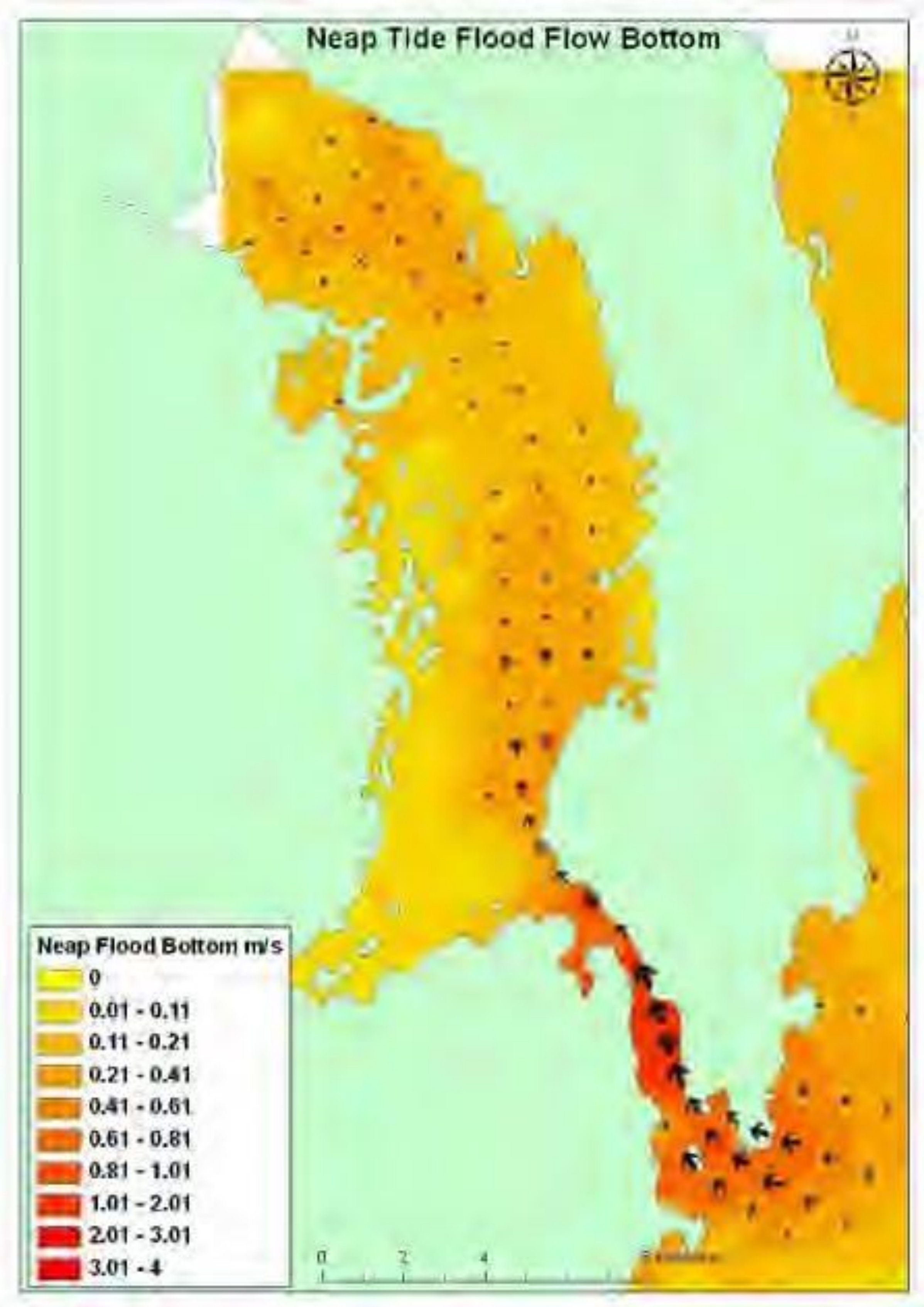


Figure 3.9: Bottom current velocities and direction during a neap tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

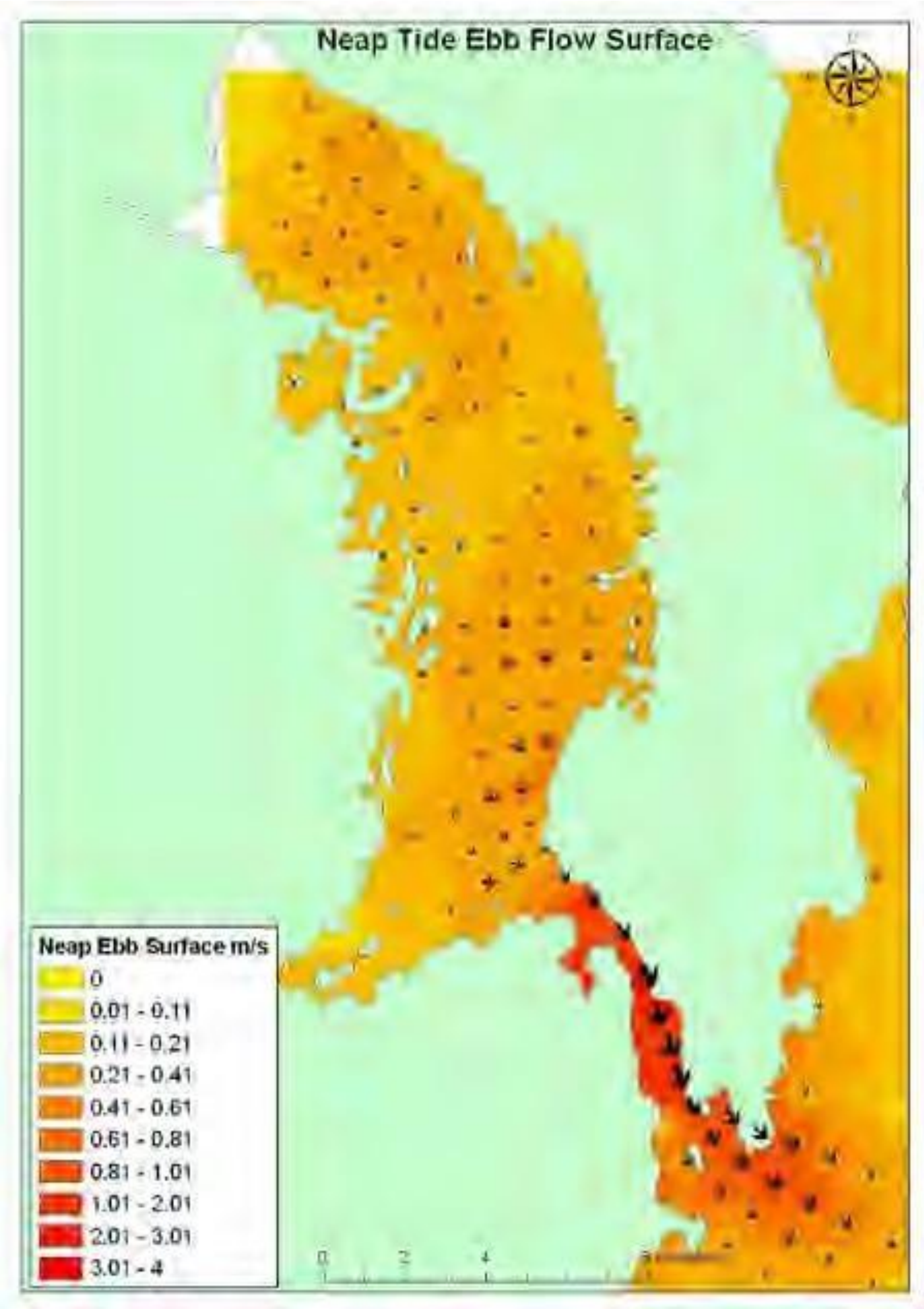


Figure 3.10: Surface current velocities and direction during a neap tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

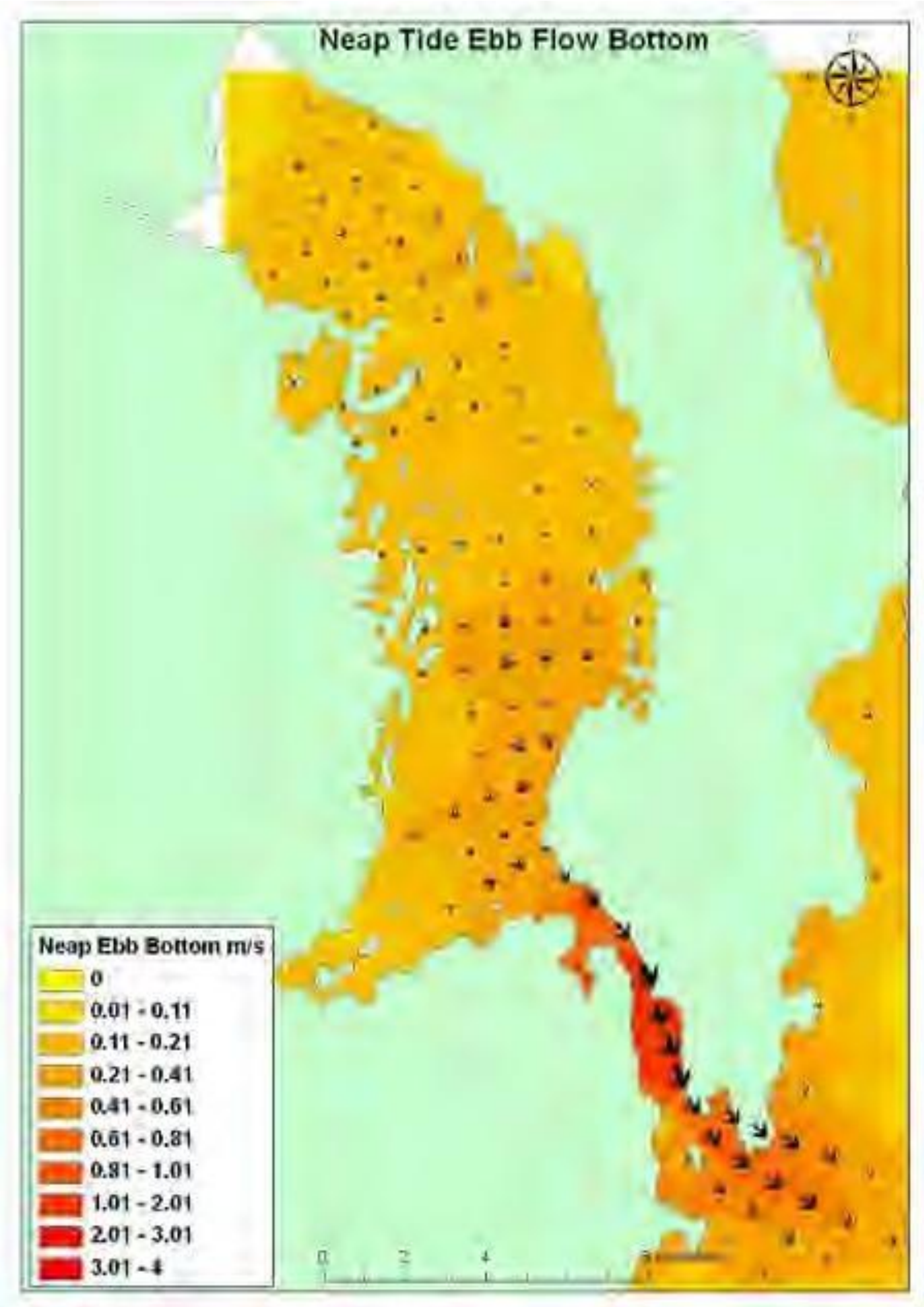


Figure 3.11: Bottom current velocities and direction during a neap tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

3.4. Wind and Waves

Average wind speed data for Northern Ireland from 1971-2000 can be seen in Figure 3.12 (Met Office, 2011a). It can be seen from these maps that the eastern coast of Northern Ireland is one of the windiest areas. November to February experienced the strongest wind speeds (10-20kn) while July and August experienced the weakest winds (6-15kn). The strongest winds are associated with the passage of deep areas of low pressure close to or across the country. The frequency and strength of these depressions is greatest in the winter half of the year, especially from November to January, and this is when mean speeds and gusts (short duration peak values) are strongest (Met Office, 2011b). Figure 3.13 shows the seasonal averages in wind speed for Northern Ireland from 1971-2000, as expected summer experienced the weakest speeds (6-15kn) while winter experienced the strongest (10-20kn).

As Atlantic depressions pass the UK and Ireland the wind typically starts to blow from the south or south west, but later comes from the west or north-west as the depression moves away (Met Office, 2011b). The range of directions between south and north-west accounts for the majority of occasions and the strongest winds nearly always blow from these directions. Therefore the prevailing wind over Strangford Lough ranges from a southerly all the way around to a northwesterly.

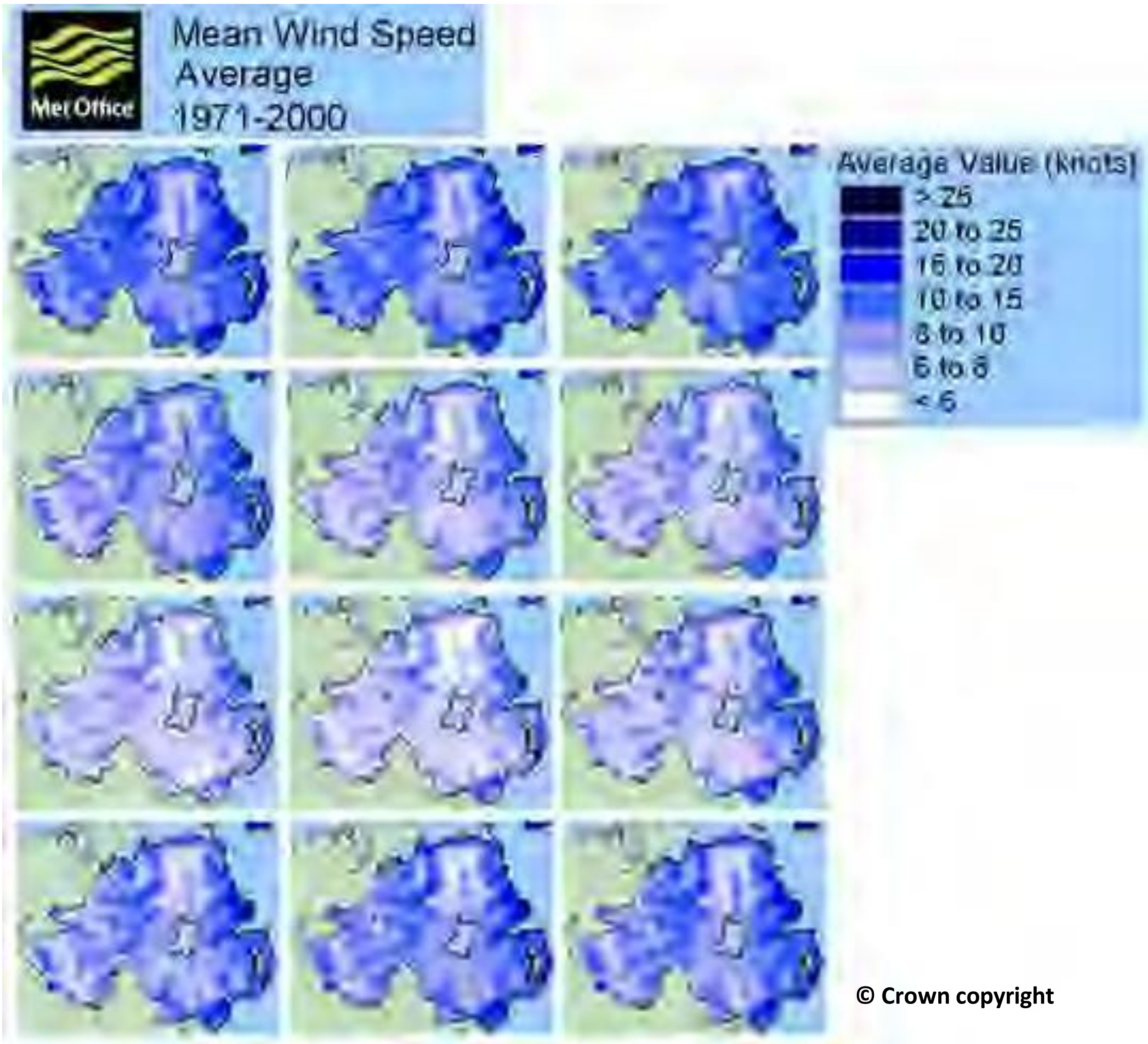


Figure 3.12: Average wind speed data for Northern Irleand from 1971 to 2000 (Source: Met Office, 2011a).

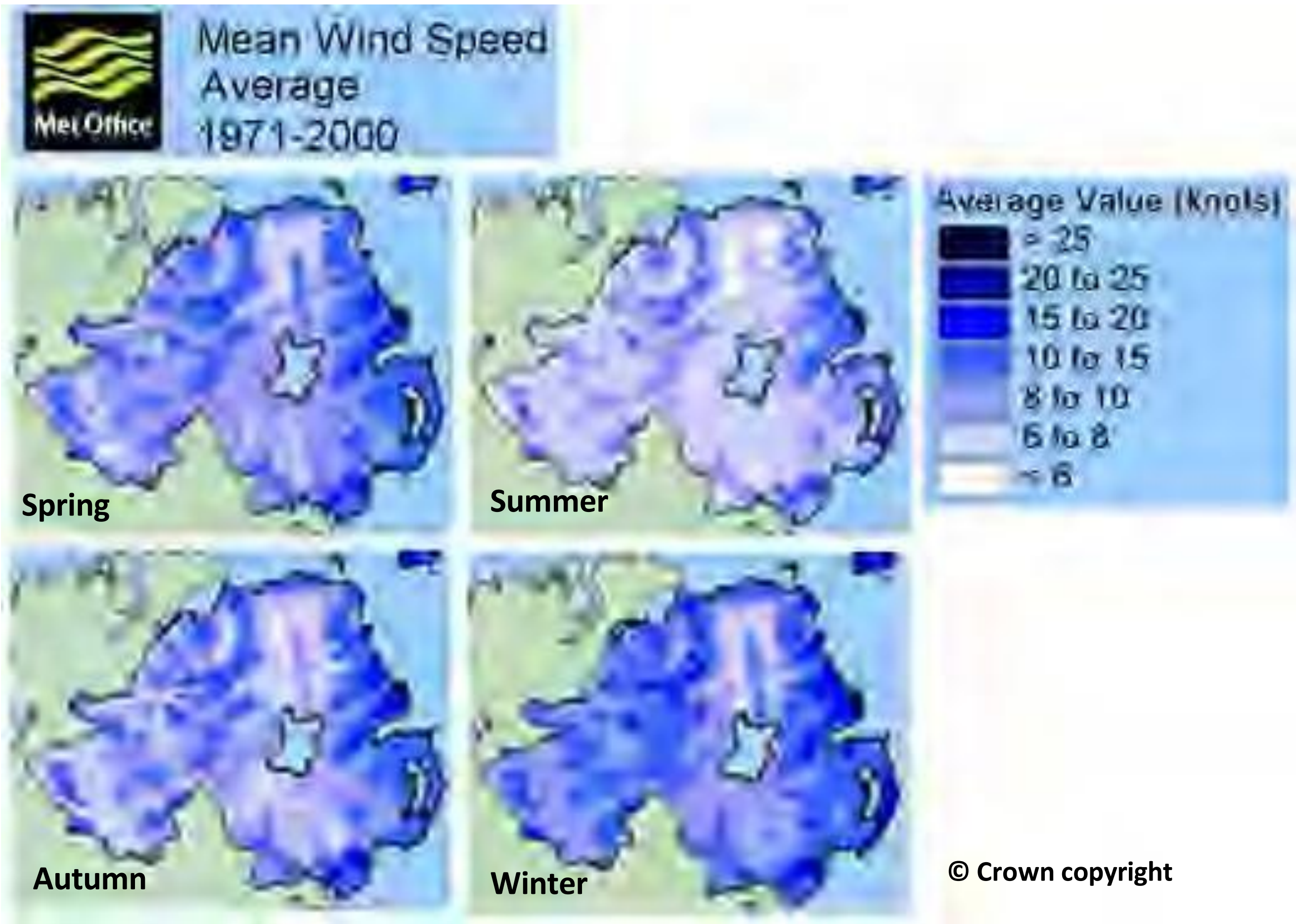


Figure 3.13: Average seasonal wind speed data for Northern Ireland from 1971-2000 (Source: Met Office, 2011a).

Wind conditions affect the hydrodynamic conditions in Strangford 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.

Especially over the shallow areas of Strangford Lough, wave-induced bottom friction may lead to resuspension of material and entrainment of sediments in the water column. Figure 3.14 shows the pattern of water movement due to wave action in Strangford Lough, the greater the energy being shown by the larger arrows.

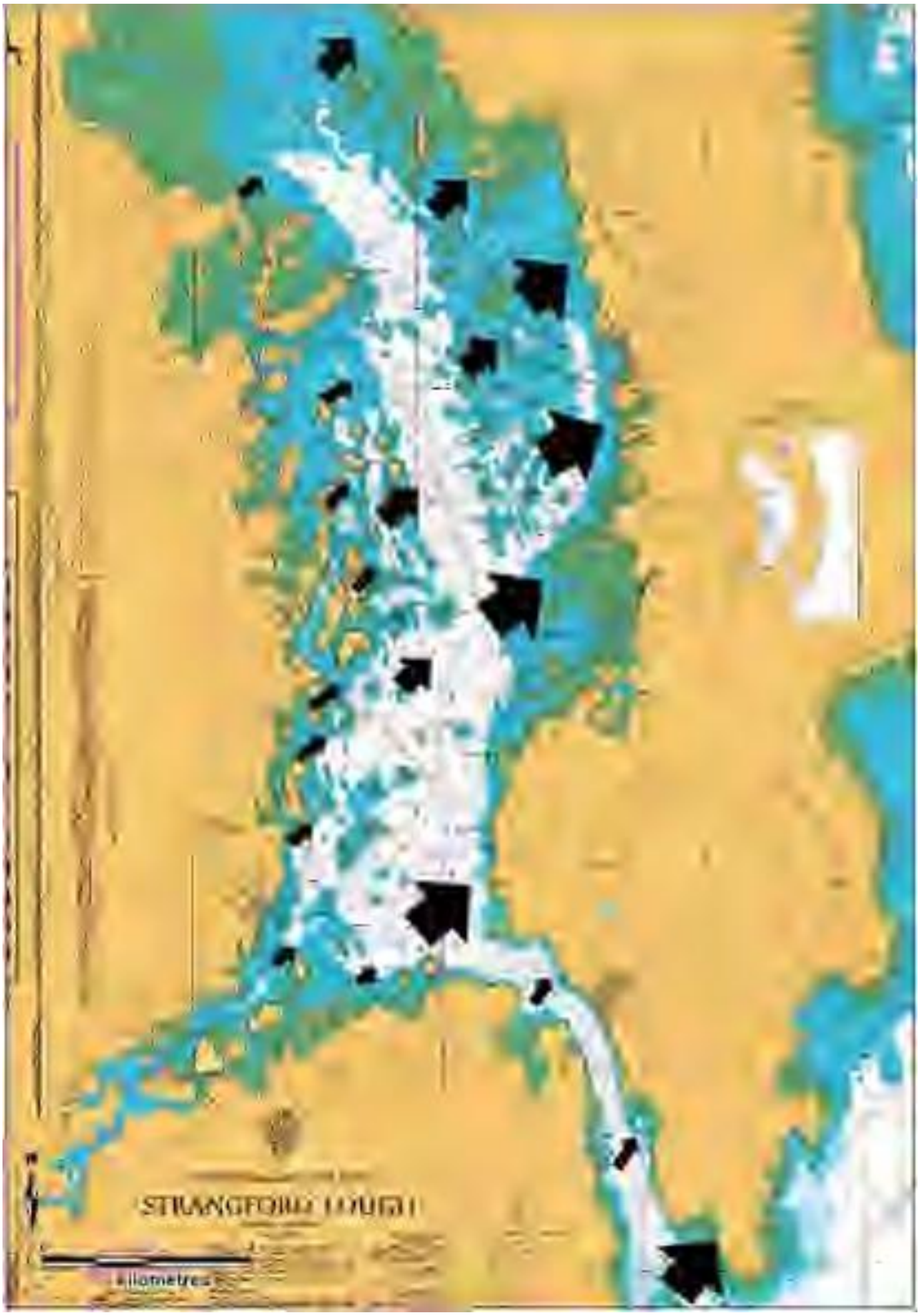


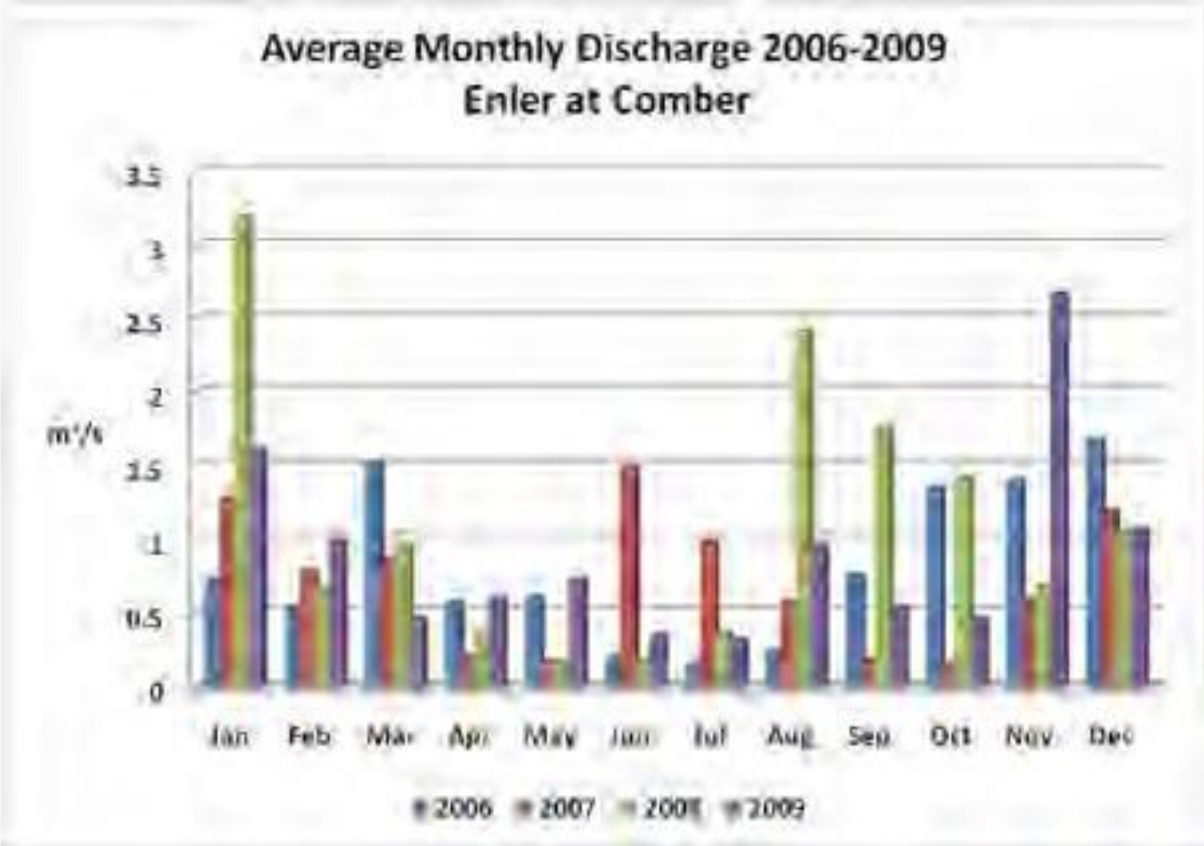
Figure 3.14: Pattern of water movement in Strangford Lough due to wave action (adapted from Brown, 1990).

3.5. River Discharges

The main freshwater sources to Strangford Lough are the Comber River (through Comber town) in the northwest and the Quoile River (through Downpatrick) in the southwest. The Comber River drains 11% of the total Strangford catchment area and the Quoile River drains 31% (CEFAS, 2005). River flow into the lough is approximately 3.5m^3/s (Ferreira *et al.,* 2007). The Rivers Agency operates 2 hydrometric monitoring stations within the Strangford Lough catchment area; Enler at Comber and Annacloy at Kilmore Bridge. The mean flow at Enler is 0.78 m^3/s and at Annacloy is 3.5 m^3/s (NRFA [National River Flow Archive], 2011). Figure 3.15 shows all rivers discharging into Strangford Lough or a tributary of Strangford Lough and the two hydrometric monitoring stations within the catchment.

Figure 3.16 shows the averaged and total flow of the Enler River at Comber from 2006 to 2009 (Data for the Annacloy at Kilmore Bridge was not available). Over the 4 year period, April and May had the least flow (52.7 and 51.9 m^3/s respectively) with January and November having the highest flows (211.1 and 160.5 m^3/s respectively). January 2008 had the highest overall flow (98.85 m^3/s total; 3.19 m^3/s average) and July 2006 had the lowest overall flow (4.52 m^3/s total; 0.15 m^3/s average).

Figure 3.15: Rivers and river monitoring stations (Source: NRFA, 2011; NIEA, 2011).



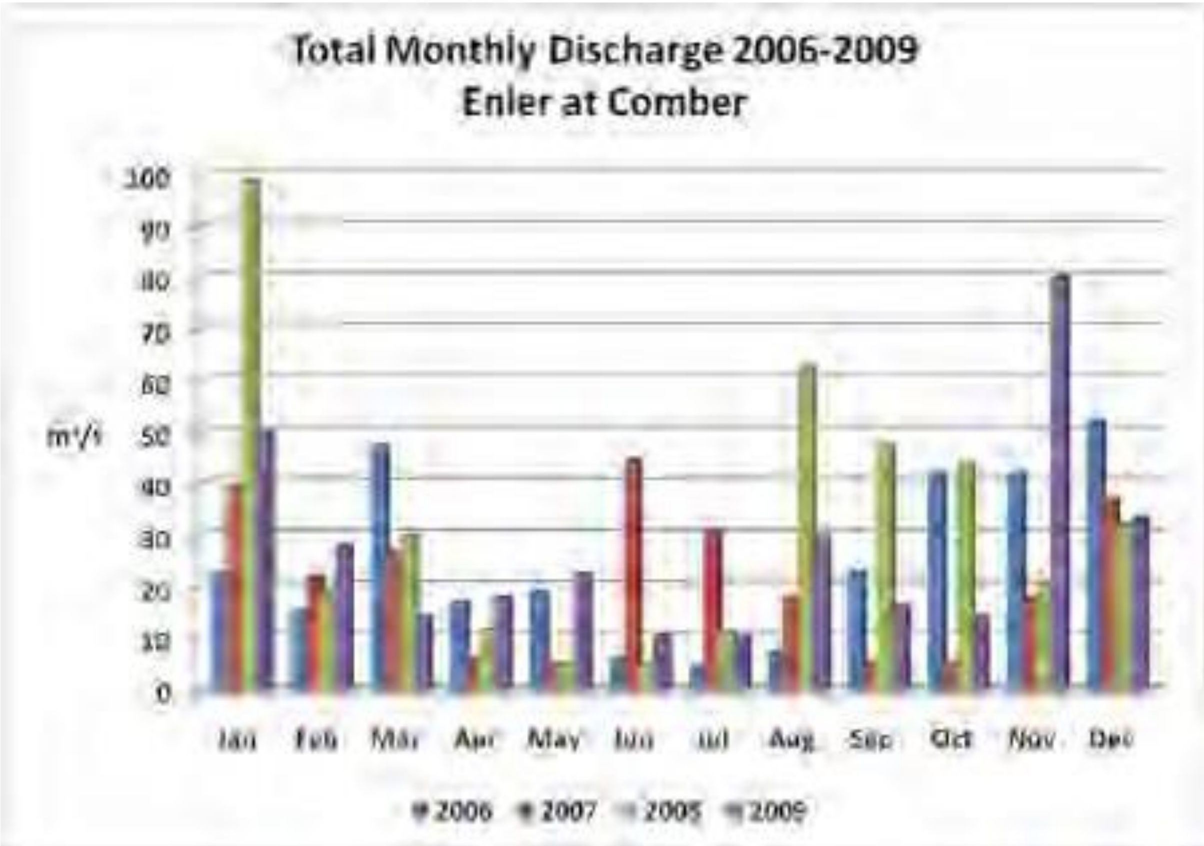


Figure 3.16: Average and monthly flow data from the Enler at Comber (Source: NRFA, 2011).

3.6. Rainfall Data

3.6.1. Amount & Time of Year

Figures 3.17 and 3.18 show the average monthly rainfall data for Northern Ireland (Met Office, 2010) from 1971 to 2000. It is clear form these maps that the Strangford Lough area is one of the driest in Northern Ireland. Table 3.2 shows the average rainfall range and median value along the Strangford Lough coastline. During the period 1971 to 2000, the average rainfall around the coastline of Strangford Lough ranged from 30- 110mm, with the lowest levels occurring in May (40-60mm) and the highest levels occurring in November (50- 110mm). The lowest median value was 50mm in May and the highest was 80mm in January, November and December. Figure 3.19 shows the seasonal averages from 1971 to 2000 for Northern Ireland. Table 3.3 shows the seasonal rainfall ranges and median values. Seasonally, spring and summer were the driest seasons (140mm) and winter was the wettest season (250mm).

Table 3.2: **Rainfall range and median monthly rainfall (mm) data along the Strangford Lough coastline (Source: Met Office, 2010).**

Month	Rainfall Range (mm)	Median (mm)
Jan	60-100	80
Feb	30-90	60
Mar	50-80	65
Apr	45-60	52.5
May	40-60	50
Jun	40-65	52.5
Jul	40-70	55
Aug	50-80	65
Sept	50-90	70
Oct	50-100	75
Nov	50-110	80
Dec	60-100	80

Table 3.3: Seasonal rainfall range and median values (mm) from 1971-2000 (Source: Met Office, 2010).

Season	Rainfall Range (mm)	Median
Spring	140-200	170
Summer	140-200	170
Autumn	200-280	240
Winter	200-300	250

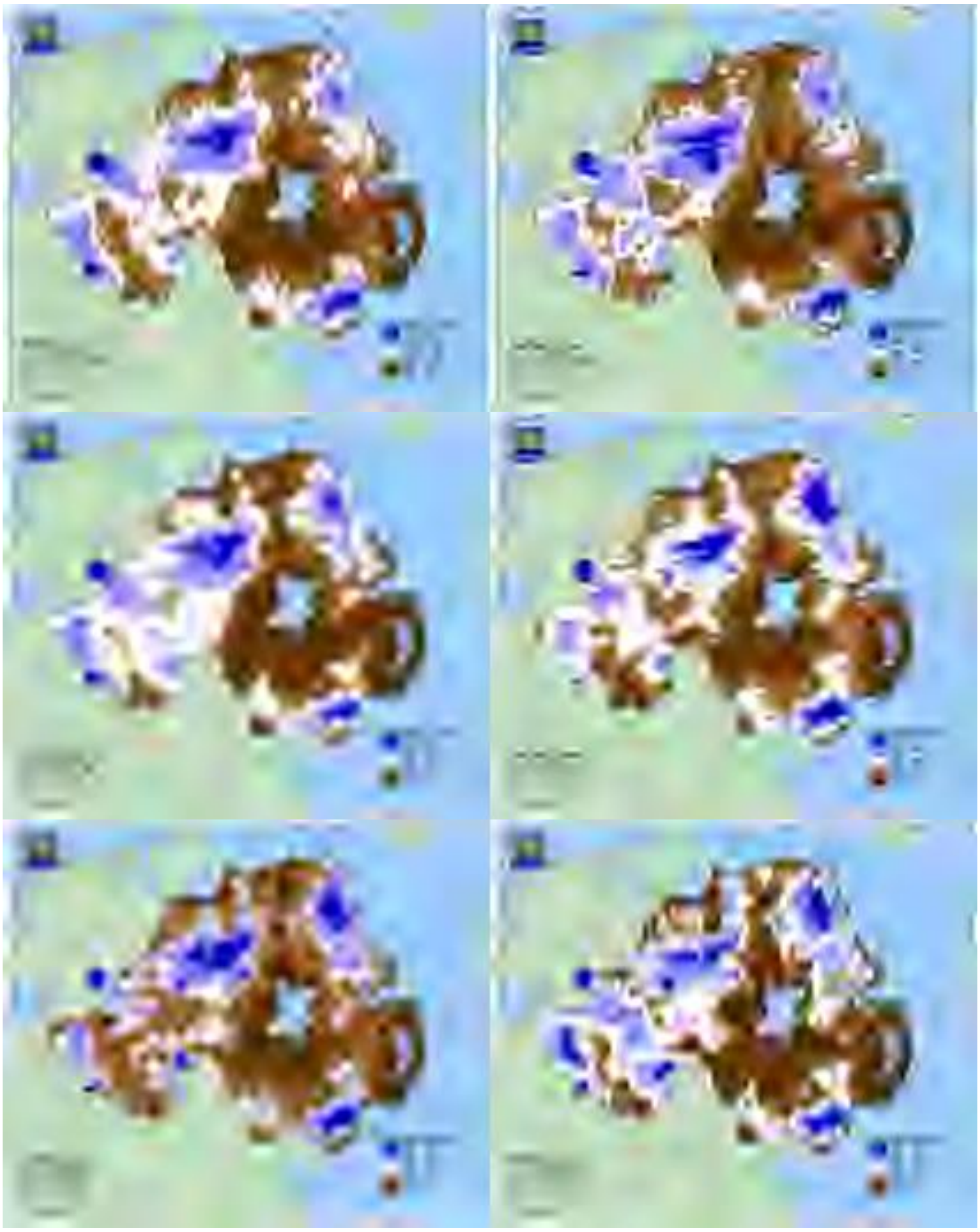


Figure 3.17: Average monthly rainfall (mm) data for January to June from 1971 to 2000 for Northern Ireland (Source: Met Office, 2010).

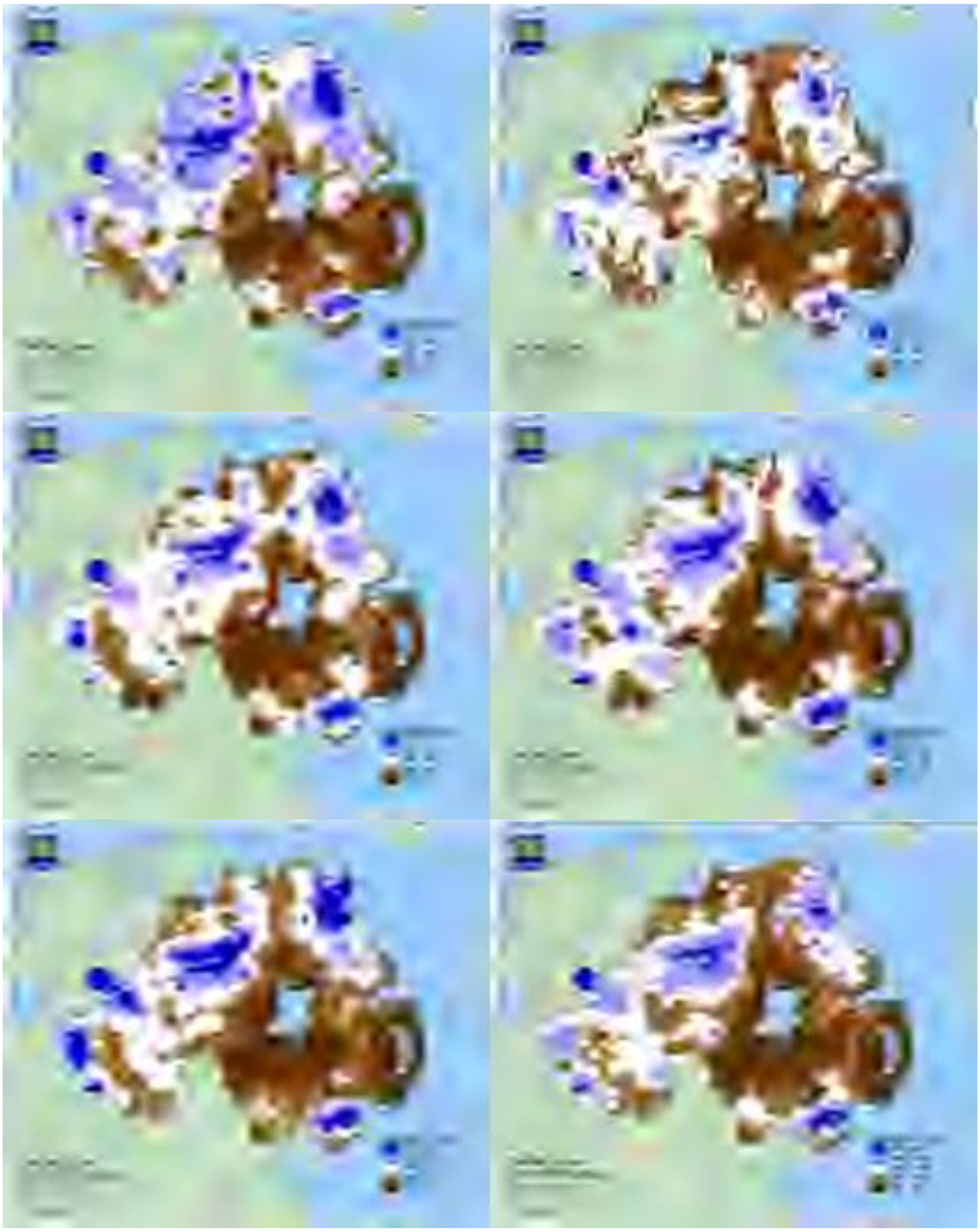


Figure 3.18: Average monthly rainfall (mm) data for July to December from 1971 to 2000 for Northern Ireland (Source: Met Office, 2010).

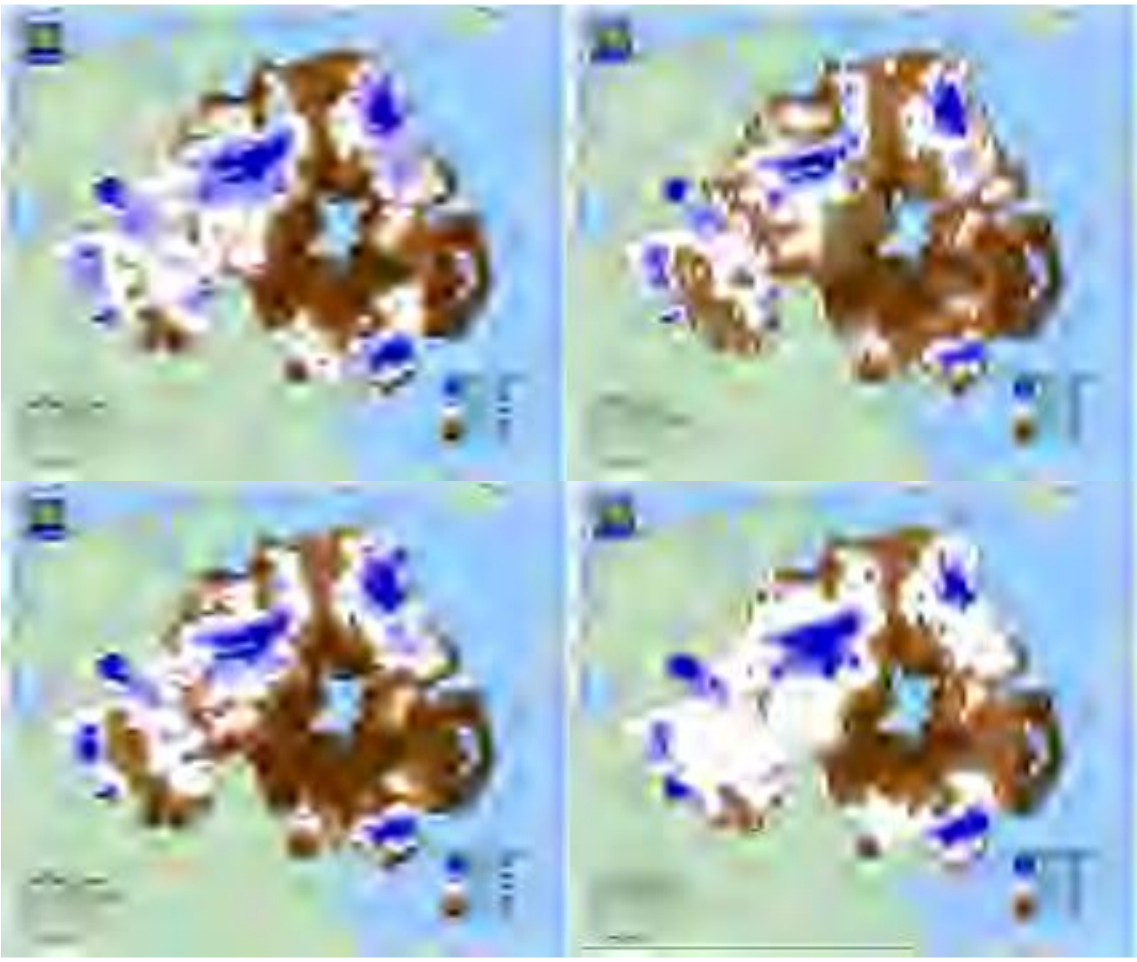


Figure 3.19: Seasonal rainfall averages (mm) from 1971 to 2000 for Northern Ireland (Source: Met Office, 2010).

Tables 3.4 and 3.5 show the rainfall range and median values for the past 5 years for Strangford Lough (Met Office, 2011c). Lowest rainfall levels of 0-25mm were seen in April 2007 and May 2008 with the highest occurring January 2008, June 2007, August 2008 and November 2009. Table 3.6 shows seasonal rainfall figures for the Strangford Lough area based on median rainfall values from 2006-2010 (Met Office, 2011c). The following seasonal fluctuations were observed from 2006-2010: In 2006, summer was the driest season and autumn was the wettest, in 2007 and 2008, spring was driest and summer was the wettest, in 2009 spring was the driest and autumn was the wettest and in 2010 spring and summer were the driest and autumn was the wettest.

Table 3.4: Averaged monthly rainfall (mm) data summarised for the Strangford Lough area from 2006-2010 (Source: Met Office, 2011c).

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2010	75-150	50-75	75-150	25-75	25-50	25-50	75-150	25-75	75-150	50-75	100-150	50-75
2009	75-150	0-50	25-50	75-150	50-100	25-75	75-150	100-150	25-50	75-100	100-200	50-150
2008	100-200	25-50	75-150	25-50	0-25	25-75	75-150	100-200	75-150	75-150	25-50	75-100
2007	50-100	50-100	50-75	0-25	25-75	100-200	75-150	75-150	0-25	25-50	50-100	75-100
2006	25-50	25-50	100-150	25-75	75-150	0-50	25-75	50-100	75-150	75-150	75-150	75-100

Table 3.5: Median monthly rainfall (mm) data summarised for the Strangford Lough area from 2006-2010 (Source: Met Office, 2011c).

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2010	112.5	62.5	112.5	50	37.5	37.5	112.5	50	112.5	62.5	125	62.5
2009	112.5	25	37.5	112.5	75	50	112.5	125	37.5	112.5	150	100
2008	150	37.5	112.5	37.5	12.5	50	112.5	150	112.5	112.5	37.5	112.5
2007	75	75	62.5	12.5	50	150	112.5	112.5	12.5	37.5	125	112.5
2006	37.5	37.5	125	50	112.5	25	50	75	112.5	112.5	112.5	112.5

Table 3.6: Total seasonal rainfall (mm) values from 2006-2010 based on median rainfall values (Source: Met Office, 2011c).

Season/Year	2010	2009	2008	2007	2006
Spring	200	225	162.5	125	287.5
Summer	200	287.5	312.5	375	150
Autumn	300	300	262.5	175	337.5
Winter	237.5	237.5	300	262.5	187.5

3.6.2. Frequency of Significant Rainfalls

Figure 3.20 shows the average monthly median rainfall for the Strangford Lough area from 1971-2000 (Met Office, 2010). October to January were the wettest months. This is partly a reflection of the high frequency of winter Atlantic depressions and the relatively low frequency of summer thunderstorms in Northern Ireland (Met Office, 2011b). Figure 3.21 shows the average monthly median rainfall for Strangford Lough from 2006 – 2010 (Met Office, 2011c). In these more recent years, in addition to October to January been amongst the wettest months, March, July and August were also very wet months. During these months there may be an increased risk of contamination from land run-off and rainfall associated sewer overflows. This data highlights the fact that it is not just the winter months that are at risk of increased contamination.

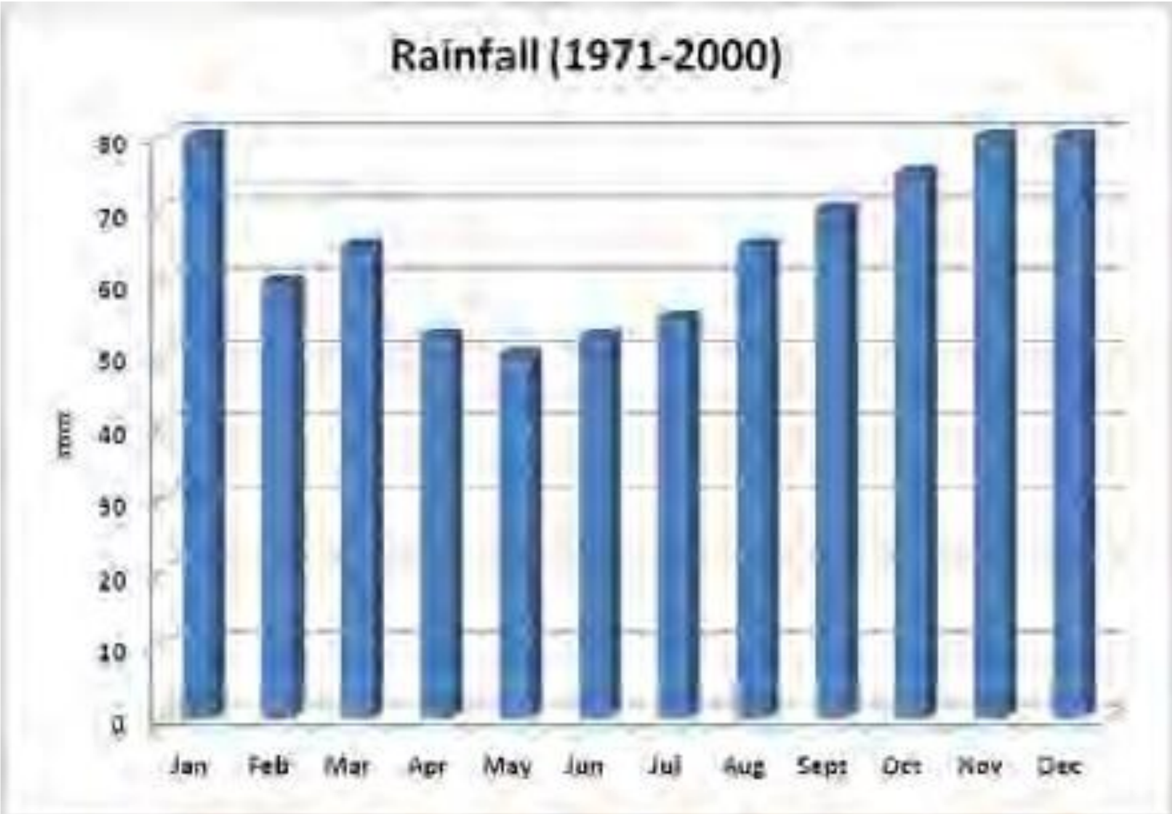


Figure 3.20: Average monthly rainfall (mm) data along the Strangford Lough coast from 1971-2000 (Source: Met Office, 2010).

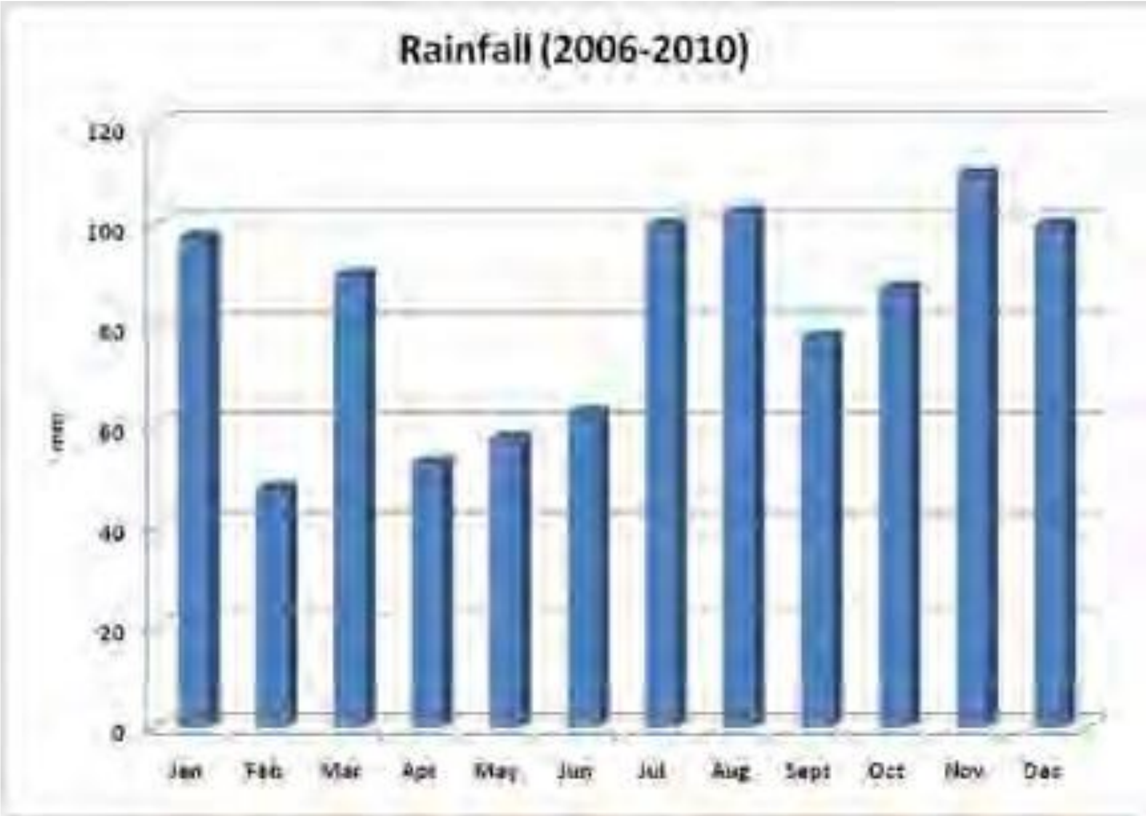


Figure 3.21: Average monthly rainfall (mm) data along the Strangford Lough coast from 2006-2010 (Source: Met Office, 2011c).

3.7. Salinity

Salinity is the saltiness or dissolved salt (sodium chloride, magnesium, calcium sulphates and bicarbonates) content of a body of water. Freshwater typically has a salinity of <0.5 PSU and seawater typically has a salinity of between 30-35 PSU. The Agri-Food & Biosciences Institute (AFBI) collect, manage and process data on coastal water quality including salinity via a network of remotely moored Environmental Monitoring Stations (EMS) in Strangford Lough. 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 this data with a base station on-land. There are four EMS stations located within Strangford Lough (See Figure 3.22). The Strangford Lough North EMS is located approximately 7.7km southeast of Comber, the Strangford Lough Narrows EMS is located outside Portaferry Marina, the Quoile Mooring is located inside the tidal barrier and the Quoile Mooring 2 is located outside the barrier. Salinity data is collected daily. In addition, the Northern Ireland Environment Agency (NIEA) Water Management Unit collect water samples for salinity analysis (amongst other parameters – see Section 5.1.1) from various locations around Strangford Lough (See Figure 3.22). Data is collected quarterly.

Figure 3.22: Location of the salinity monitoring sites in Strangford Lough.

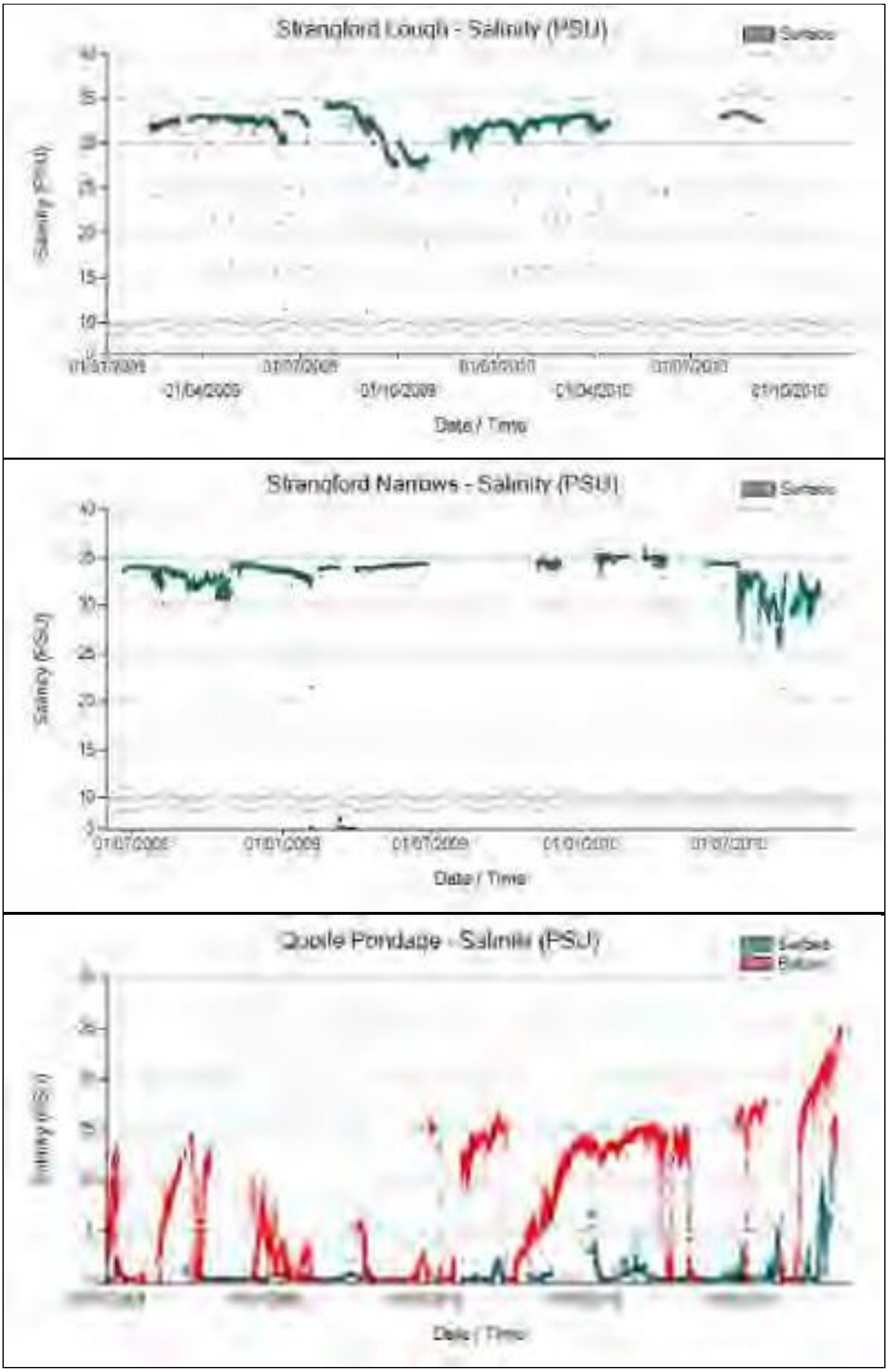


Figure 3.23: Surface and bottom salinity (where available) from the Strangford Lough EMS locations (© Agri-Food and Biosciences Institute, 2006).

Figure 3.23 shows the average daily salinity levels from the North, Narrows and Quoile EMS recorders (AFBI, 2006). As is expected the waters of the Quoile are considerably less saline than waters form the main body of the lough. Surface salinities ranged from approximately 0 to 13 PSU and bottom salinities ranged from approximately 0 to 25 PSU at Quoile. Surface salinities at the North site ranged from approximately 28 to 35 PSU and from approximately 26 to 36 PSU at the Narrows site. A slight seasonal effect on salinity occurs within the lough, typically with higher salinities in the summer and lower salinities through the autumn and winter. Salinity values from the NIEA sampling sites ranged from 33.53 to 34.3 PSU (it should be noted however that NIEA salinity values were only once every quarter and do not reflect the wider ranges recorded at the EMS sites. The freshwater sources shown in Figure 3.15 (page 49) have only localised effects on salinity in the lough, which is otherwise fully saline throughout its length (approximately 33 PSU [AFBI, 2011]).

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. Turbidity values are only available for the Strangford Lough North EMS site (see Figure 3.22 above for station location) and all values since 2008 were ≤1 FTU (Formazin Turbidity Unit), however between 2002 and 2005 levels reached close to 100 FTU, typically around the time of phytoplankton blooms (as turbidity is a measure of the cloudiness of the water, factors such as water colour play a part in determing turbidity level, so turbidity can be high due to tannins in the water or spring blooms and be in no way related to suspended sediment in the water). Suspended sediment loads in the Narrows were monitored between December 2005 and May 2005 and values ranged from 3.19 mg/l after a calm period on the ebbing tide to 32.65 mg/l after the largest storm in a decade again on the ebbing tide (QUB [Queens University Belfast], 2005).

3.9. Residence Times

Residence time is a measure of the average time a substance spends within a physical system; this substance could be any particle flowing with the water. Residence time are an indicator of how long a pollutant or a biological organism will reside in a bay/estuary before being forced out of its mouth due either to river discharge or tidal flow. 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 3.24 (Source: Ferreira *et al.,* 2007). These values are calculated from the SMILE Delft3D Model. Strangford 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.

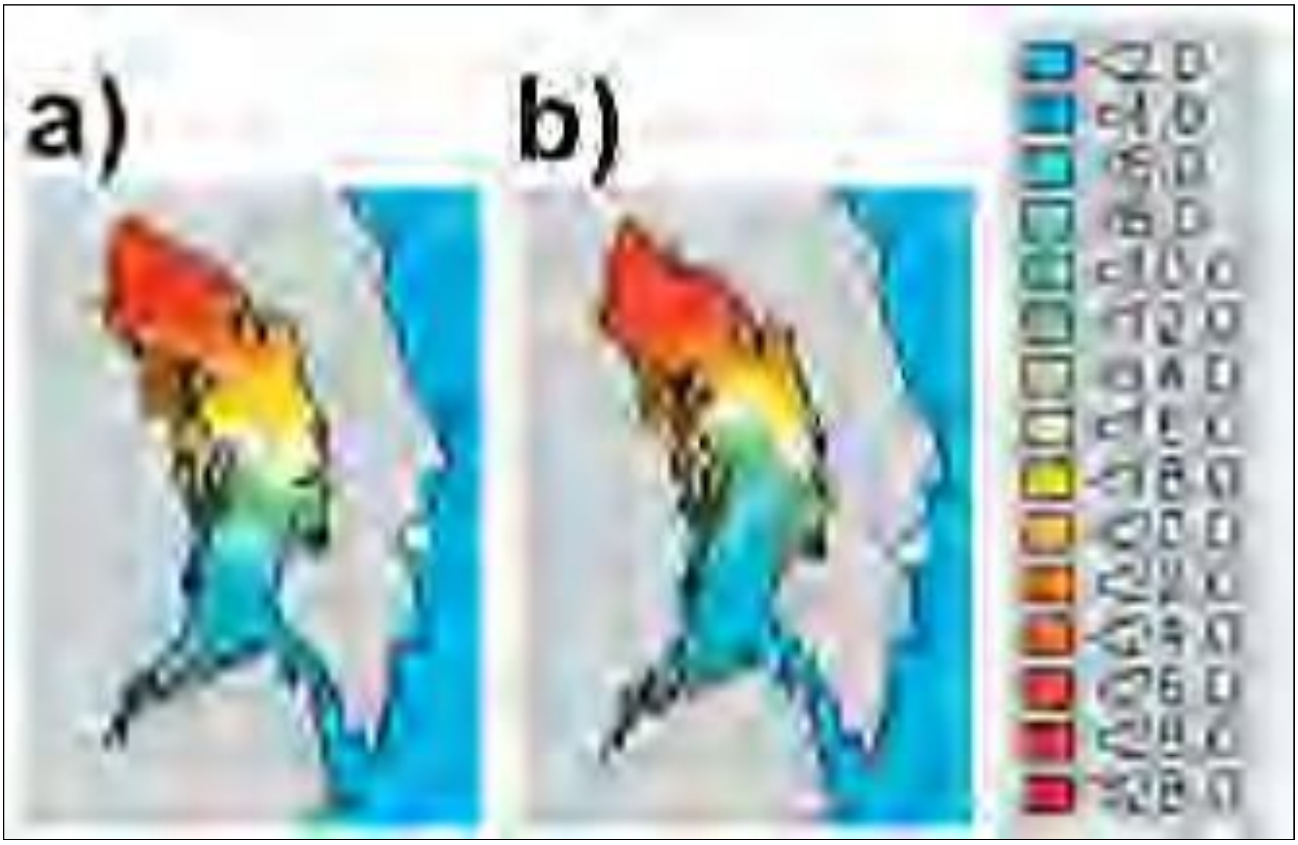


Figure 3.24: Residence times (days) within Strangford Lough a) near surface and b) near bottom (Source: Ferreira *et al.,* 2007).

3.10. Discussion

The bathymetric and hydrographic characteristics of the Narrows, with greatest depths and strongest currents make it a well mixed and well flushed area and as a result any contaminants in the Narrows are diluted and dispersed rapidly. Inside the Narrows, in the lough proper, there are strong currents between Ballyhenry Point and Gransha Point and moderate current speeds inside of Gransha Point. Depths in these areas range from shallow (2-5m) to deeper pools from between 30-60m. These areas are considered to be well mixed and well flushed over the course of a tidal cycle. There are three areas in the lough, where depths are shallow and current speeds are weak and as a result these areas may act as sinks for contaminants. These areas are in the southwest of the lough in the area of the Quoile River, along the western shoreline between Ringhaddy and Conly Island and in the northwestern region of the lough inside the Comber River area. These areas also have varying amounts of freshwater input and as a result may be more vulnerable to contamination. Water movement as a result of wave action is towards the eastern shoreline and the prevailing wind direction also results in water movement towards the eastern and northern shoreline, this and the fact that there are strong to moderate current flows in these areas it is likely that these areas will experience varying levels of sediment disturbance and resuspension particularly in the shallower areas.

4. Identification of Pollution Sources

4.1. Desktop Survey

Pollution sources were considered within the catchment area of Strangford Lough (see Figure 4.1). The catchment area covers an area of 771.5km^2 (Roberts *et al.,* 2004b) and it is approximately 38.5km east west at its widest point and 42.3km north south at its longest point. The rivers, which drain into Strangford Lough can also be seen in Figure 4.1. The entire catchment area (as shown in Figure 4.1) does not drain into Strangford Lough. Only the pollution sources, flowing into the lough or into a tributary of the lough were considered as part of this survey i.e. sources flowing into the Irish Sea or Dundrum Bay were not considered.

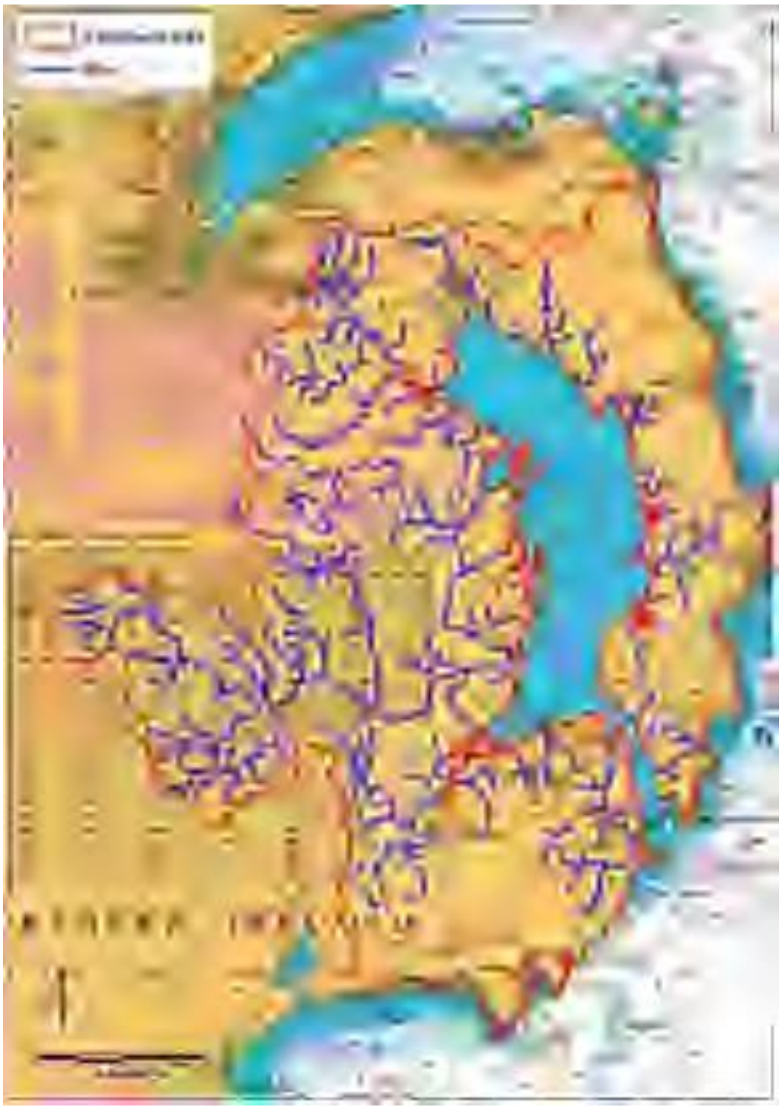


Figure 4.1: Strangford Lough catchment area and rivers used for assessment of the pollution sources (Source: NIEA, 2011).

4.1.1. Human Population

Strangford Lough and its catchment area are located entirely in Co. Down. Population census data for Northern Ireland is given in units of Super Output Areas (SOA). Figure 4.2 shows the SOAs within the Strangford Lough catchment area which drain into Strangford Lough.

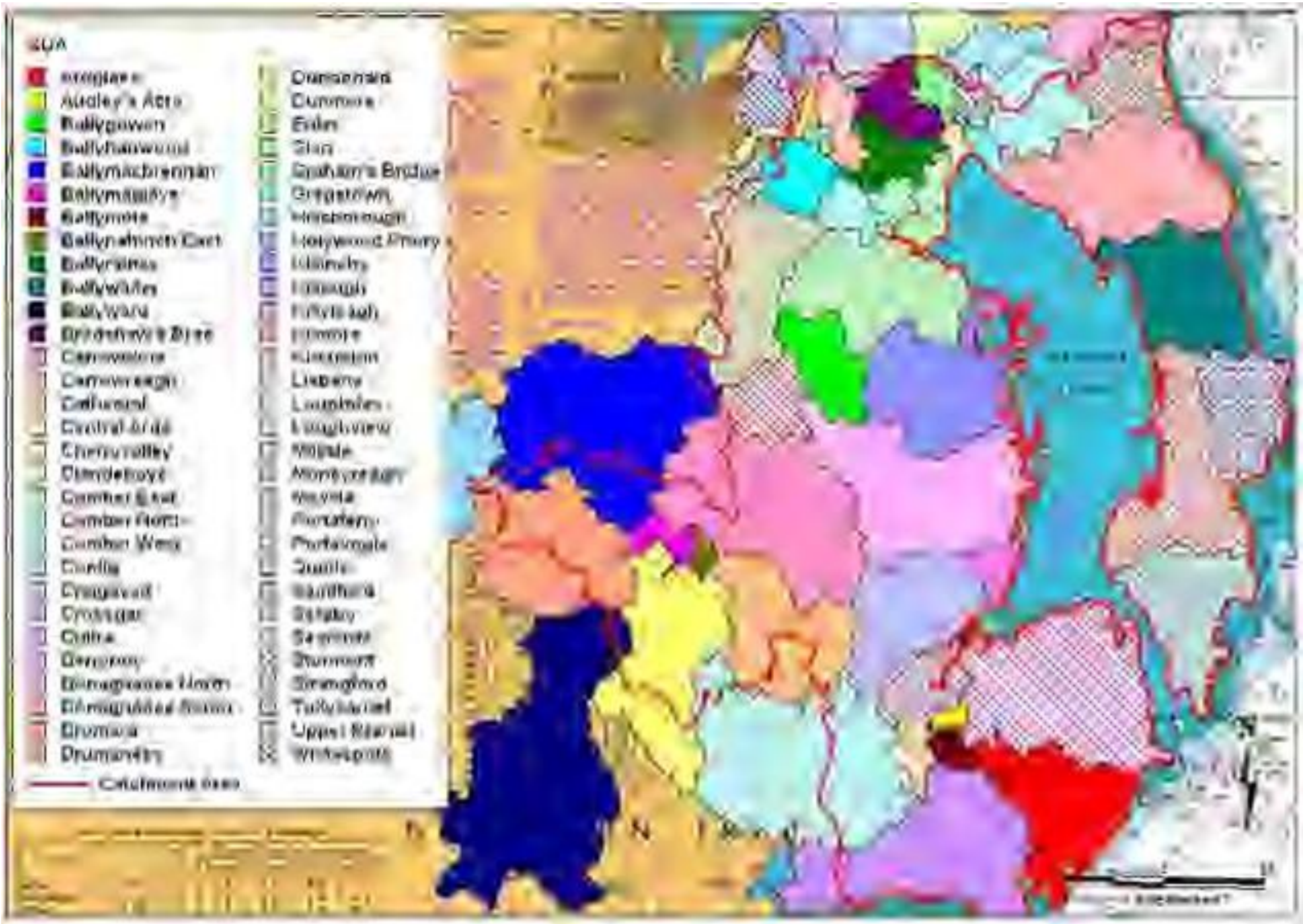


Figure 4.2: SOAs within the Strangford Lough Catchment Area.

Data on human populations for 2008 for Northern Ireland was obtained from The Northern Ireland Statistics and Research Agency (NISRA) website (NISRA, 2010). Figure 4.3 shows the human population within the Strangford Lough catchment area and Table 4.1 shows this data in tabular form.

Population size around the coast of Strangford Lough ranges from 2,498 people in Strangford SOA (located along the southern shore of the lough) to 4,677 people in Gregstown SOA (located in Newtownards, along the northern coast of the lough). Population size along the eastern shoreline ranges from 3,252 people in Kircubbin to 3,923 people in Ballywalter. Population size along the western shoreline ranges from 2,675 people in Central Ards (in Newtownards) to 3,281 people in Derryboy. Population sizes are higher in a number of areas away form the lough's shoreline e.g. Kilmore (4,734 people), Dromara (4,436 people), Killough (4,174 people), Portavogie (4,727 people) and Carrowreagh (4,054 people). The largest population centres (>5,000 people) in the study area are located around Belfast and Bangor and are Cherryvalley (5,731 people), Conlig (5,619 people) and Stormont (5,339 people). These population centres are located along the boarder of the catchment area and only a very small percentage actually lies within the catchment area. The total population within the Strangford Lough catchment is estimated at approximately 150,000 people[5].

Figure 4.4 and Table 4.2 shows the 2008 population size in the main urban centres within the catchment area (NISRA, 2011). Newtownards (28,437) and Downpatrick (10,737) are the largest population centres, located to the north and south of the lough. Comber was the next largest centre located to the northwest of the lough. The remaining coastal centres are all villages/intermediate settlements with populations ranging from 1,037 (Greyabbey) to 3,028 (Killyleagh).

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 Strangford Lough system.

[5] Given the fact that not all SOAs in their entirety are located within the catchment area, an estimate of the total population within the catchment area was calculated based on percentages located within the catchment area.

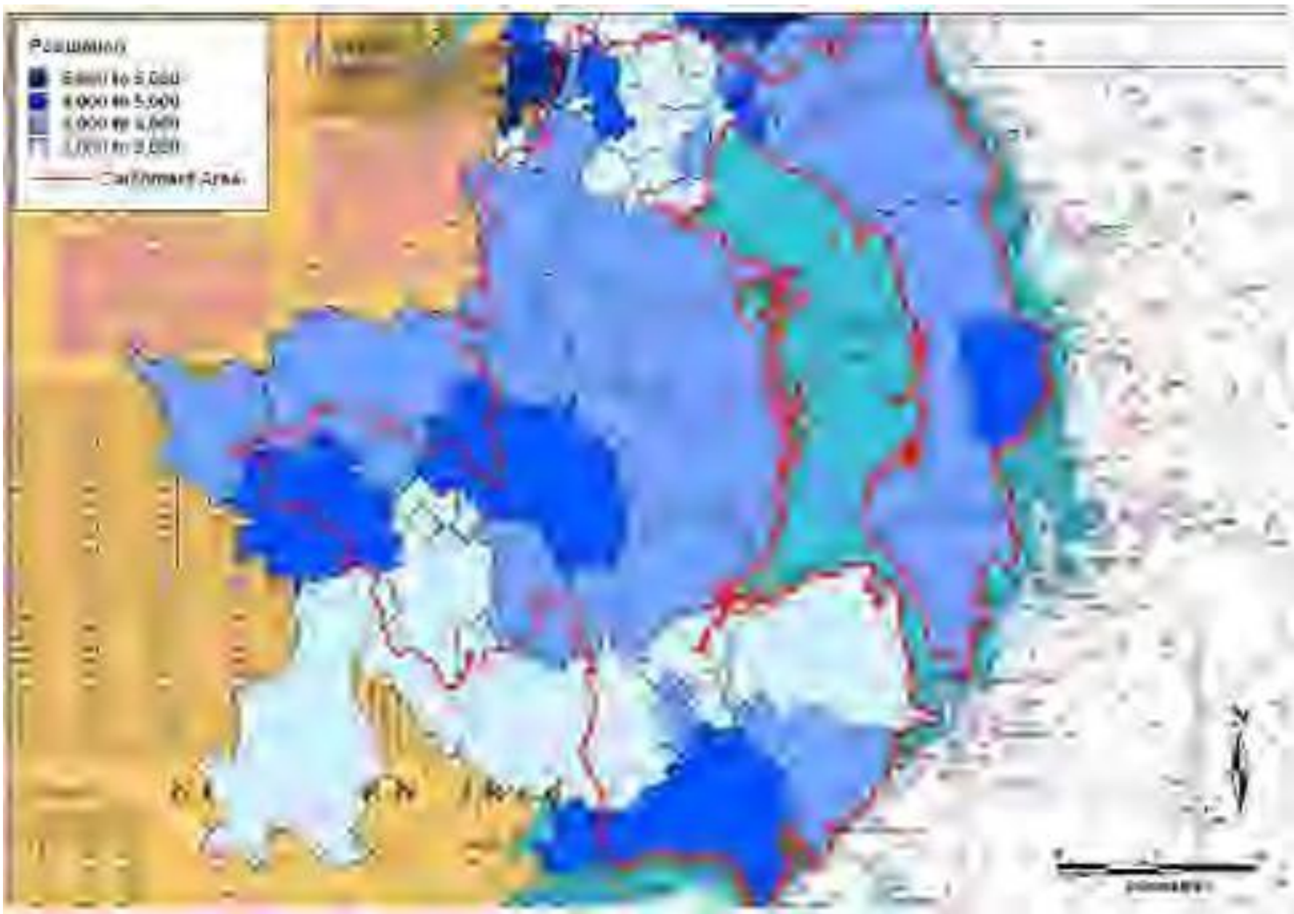


Figure 4.3: Human population within the Strangford Lough Catchment Area (Source: NISRA, 2010).

Table 4.1: Human population within the Strangford Lough Catchment Area (Source: NISRA, 2010).

SOA	Population	SOA	Population
Ballynahinch East	2433	Dundonald	3275
Holywood Priory	2687	Carrowreagh	4054
Cultra	2504	Ballyhanwood	3003
Craigavad	2660	Whitespots	3095
Strangford	2498	Scrabo	3177
Seaforde	2959	Portavogie	4727
Killyleagh	3137	Portaferry	3388
Dunmore	2875	Movilla	4866
Ballymote	2741	Millisle	3821
Audley's Acre	2287	Loughries	3727
Upper Braniel	2350	Lisbane	3086
Tullycarnet	2525	Kircubbin	3252
Graham's Bridge	2397	Killinchy	3106
Enler	2428	Gregstown	4677
Ballyward	2909	Glen	2800
Central Ards	2675	Donaghadee South	3175
Ballyrainey	2457	Donaghadee North	3245

SOA	Population	SOA	Population
Ballymacbrennan	3139	Comber West	2933
Saintfield	3507	Comber North	2629
Quoile	2724	Comber East	2921
Kilmore	4734	Carrowdore	3360
Killough	4174	Bradshaw's Brae	2937
Drumaness	3721	Ballywalter	3923
Derryboy	3281	Ballygowan	3639
Dromara	4436	Loughview	4141
Crossgar	3144	Conlig	5619
Cathedral	3459	Clandeboye	4859
Ballymaglave	2977	Hillsborough	3530
Ardglass	3058	Stormont	5339
Moneyreagh	3744	Cherryvalley	5731

Figure 4.4: Populations of urban centres within the catchment area (Source: NISRA, 2011).

Table 4.2: Populations of urban centres within the catchment area (Source: NISRA, 2011).

Name	Settlement	Population
Greyabbey	Village	1037
Kircubbin	Village	1188
Portaferry	Village	2514
Portavogie	Village	2042
Ballywalter	Village	1647
Millisle	Village	2089
Donaghadee	Small Town	6856
Newtownards	Large Town	28437
Comber	Small Town	8933
Ballygowan	Intermediate Settlement	2828
Killyleagh	Intermediate Settlement	3028
Downpatrick	Medium Town	10737
Drumaness	Village	1300
Ballynahinch	Small Town	5633
Saintfield	Intermediate Settlement	3445
Ardglass	Village	1605
Annahilt	Village	1115

4.1.2. Tourism

In 2009, 1,918,000 tourists visited Northern Ireland (NITB {Northern Ireland Tourist Board}, 2009) compared with 2,076,000 in 2008. This was the lowest figure recorded since 2004 and is a 3.4% decrease on 2004 figures and a 7.6% decrease on 2008 numbers. Of these tourists, 47% were visiting family and friends and 26% were holidaying, 32% of them arrived in between July and September and 26% of them arrived between April and June and 59% stayed with family or friends while 27% stayed in a hotel. A NITB local authority survey revealed that in 2009, 747,000 trips were made to Ards[6] with an estimate value of
£8.3 million and 265,000 trips were made to Down with an estimated value of £40.2 million (NITB, 2010). This represents approximately 11% of the visitors who visited Northern Ireland in 2009.

There are numerous activities which tourists can partake in along the shores of Strangford Lough, e.g. sailing, kayaking, canoeing, bird watching, diving, cruising, adventure centres, wildlife centres, angling, golf, mountain biking, walking and caravaning. These can be seen in Figure 4.5 below. This data was gathered from Ordnance Survey maps, Admiralty Charts, the Land & Property Services online web

[6] The Strangford Lough area is broken into 2 district councils/local authority areas – 1) Ards which covers the Ards Peninsula and the northern and northwestern area around the lough and 2) Down, which covers the southwestern and southern areas around the lough.

mapping application (www.nimap.net) and the Strangford Lough and Lecale Patrnership (SLLP) (www.strangfordlough.org).

Currently sea anglers target mackerel during the summer as well as pollack, coalfish and conger eels (SLLP, 2011a). The majority of sea angling takes place from the shore, rocks and from piers and marinas.Some angling takes place on the lough on privately owned and local charter boats and these anglers may target other species such as cod and ling in deep areas of the lough and on shipwrecks. Sailing and canoeing are among the other water sports on the lough. There are 12 sailing clubs around Strangford Lough, Strangford Lough Yacht Club (Whiterock) being the largest. Boats at these clubs range from dinghies to large cruisers. Competitive sailing takes place throughout the summer and annual regattas and other events are held. Windsurfing (or sail boarding) has become increasingly popular over recent years, particularly at Cunningburn, Kircubbin and Whiterock. The majority of windsurfing on Strangford Lough is affiliated with RYA Clubs and training centres.Little depth of water is required and insulating suits enable enthusiasts to sail throughout the year when weather permits. Typically up to 50 windsurfers would be afloat during a summer weekend on the lough.There is also some kitesurfing in Strangford Lough, again mainly at the north end, around Cunningburn.

Strangford Lough is Northern Ireland's first and only Marine Nature Reserve and there are also seven Nature Reserves located around the shores of Strangford Lough. The entire shoreline of the lough is designated as an Area of Outstanding Natural Beauty (AONB).

Increases in population in the local area due to tourism may result in an increase in the quantity of sewage discharged within the Strangford 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.

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 January 2005 to June 2011) 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 the ANOVA analysis, all shellfish flesh results that returned a less than value (i.e. <X) were given a value of X-1 (e.g. <20 becomes 19) and all samples that returned a ND (Not Detectable) result were given a value of 0.01. All beds had ≥12 results per season and all beds were used in this analysis. Box-plots are frequently used to assess and compare sample distributions of microbiological data.

Figure 4.6 shows box-plots produced for each shellfish bed after grouping the data by season. 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. Outliers (large and small) are represented by an asterisk. It should be noted that the shellfish bed box plots are shown twice in Figure 4.6, this is due to the fact that the first plot shows a very large outlier which resulted in an illegible distribution, the second plot shows the distribution without the outlier.

This analysis revealed that in autumn, there were significant differences between the Marlfield Bay scallop bed and the Reagh Bay oyster bed and in winter there were significant differences between The Dorn oyster bed and the Marlfield Bay scallop bed.

While the analysis also revealed that there were no significant differences between seasons within each harvesting bed, it can be seen in Figure 4.6 that winter and autumn levels were marginally higher than spring and summer levels at Skate Rock and summer and winter levels were higher than autumn levels at Reagh Bay. While Figure 4.6 shows higher summertime levels at The Dorn, these levels were not significantly different from the other seasons and at Marlfield Bay all seasons had quite similar levels.

No significant increases in *E. coli* levels during the summer months were evident from this analysis, implying that in Strangford Lough the effects of increased rainfall and subsequent run-off has more of an effect on *E. coli* levels than from any increase in population during the summer months.

Figure 4.5: Tourist facilities within the Strangford Lough Catchment Area.

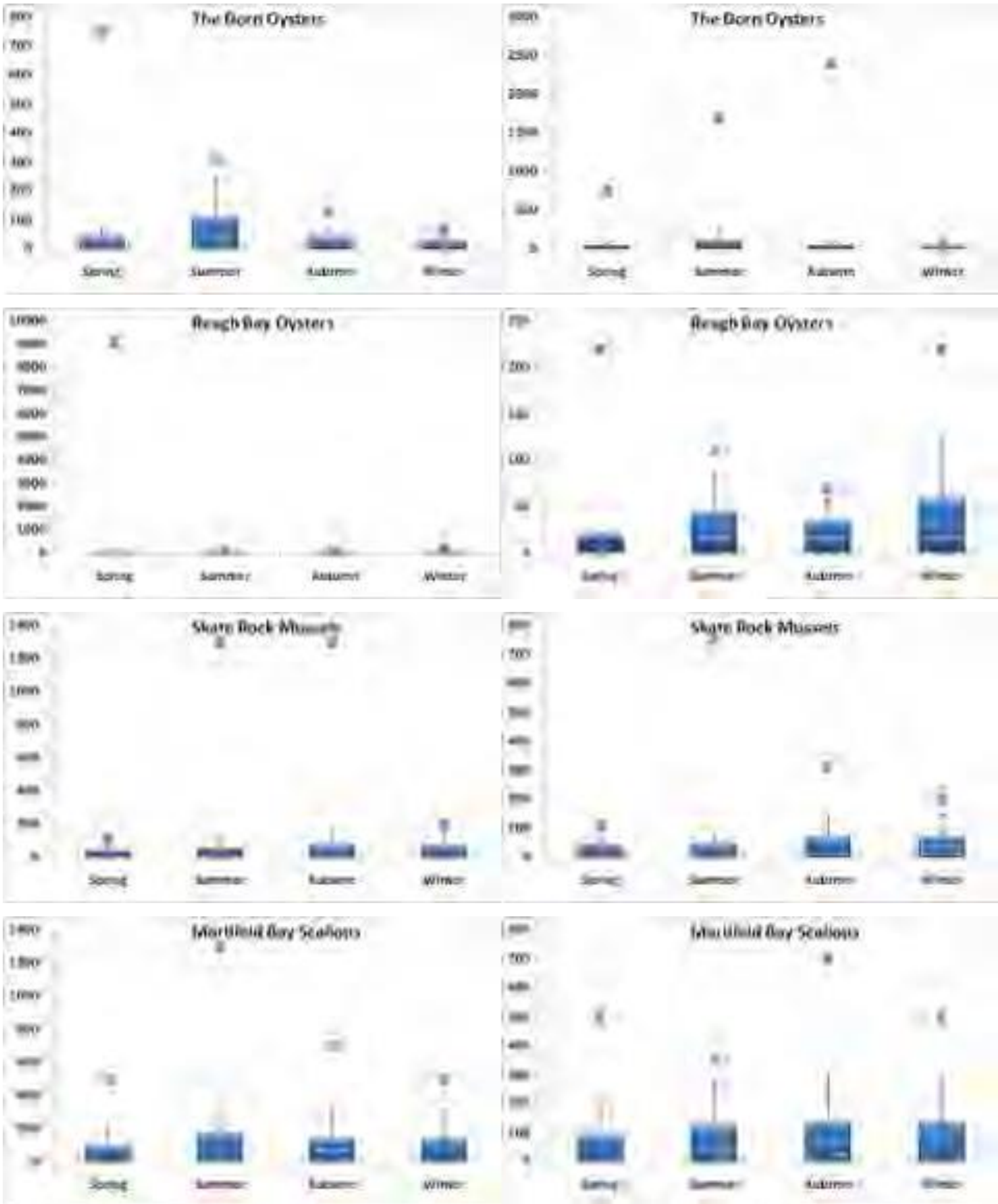


Figure 4.6: Seasonal variation of *E. coli* in shellfish flesh from Strangford Lough.

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 4.7 shows all 41 Waste Water Treatment Works within the Strangford Lough catchment area. Table 4.3 shows the coordinates and population equivalents (p.e.) of these plants. It should be noted that the locations of the Barrhall, Abbacy Rd. and Inishargy Rd. (2-10) plants were estimated using aerial photography and planning maps accessed through www.nimap.net. There are 41 Waste Water Treatment Works (WWTWs) in the Strangford Lough catchment, serving a population of approximately 108,000[7]. The major works are those at Ballyrickard, Downpatrick, Ballynahinch and Killyleagh, these four works together account for 78% of the total population equivalent of the catchment.

[7] Not all WWTW had a p.e. and not all properties in the catchment would be served by these 41 WWTW, therefore 108,000 is an underestimate of the population

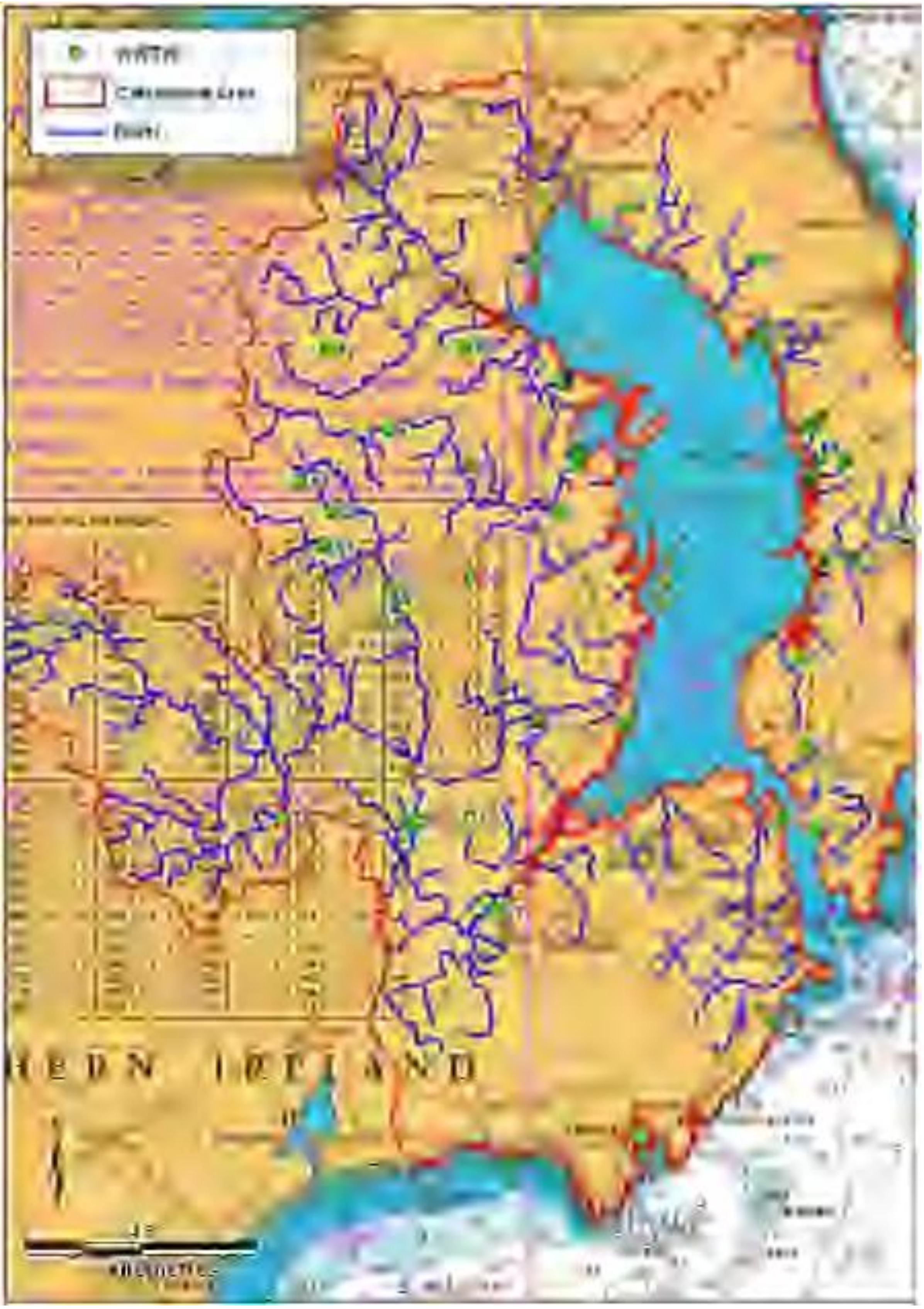


Figure 4.7: WWTWs within the Strangford Lough Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Table 4.3: WWTWs within the Strangord Lough Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Map ID	Plant	Easting	Northing	Longitude	Latitude	Current p.e.
1	Kircubbin	[Redacted]	[Redacted]	[Redacted]	[Redacted]	1698
2	Killinchy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	3111
3	Strangford	[Redacted]	[Redacted]	[Redacted]	[Redacted]	1236
4	Barrhall	[Redacted]	[Redacted]	[Redacted]	[Redacted]	27
5	Greyabbey	[Redacted]	[Redacted]	[Redacted]	[Redacted]	1223
6	Ballyrickard	[Redacted]	[Redacted]	[Redacted]	[Redacted]	50000
7	Killyleagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	7553
8	Ballygowan	[Redacted]	[Redacted]	[Redacted]	[Redacted]	3358
9	Loughries	[Redacted]	[Redacted]	[Redacted]	[Redacted]	262
10	Ringneill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	673
11	Ballycranbeg	[Redacted]	[Redacted]	[Redacted]	[Redacted]	362
12	Moneyreagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	2274
13	Abbacy Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	42
14	Drumaness	[Redacted]	[Redacted]	[Redacted]	[Redacted]	2609
15	Bells Hill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
16	Drumhirk	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
17	Ballytrim	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
18	Kilmood	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
19	Lessans	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
20	Glasdrummond Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
21	Lisowen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
22	Portaferry Deerpark	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
23	Thorney Glen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
24	Ballyhoran	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
25	Carsons Dam Bridge	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
26	Annahilt	[Redacted]	[Redacted]	[Redacted]	[Redacted]	1756
27	Downpatrick	[Redacted]	[Redacted]	[Redacted]	[Redacted]	18446
28	Annacloy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	383
29	Kilmore Crossgar	[Redacted]	[Redacted]	[Redacted]	[Redacted]	420
30	Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	4433
31	Ballynahinch	[Redacted]	[Redacted]	[Redacted]	[Redacted]	7996
32	Tullynakill Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
33	Blackstaff ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]	30
34	Craigarusky Rd 66	[Redacted]	[Redacted]	[Redacted]	[Redacted]	6
35	Inishargy Rd 2-10	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
36	Portaferry Road 96	[Redacted]	[Redacted]	[Redacted]	[Redacted]	9
37	Ringneil Road 1-5	[Redacted]	[Redacted]	[Redacted]	[Redacted]	9
38	Tubber Road 10-16	[Redacted]	[Redacted]	[Redacted]	[Redacted]	12
39	Inishargy Rd 10-12	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A

Map ID	Plant	Easting	Northing	Longitude	Latitude	Current p.e.
40	Parsonage Rd 110-120	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A
41	Carrowdore Rd 38-40	[Redacted]	[Redacted]	[Redacted]	[Redacted]	N/A

* indicates the location was estimated. N/A indicates data was Not Available

4.1.3.1. Continuous Sewage Discharges

Figure 4.78 shows the continuous sewage discharges associated with the WWTWs within the Strangford Lough catchment area. A large-scale cross-referenced map can be found in Section 4.4 Location of Sources.

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 8 direct discharges into Strangford Lough, 5 into a direct tributary of the lough and the remainder discharge into rivers which ultimately discharge into the lough. Table 4.3 shows details on the WWTW continuous discharges (Source: NI Water). Those which have a Y in the Discharge Data column of Table 4.3 have accompanying discharge analysis results, which can be found in Appendix 1 (2010). The following parameters are available for these discharges: Ammonia, Nitrate, Nitrite, Nitrogen oxides, Total Nitrogen, Phosphorus, Chloride, Biochemical Oxygen Demand, Coliforms, Suspended Solids and pH.

The largest volumes discharged by these plants come from the Ballyrickard, which discharges secondary treated waste water into the Newtown Burn River and ultimately Strangford Lough (29,700 m^3/day).

Figure 4.8: Location of Continuous Sewage Discharges within the Strangford Lough Catchement Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Table 4.4: WWTW Continuous Discharges within the Strangford Lough Catchment Area (Source: NIEA Water Management Unit,NI Water, www.nimap.net).

Map ID	Plant	Easting	Northing	Longitude	Latitude	Receiving Water Body	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
42	Kircubbin	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	MBR Treated Waste Water	1728	648	
43	Killinchy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Blackwater River	Secondary Treated Waste Water	883	338.3	Y
44	Strangford	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Secondary Treated Waste Water	597	244	Y
45	Barrhall	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Secondary Treated Effluent	24	8	
46	Greyabbey	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	MBR Treated Waste Water	1152	462	Y
47	Ballyrickard	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Newtown Burn River	Secondary Treated Waste Water	29700	9900	Y
48	Killyleagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Secondary Treated Waste Water	N/A	N/A	Y
49	Ballygowan	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Ballygowan River	Secondary Treated Waste Water	2400	622	Y
50	Loughries	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Strangford Lough	Secondary Treated Waste Water	136	57	Y
51	Ringneill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Secondary Treated Waste Water	346	180	Y
52	Ballycranbeg	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Blackstaff River	Secondary Treated Waste Water	N/A	N/A	Y
53	Moneyreagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Ballystockart River	MBR Treated Waste Water	N/A	N/A	Y
54	Abbacy Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Strangford Lough	Secondary Treated Effluent	81	27	
55	Drumaness	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Ballynahinch River	MBR Sec Act	N/A	N/A	Y
56	Bells Hill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Quoile River	RBC Sec Bio	N/A	N/A	
57	Drumhirk	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Comber River	Filter Sec Bio	N/A	N/A	
58	Ballytrim	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Dibney River	Package Aeration Sec Act	N/A	N/A	
59	Kilmood	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Blackwater River	RBC Sec Bio	N/A	N/A	

Map ID	Plant	Easting	Northing	Longitude	Latitude	Receiving Water Body	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
60	Lessans	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Filter Sec Bio	N/A	N/A	
61	Glasdrummond Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Carsons Dam River	Filter Sec Bio	N/A	N/A	
62	Lisowen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Carsons Dam River	Filter Sec Bio	N/A	N/A	
63	Portaferry Deerpark	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Act Sludge Sec Act	N/A	N/A	
64	Thorney Glen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Ext Aer Ter A1	N/A	N/A	
65	Ballyhoran	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Unscreened	N/A	N/A	
66	Carsons Dam Bridge	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Carsons Dam River	N/A	N/A	N/A	
67	Annahilt	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Annahilt River	Act Sludge Sec Act	N/A	N/A	Y
68	Downpatrick A	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Quoile River	Ext Aer Ter A1	N/A	N/A	Y
69	Downpatrick B	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Quoile River	Ext Aer Ter A1	N/A	N/A	Y
70	Annacloy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Annacloy River	Ext Aer Ter A1	N/A	N/A	Y
71	Kilmore Crossgar	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Annacloy River	Oxidation Ditch Sec Act	N/A	N/A	Y
72	Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Carsons Dam River	Act Sludge Sec Aer	N/A	N/A	Y
73	Ballynahinch	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Ballynahinch River	Oxidation Ditch Ter A2	N/A	N/A	Y
74	Tullynakill Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Filter Sec Bio	N/A	N/A	
75	Blackstaff ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Blackstaff River	Secondary Treated Effluent	24	8	
76	Craigarusky Rd 66	[Redacted]	[Redacted]	[Redacted]	[Redacted]	River Blackwater	Secondary Treated effluent	1.8	2	
77	Inishargy Rd 2-10	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Strangford Lough	Secondary treated effluent	N/A	5	
78	Portaferry Road 96	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Strangford Lough	Secondary treated effluent	20	6.7	
79	Ringneil Road 1-5	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Strangford Lough	Secondary Settled effluent	7.2	2.4	
80	Tubber Road	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib Strangford Lough	Secondary Treated effluent	9.3	3.2	

Map ID	Plant	Easting	Northing	Longitude	Latitude	Receiving Water Body	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
	10-16									
81	Inishargy Rd 10-12	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Unknown	N/A	N/A	
82	Parsonage Rd 110-120	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Unknown	N/A	N/A	
83	Carrowdore Rd 38-40	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Unnamed Water Body	Unknown	N/A	N/A	

* Indicates the coordinates were estimated. N/A indicates data was Not Available. FFT = Flow to Full Treatment. DWF

4.1.3.2. Rainfall Dependent Sewage Discharges

Figures 4.9 and 4.10 show all rainfall dependent discharges i.e. overflows and septic tanks respectively, within the catchment area. Table 4.5 documents the Combined Sewer Overflows (CSO) and Sewage Pumping Station (SPS) overflows which discharge into Strangford Lough or a tributary of it and Table 4.6 documents the septic tanks. There are 168 rainfall dependent discharges within the Strangford Lough catchment area.

Figure 4.9: All overflow discharges within the Strangford Lough Catchment Area (Source: NI Water, NIEA Water Management Unit).

Figure 4.10: All septic tanks within the Strangford Lough Catchment Area (Source: NI Water, NIEA Water Management Unit).

Table 4.5: CSO and SPS overflows within the Strangford Lough catchment Area (Source: NI Water, NIEA Water Management Unit).

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
84	Portaferry (2) SPS	359331.01	350721.03	-5.5474	54.3801	Combined	CSO
85	Comber Rd SPS	348932.78	372757.74	-5.69622	54.5811	Combined	CSO
86	White Rock SPS	352556.50	361801.76	-5.64589	54.4816	Combined	CSO
87	Killyleagh CSO	352936.05	352692.97	-5.64473	54.3997	Combined	Works
88	Nat Walk CSO	353058.63	352565.44	-5.64291	54.3986	Combined	In Sewer
89	Lapwing SPS	350651.4	373001.1	-5.66953	54.5827	Foul	N/A
90	Bishopscourt SPS	357861.4	341975.1	-5.57463	54.302	Combined	CSO
91	Annacloy SPS	344991	348269	-5.76914	54.3624	Combined	CSO
92	Ballyhanwood SPS	341151	373407	-5.81618	54.5891	Combined	CSO
93	Millars Lane SPS	342955.6	372850.6	-5.78855	54.5836	Combined	CSO
94	Balloo SPS	349647	360914	-5.69119	54.4745	Combined	CSO
95	Saintfield SPS	341115.9	358363.2	-5.82392	54.4541	Combined	None
96	Ballydrain Road SPS	346614	368368	-5.73424	54.5423	Foul	CSO
97	Poundburn SPS	329540.3	354985.2	-6.00377	54.4268	Combined	None
98	Magheratimpany SPS	338762.8	348632.7	-5.86473	54.3674	Combined	CSO
99	Crossgar SPS	345236	352124.6	-5.76349	54.3969	Combined	CSO
100	Ballystockard SPS	344234	371253	-5.76958	54.5689	Combined	CSO
101	Millbrook Lodge SPS	337409.3	351524.8	-5.8842	54.3937	Combined	CSO
102	The Green SPS	359654.6	362837	-5.53591	54.4887	Combined	None
103	Watermeade SPS	357456	368069	-5.56701	54.5364	Combined	CSO
104	Old Forge SPS	351371.6	374926.4	-5.65741	54.5998	Foul	None
105	Portaferry Road (2) SPS	350028.7	373046.2	-5.67913	54.5833	Surface	None
106	Scrabo Road SPS	347924.7	373767.9	-5.71129	54.5904	Combined	CSO
107	South Street SPS	349132.1	373609.6	-5.69271	54.5886	Combined	CSO
108	West Winds SPS	348717	372182	-5.69985	54.576	Combined	N/A

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
109	Bradshaws Brae SPS	345305	375061	-5.75115	54.6028	Combined	CSO
110	Raholp Village SPS	353536	347463.9	-5.6382	54.3526	Combined	CSO
111	IDB Lands 2 SPS	347382.2	346312.8	-5.73335	54.3441	Foul	None
112	Ardenlee SPS	349927.3	345655.4	-5.69457	54.3375	Foul	CSO
113	Quoile SPS	349504.8	346270.5	-5.70075	54.3431	Foul	CSO
114	Strangford Road SPS	348758.4	345611.5	-5.71255	54.3374	Combined	N/A
115	Ardfern SPS	350544	345416.1	-5.68522	54.3351	Foul	N/A
116	Racecourse Road SPS	348339.5	343375.6	-5.7201	54.3175	Foul	CSO
117	Church Street Downpatrick SPS	348700	344923	-5.71379	54.3312	Combined	N/A
118	Market Street SPS	348556.1	344517.9	-5.7162	54.3277	Combined	N/A
119	IDB Lands 1 SPS	347074.8	346394.7	-5.73803	54.3449	Foul	N/A
120	Cumber Drive SPS	339418.8	349090.1	-5.85442	54.3713	Foul	None
121	Craigantlet South SPS	344095	376599	-5.7691	54.6169	Combined	CSO
122	Rubane 2 SPS	361403.3	360354.1	-5.5103	54.4659	Combined	CSO
123	Blackstaff SPS	360425	359554	-5.52581	54.459	Combined	None
124	Cloughy Road SPS	360235.2	351457.7	-5.5331	54.3864	Foul	None
125	Rubane 1 SPS	361555	361132	-5.50754	54.4728	Combined	None
126	Strangford Village Green SPS	358871	349735	-5.555	54.3714	Combined	None
127	Shore Road Portaferry 1 SPS	359558	350371	-5.5441	54.3769	Foul	None
128	Long Island Drive SPS	360200.7	362518.7	-5.52766	54.4857	Foul	N/A
129	Landsdowne Road Storm SPS	348752	372076.9	-5.69936	54.575	Surface	N/A
130	Landsdowne Road Foul SPS	348748	372082.7	-5.69942	54.5751	Foul	N/A
131	Upper Newtonards Road SPS	341651	373974	-5.80818	54.5941	Combined	None
132	Comber Road Dundonald SPS	342197.1	373256.7	-5.80008	54.5875	Combined	CSO
133	Rolls Royce SPS	343089.1	374134.5	-5.78587	54.5951	Combined	N/A
134	Whiterock Road SPS	351091	360883	-5.66895	54.4738	Combined	None
135	Maymore SPS	352411	353818	-5.65224	54.41	Combined	CSO
136	Inishmore Killyleagh SPS	352447.5	352077.2	-5.65257	54.3944	Foul	N/A

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
137	Cochranes SPS	345648.6	352414	-5.757	54.3994	Foul	CSO
138	Annahilt (2) SPS	330079.7	357018.2	-5.99458	54.4449	Combined	CSO
139	Clanwilliams Court SPS	335549.8	352684.5	-5.91228	54.4046	Combined	None
140	Down Business SPS	336385	352460	-5.89953	54.4024	Foul	None
141	Glass Factory SPS	336679.4	353440.4	-5.89455	54.4111	Combined	None
142	Antrim Road SPS	336406	352251	-5.8993	54.4005	Combined	CSO
143	Town Ballynahinch SPS	336864.4	352250.8	-5.89225	54.4003	Combined	CSO
144	Ravara SPS	342778	363517.4	-5.79582	54.4999	Foul	N/A
145	The Links SPS	358858	349307	-5.55543	54.3675	Combined	CSO
146	Crossnacreevy SPS	339464	369467	-5.84413	54.5542	Combined	CSO
147	Comber Combined SPS	346331.3	369209.2	-5.73819	54.55	Combined	CSO
148	Comber Storm SPS	346344	369187	-5.73801	54.5498	Surface	None
149	Inisharoan SPS	352418.1	361383.4	-5.64824	54.4779	Foul	CSO
150	Shore Road SPS	359474	363602	-5.53828	54.4957	Foul	None
151	Rockfield SPS	360134	351055	-5.53488	54.3828	Combined	None
152	Ballyhoran 1 SPS	359225	341760	-5.55382	54.2997	Combined	CSO
153	The Moorings SPS	352516.1	351994.4	-5.65155	54.3936	Foul	N/A
154	Russell Park SPS	348580.9	344031.2	-5.71607	54.3233	Combined	N/A
155	Ballyhoran 2 SPS	359127.6	341468.2	-5.55547	54.2971	Combined	CSO
156	Raholp SPS	353409.6	347497.9	-5.64013	54.353	Unknown	CSO
157	Lisbarnet SPS	348542.7	365124.5	-5.7061	54.5126	Foul	CSO
158	Shore Road Kircubbin CSO	359545	363248	-5.53737	54.4925	Combined	In Sewer
159	Bangor Road Newtownards CSO	349627.2	374725.2	-5.68449	54.5985	Combined	In Sewer
160	91 Bangor Road Newtownards CSO	349602	374621	-5.68493	54.5976	Combined	In Sewer
161	Bangor Road Newtownards CSO	349585	374434	-5.68529	54.5959	Combined	In Sewer
162	Brooklands Avenue CSO	342612.3	373926.7	-5.79334	54.5934	Combined	In Sewer
163	Poundburn CSO	329522.9	354963.5	-6.00405	54.4266	Combined	Works
164	Down Council Strangford Road CSO	349038	345822	-5.70815	54.3392	Combined	In Sewer

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
165	Stream Street One CSO	348806	343988	-5.71263	54.3228	Combined	In Sewer
166	Folly Lane Downpatrick CSO	348699	344229	-5.71415	54.325	Surface	In Sewer
167	Stream Street Two CSO	348698	343912	-5.71433	54.3222	Combined	In Sewer
168	Malone Park CSO	348861	345680	-5.71094	54.338	Combined	In Sewer
169	Dunmore Road One CSO	336734.7	349247.1	-5.89563	54.3734	Combined	In Sewer
170	Comber Road Enler CSO	342361.9	373034.1	-5.79764	54.5854	Combined	In Sewer
171	Comber Road Shopping Centre CSO	341564.9	373812.3	-5.80959	54.5926	Combined	In Sewer
172	Seaview CSO	352663	352433.4	-5.64907	54.3975	Combined	In Sewer
173	Whiterock Bay CSO	352422	361866	-5.64793	54.4822	Foul	In Sewer
174	Teconnaught Road CSO	344588.4	350658.6	-5.77417	54.3839	Combined	In Sewer
175	Town CSO	336860.2	352255.5	-5.89231	54.4004	Combined	In Sewer
176	Dromore Road CSO	336299	352208	-5.90097	54.4001	Combined	In Sewer
177	Bells Hill CSO	347071.3	348921.7	-5.73684	54.3676	Combined	Works
178	97 Bangor Road Newtownards CSO	349609	374706	-5.68478	54.5983	Combined	In Sewer
179	Lessans CSO	340094.8	361674.9	-5.83809	54.4841	Combined	Works
180	John Street Police Station CSO	348836	373857	-5.69716	54.591	Combined	In Sewer
181	Greyabbey Square CSO	357912	367902	-5.56006	54.5347	Combined	In Sewer
182	Boyd Avenue CSO	359807	362502	-5.53374	54.4857	Combined	In Sewer
183	Saul Street CSO	349101	345064	-5.70756	54.3324	Combined	In Sewer
184	The Slip CSO	358875	349718	-5.55495	54.3712	Combined	In Sewer
185	Killysuggan CSO	347182	374725	-5.72229	54.5992	Combined	In Sewer
186	Ballybarnes Meadow CSO	345884	375229	-5.74211	54.6041	Combined	In Sewer
187	Pound Bridge CSO	345423	369365	-5.75214	54.5516	Combined	In Sewer
188	Ballyrogan Park CSO	345142	374870	-5.75376	54.6011	Combined	In Sewer
189	Grand Prix Mews CSO	341774	373567	-5.80647	54.5904	Combined	In Sewer
190	Mill Street John CSO	348396	373971	-5.7039	54.5921	Combined	In Sewer
191	Downhill Terrace CSO	336294	352902	-5.90073	54.4063	Combined	In Sewer
192	Brooklands Crescent CSO	342907	374085	-5.78871	54.5947	Combined	In Sewer

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
193	Upper Newtownards Road CSO	341832	374044.1	-5.80535	54.5946	Combined	In Sewer
194	Cumberland Road CSO	341368.7	373506.2	-5.81277	54.5899	Combined	In Sewer
195	Crossgar CSO	345226.6	352142.5	-5.76363	54.3971	Combined	Works
196	Dunmore Road Two CSO	336784.3	349191.5	-5.89489	54.3729	Combined	In Sewer
197	Magheratimpiny CSO	338750.6	348632	-5.86491	54.3673	Combined	In Sewer
198	Carlisle Park CSO	337401	351899	-5.88415	54.397	Combined	In Sewer
199	Greenview CSO	339755.9	348693.5	-5.84943	54.3676	Combined	In Sewer
200	CSO 03	348866	372917	-5.69717	54.5825	N/A	N/A
201	CSO 04	348862	373012	-5.69719	54.5834	N/A	N/A
202	CSO 05	348855	373120	-5.69724	54.5843	N/A	N/A
203	CSO 06	348863	372804	-5.69728	54.5815	N/A	N/A
204	CSO 07	348840	373352	-5.69735	54.5864	N/A	N/A
205	CSO 08	348844	373278	-5.69733	54.5858	N/A	N/A
206	CSO 09	348854	373206	-5.69721	54.5851	N/A	N/A
207	CSO 10	348826	373443	-5.69752	54.5872	N/A	N/A

Table 4.6: Septic tanks within the Strangford Lough catchment Area (Source: NI Water, NIEA Water Management Unit).

Map ID	Name	Easting	Northing	Longitude	Latitude
208	Tubber Road (10-16)	360086	363268	-5.52902	54.4925
209	Lisbane Road (38-40)	361468	358700	-5.51021	54.451
210	Ravara Road (9-19)	342540	363399	-5.79956	54.4989
211	Ballygowan Road (41-47)	344197	367572	-5.77195	54.5359
212	Clattering Ford	344908	368371	-5.76058	54.5428
213	The Demesne	340409	359305	-5.83437	54.4627
214	Moneyreagh Road (51-55)	340601	367825	-5.82735	54.5392
215	Inishargy Road (10-12)	360100.3	364784.4	-5.52798	54.5061
216	Movilla Road (136-140)	352174.5	374855.1	-5.64504	54.5989
217	Ballymiscaw Road (33-37)	341097.2	376056.1	-5.81574	54.6129
218	Upper Ballygelagh Road (12-18)	361175.1	357625.9	-5.5153	54.4415
219	Ballykeel Cottages (1-4)	341558.6	376353.4	-5.80846	54.6155
220	Carrowdore Road (38-40)	357396.4	370817.6	-5.56647	54.5611
221	Ballyeasborough Road (15-17)	364243.9	361404	-5.46595	54.4744
222	Blackstaff (ST)	360440	359445	-5.52564	54.458
223	Newcastle Road (58-66)	339524.9	347328.2	-5.85362	54.3554
224	Drumaroad Draper Hill - Chapel Hill	336825.4	344679.8	-5.89633	54.3324
225	Parsonage Road (110-120)	361166.6	363202.9	-5.51239	54.4915
226	Ballyrainey Road (65-67)	345535.7	372141.2	-5.74903	54.5765
227	Ringneill Road (1-5)	350132.9	365844.3	-5.6812	54.5186
228	Kilcarn Road	344926	360391.2	-5.76422	54.4712
229	Moss Road (76-78)	346117.8	362744.5	-5.74469	54.492
230	Lisbarnett Road (47-53)	346622.2	362973.2	-5.7368	54.4939
231	Tullyhubbert Road (75-81)	342012.9	365344.6	-5.80675	54.5165
232	Ballylone Road	337643	352724	-5.88005	54.4044

Map ID	Name	Easting	Northing	Longitude	Latitude
233	Ballycreely Road	342541.1	366281.4	-5.79814	54.5248
234	Jacksons Cresent (7-8)	342747.2	359437.3	-5.79827	54.4633
235	Jacksons Cresent (9-10)	342778.8	359470.2	-5.79777	54.4635
236	Station Road (155-157)	344433.7	360404.1	-5.77181	54.4715
237	Moneyreagh Road (139-141)	341590.9	366387.3	-5.81276	54.526
238	Comber Road (102-106)	349294.9	362298.2	-5.69592	54.4871
239	Craigarusky Road (66-68)	350772.6	362664.2	-5.67295	54.4899
240	Killinchy Road (96-100)	347184.8	366640.4	-5.72629	54.5267
241	Kirkland Road (6-12)	351786	355668.8	-5.66091	54.4268
242	Moss Road (36-38)	344204.4	363347.9	-5.7739	54.498
243	Ballyalton Road (20-22)	346960.3	371980.1	-5.72709	54.5747
244	Portaferry Road (96-100)	351270.9	371930.4	-5.66051	54.5729
245	Ballybarnes Road (80-82)	346237.6	376310.3	-5.73611	54.6137
246	Gransha Road (26-28)	340716.6	368874.7	-5.82507	54.5485
247	Ballydrain Road (39-43)	348269.3	367255.5	-5.70925	54.5319
248	Jacksons Cresent (1-6)	342720.2	359420.8	-5.79869	54.4631
249	Drumreagh Road (9-11)	346059.9	362483.6	-5.74571	54.4897
250	Ballygowan Road Comber (102-104)	343544.1	364427.1	-5.78356	54.5078
251	Inishargy Road (2-10)	359653.3	364412.1	-5.53508	54.5029

4.1.3.3. Emergency Discharges

Figure 4.11 shows all emergency discharges located within the Strangford Lough catchment area. These emergency overflows are in connection with SPSs, CSOs and private sewage systems and their details can be seen in Table 4.7 (Source: NIEA Water Management Unit, NI Water).

Figure 4.11: Emergency discharges within the Strangford Lough Catchment Area.

Table 4.7: Details on emergency discharges (Source: NI Water, NIEA Water Management Unit).

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
252	Portaferry (1) SPS	350055.57	373053.54	-5.67872	54.5834	Foul
253	Kilclief 2 Shore SPS	359780.96	345506.25	-5.54328	54.3331	Foul
254	Leathem Square SPS	341622.1	373694	-5.80876	54.5916	Foul
255	Ballydugan Road Ind Est SPS	348500.2	343600.4	-5.71752	54.3194	Foul
256	Lissara Close SPS	345351.3	352357.3	-5.76161	54.399	Foul
257	Oakdale SPS	342892.8	363758	-5.79394	54.502	Foul
258	Carsons Road SPS	343703.9	364005.4	-5.7813	54.504	Foul
259	Station Lane SPS	342963.9	363762.9	-5.79284	54.502	Combined
260	Gransha LaMon SPS	341439.8	368958.4	-5.81386	54.5491	Foul
261	Killinchy Road SPS	346190	368649	-5.74065	54.545	Foul
262	The Old Mill Race SPS	345297.8	368694.6	-5.75441	54.5456	Foul
263	Kinedale SPS	335694	352808.4	-5.91001	54.4057	Foul
264	Limpey SPS	340585.6	367683.7	-5.82766	54.5379	Foul
265	Darragh Cross West SPS	343793.9	357693.4	-5.78298	54.4473	Foul
266	Spa SPS	337151	348893.4	-5.88939	54.3701	Combined
267	Lisburn Road SPS	336265.7	352769.3	-5.90123	54.4052	Foul
268	Churchview SPS	336230	352681.8	-5.90182	54.4044	Foul
269	Cooks Cove SPS	359858	362466	-5.53297	54.4853	Combined
270	Ryan Park SPS	338394	370502	-5.86017	54.5638	Foul
271	Teal Rocks SPS	350342	372865	-5.67439	54.5816	Foul
272	Sunderland Park SPS	348596	372620	-5.70149	54.5799	Foul
273	Glenford Way SPS	348289.7	374678.4	-5.70519	54.5985	Foul
274	Braeside SPS	347387.1	374719.9	-5.71912	54.5991	Foul
275	Kilclief 1 SPS Ballycotton SPS	359123.3	345499.4	-5.55339	54.3333	Foul
276	Raholp Village SPS	353536	347463.9	-5.6382	54.3526	Combined

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
277	Ardenlee SPS	349927.3	345655.4	-5.69457	54.3375	Foul
278	Quoile SPS	349504.8	346270.5	-5.70075	54.3431	Foul
279	Mearne Road SPS	349700.4	346428.6	-5.69767	54.3445	Foul
280	Racecourse Road SPS	348339.5	343375.6	-5.7201	54.3175	Foul
281	IDB Lands 3 SPS	346776.3	345935.9	-5.74284	54.3409	Foul
282	Cumber Road SPS	339557.4	349482.7	-5.85211	54.3748	Foul
283	Drumaness Village SPS	339577.8	349067	-5.85199	54.371	Foul
284	Kerries Glen SPS	349859	360951	-5.68791	54.4748	Foul
285	Annsfield SPS	351945	352353	-5.66016	54.397	Foul
286	Oaklands Darragh Cross SPS	344973.1	358273.4	-5.76453	54.4522	Foul
287	Darragh Cross 3 SPS	345209.8	358742.9	-5.76066	54.4563	Foul
288	Darragh Cross 1 SPS	344926.1	358161.5	-5.76531	54.4512	Foul
289	Orchard Annahilt SPS	329735.5	356211.5	-6.00023	54.4378	Foul
290	Meadowvale SPS	343454.9	363474	-5.7854	54.4993	Foul
291	Loughside Drive SPS	337013	352268	-5.88996	54.4005	Foul
292	The Links SPS	358858	349307	-5.55543	54.3675	Combined
293	Lisleen SPS	340475.4	368800	-5.82883	54.5479	Foul
294	Lynnehurst Drive SPS	344615	369332	-5.76464	54.5516	Foul
295	Glencroft SPS	344503	369352	-5.76636	54.5518	Foul
296	Hillside Park SPS	345831	369106	-5.74597	54.5492	Foul
297	Glen Park SPS	344561	368906	-5.76568	54.5477	Foul
298	Carnesure Manor SPS	345794.6	368612.9	-5.74677	54.5448	Foul
299	Carnesure Terrace SPS	345531	368940	-5.75068	54.5478	Foul
300	Annahilt (1) SPS	330332	357583	-5.99044	54.4499	Foul
301	Killinchy Street SPS	345940	369137	-5.74427	54.5494	Foul
302	Darragh Cross 2 SPS	345158.9	358270.8	-5.76167	54.4521	Foul
303	Raholp SPS	353409.6	347497.9	-5.64013	54.353	Unknown
304	Cathedral View SPS	348537.7	343761.3	-5.71686	54.3209	Foul

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
305	Thornleigh SPS	349960	365793	-5.68389	54.5182	Foul
306	Lisbarnet SPS	348542.7	365124.5	-5.7061	54.5126	Foul
307	Poundburn CSO	329524.3	354978.9	-6.00402	54.4268	Combined
308	O' Hagan Construction Ltd	352480	352000	-5.65211	54.3937	Private Sewage : Emergency Overflow
309	Eastonville Traders Ltd	349570	346370	-5.6997	54.344	Private Sewage : Emergency Overflow

4.1.4. Industrial Discharges

Figure 4.12 shows the industrial discharges within the Strangford Lough catchment area accounted for during the desk-based assessment. A large-scale cross-referenced Figure can be found in Section 4.4 Location of Sources. In total there are 15 industrial discharges and all are located around the shores of the lough. Details on these industrial discharges can be seen in Table 4.8.

Figure 4.12: All industrial discharges within the Strangford Lough Catchment Area (Source: NIEA Water Management Unit).

Table 4.8: Details on industrial discharges with the Strangford lough Catchment Area (Source: NIEA Water Management Unit).

Map ID	Station	File Ref	Company	Easting	Northing	Longitude	Latitude	Industry
310	62164	TC80/03	The National Trust (NI) Region	355270	369540	-5.59998	54.5503	Private Sewage : Unspecified
311	60919	TC75/89	Alan Dunlop Ltd	350800	363100	-5.6723	54.4938	Private Sewage : Unspecified
312	60935	TC33/94	Environment & Heritage Service	359600	360400	-5.53806	54.4669	Herbicides
313	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
314	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
315	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
316	60942	TC109/97	R J M Farms	348400	370500	-5.70559	54.5609	Food Processing : Unspecified
317	60943	TC108/97	Sparky Pac	348300	370600	-5.70709	54.5619	Food Processing : Unspecified
318	60944	TC39/94	The Wildfowl and Wetlands Trust	349200	367300	-5.69486	54.532	Private Sewage : Unspecified
319	60945	TC145/88	Cuan Sea Fisheries Ltd	352700	362600	-5.64326	54.4888	Food Processing : Shell Fishery
320	61816	TC14/99	Unknown	359000	356100	-5.54962	54.4285	Food Processing : Shell Fishery
321	62783	TC296/05	Down Cruising Club	352350	362800	-5.64856	54.4907	Private Sewage : Unspecified
322	63688	TC206/07	Laing O'Rouke	348630	370520	-5.70203	54.5611	Site Drainage : Unspecified
323	64325	TC100/09	Unknown	352680	362280	-5.64374	54.4859	Private Sewage : Unspecified
324	64339	TC68/08	Queens University Belfast	359280	350790	-5.54815	54.3807	Site Drainage : Unspecified

4.1.5. Landuse Discharges

Figure 4.13 shows the Corine land use within the Strangford Lough catchment area. Figure 3.15 (page 50) shows all rivers/streams within the catchment area.

Within the catchment area, landuse is dominated by pastures (601.4km^2; 66.8%), followed by complex cultivation patterns (142.5km^2; 15.8%) and agriculture/natural vegetation (37.68km^2; 4.2%) (See Figure 4.14). Forestry (coniferous, broad-leafed and mixed) makes up 0.8% of the landuse in the area (7.3km^2). In total, agricultural activities (non-irrigated arable land, pastures, complex cultivation patterns and agriculture/natural vegetation) comprise 90.2% (812.14km^2) of the landuse in the area.

Figure 4.13: Corine land use within the Strangford Lough Catchment Area (Source: The loughs Agency).

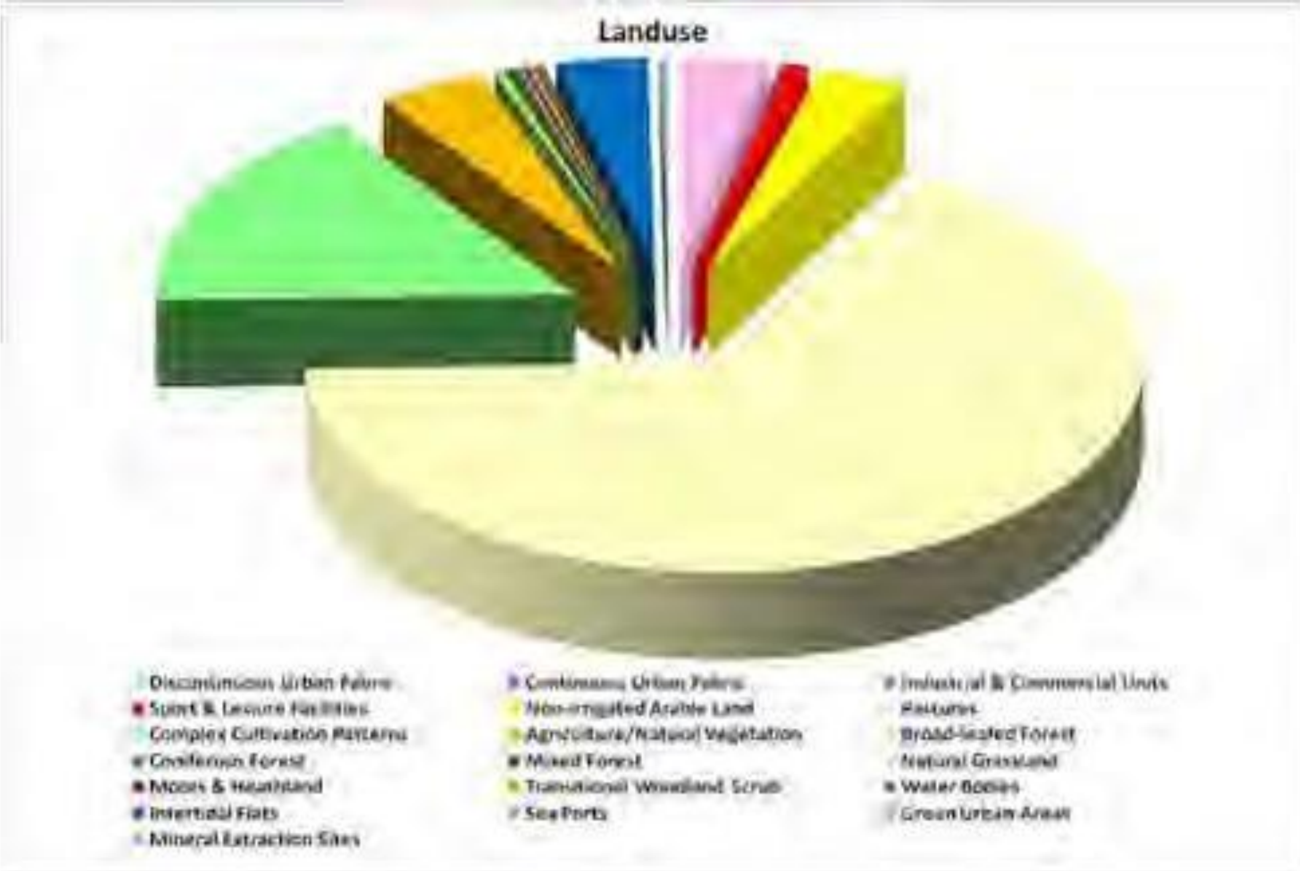


Figure 4.14: Breakdown of landuse within the Strangford Lough Catchment Area.

Data from the Department of Agriculture and Rural Development Farm Census 2009 (DARD, 2009) can be seen in Table 4.9 below. Figures 4.15 to 4.22 show thematic maps for each category in Table 4.9. It should be noted that the values given are for the entire SOA, not just the area within the catchment area, this is of particular importance in relation to Ballyward as it contains the highest numbers for a number of the parameters discussed but only 2.5% of the area lies within the catchment area.

There are no farms or agricultural activity in the following areas: Ballynahinch East (Down), Ballymote (Down), Audley's Acra (Down), Tullycarnet (Castlereagh), Graham's Bridge (Castlereagh), Enler (Castlereagh), Dundonald (Castlereagh), Whitespots (Ards), Scrabo (Ards), Movilla (Ards), Gregstown (Ards), Donaghadee South (Ards), Clandeboye (North Down), Stormont (Belfast) and Cherryvalley (Belfast).

Numbers of farms within the catchment area ranged from 5 in Holywood Priory (North Down), Cultra (North Down), Killyleagh (Down) and Comber North (Ards) to 219 in Ballyward (Banbridge). The total area farmed within the catchment area varied from 148ha in Cultra (North Down) to 7,554ha in Ballyward (Banbridge).The total crops farmed within the catchment area varied from 7ha in Ballymaglave (Down) to 1,476 in

Ballymacbrennan (Lisburn). Total grass and rough grazing areas within the catchment area ranged from 29ha in Comber North (Ards) to 7,359ha in Ballyward (Banbridge).

The total number of cattle within the catchment area ranged from 0 in Comber East (Ards) to 11,007 in Ballyward (Banbridge). The total number of sheep within the catchment area ranged from 0 in Upper Braniel (Castlereagh) and Bradshaw's Brae (Ards) to 24,981 in Ballyward (Banbridge).

Numbers of pigs within the catchment area ranged from 0 in Holywood Priory (North Down), Saintfield (Down), Crossgar (Down), Cathedral (Down), Ardglass (Down), Carrowreagh (Castlereagh), Lisbane (Ards), Killinchy (Ards), Glen (Ards), Donaghadee North (Ards), Comber West (Ards), Comber North (Ards), Comber East (Ards), Bradshaw's Brae (Ards), Loughview (North Down) and Conlig (North Down) to 11,636 in Portaferry (Ards).

Poultry is only farmed in 15 of the SOAs: Strangford (Down), Seaforde (Down), Ballyward (Banbridge), Ballyrainey (Ards), Ballymacbrennan (Lisburn), Saintfield (Down), Kilmore (Down), Kilough (Down), Moneyreagh (Castlereagh), Kircubbin (Ards), Killinchy (Ards), Donaghadee North (Ards), Carrowdore (Ards), Bradshaw's Brae (Ards) and Ballygowan (Ards). Within these 15 SOAs, poultry numbers ranged from 1,000 in Strangford, Ballyrainey, Moneyreagh and Bradshaw's Brae to 126,000 in Ballymacbrennan.

With regards to the SOAs boardering the lough (i.e. Portaferry, Kircubbin, Ballywalter, Carrowdore, Gregstown, Central Ards, Scrabo, Comber East, Lisbane, Killinchy, Derryboy, Killyleagh, Crossgar, Quoile and Strangford), 3 of them are urban areas and do not carry out any agricultural activity (Gregstown, Central Ards and Scrabo). The number of farms around the lough ranged from <10 5 (Killyleagh [5] and Comber East [6]) to >90 (Derryboy [99] and Carrowdore [93]) and the area farmed ranged from <250ha (Killyleagh [163ha] and Comber East [225ha]) to >4,000ha (Carrowdore [4,561ha) and Strangford [4,144ha]). Total crops ranged from <50ha (Killyleagh [16ha] and Quoile [47ha]) to >700ha (Kircubbin [726ha]) and total grass and rough grazing ranged from <150ha (Comber East [31ha] and Killyleagh [132ha]) to >3,500ha (Carrowdore [3,745ha] and Strangford [3,560]). Numbers of cattle ranged from <250 (Comber East [0] and Killyleagh [244]) to >9,000 (Carrowdore [9,727]). Numbers of sheep ranged from <250 (Killyleagh [29], Comber East [135], Quoile [229]) to >10,000 (Carrowdore [11,684]. Numbers of pigs ranged from <1,000 (Lisbane [0], Comber East [0], Killinchy [0], Crossgar [0], Killyleagh [1], Strangford [13], Quoile [106], Kircubbin [27], Carrowdore [19] and Ballywalter [15]) to >9,000 (Portaferry [11,636] and Derryboy [9,093]). Poultry was only found in 4 of the SOAs boardering the lough and numbers ranged from <10,000 (Strangford [1,000] and Killinchy [9,000]) to >50,000 (Carrowdore [50,000] and Kircubbin [60,000]).

Table 4.9: Farm census data for all SOAs within the Strangford Lough Catchment Area (Source: DARD, 2009).

SOA	No. Farms	Area Farmed (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)	Cattle	Sheep	Pigs	Poultry ('000s)
Ballynahinch East	0	0	0	0	0	0	0	0
Holywood Priory	5	233	28	196	443	0	0	0
Cultra	5	148	14	133	48	38	19	0
Craigavad	18	1022	132	877	2551	32	78	0
Strangford	83	4144	477	3560	8469	4402	13	1
Seaforde	116	4641	807	3624	7100	10410	19	4
Killyleagh	5	163	16	132	244	29	1	0
Dunmore	113	3525	84	3401	5155	14915	728	0
Ballymote	0	0	0	0	0	0	0	0
Audley's Acre	0	0	0	0	0	0	0	0
Upper Braniel	6	170	8	160	311	0	10	0
Tullycarnet	0	0	0	0	0	0	0	0
Graham's Bridge	0	0	0	0	0	0	0	0
Enler	0	0	0	0	0	0	0	0
Ballyward	219	7554	129	7359	11007	24981	2610	32
Central Ards	0	0	0	0	0	0	0	0
Ballyrainey	11	657	394	248	398	962	46	1
Ballymacbrennan	131	5639	1470	3992	8301	6808	5682	126
Saintfield	36	1366	65	1207	2688	2035	0	19
Quoile	12	622	47	488	598	229	106	0
Kilmore	127	5101	363	3803	8364	4676	1270	63
Killough	84	4939	782	4117	7873	12786	3991	33
Drumaness	75	2312	37	2257	4404	2918	7	0
Derryboy	99	3933	461	3377	6405	9026	9093	0
Dromara	113	4142	105	4019	7654	13364	1190	0

SOA	No. Farms	Area Farmed (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)	Cattle	Sheep	Pigs	Poultry ('000s)
Crossgar	50	2485	115	2337	4131	3208	0	0
Cathedral	6	314	159	149	83	371	0	0
Ballymaglave	6	172	7	164	364	22	1000	0
Ardglass	56	2913	783	2070	5402	2462	0	0
Moneyreagh	51	2310	284	2006	5024	1123	847	1
Dundonald	0	0	0	0	0	0	0	0
Carrowreagh	7	2103	148	1316	968	1977	0	0
Ballyhanwood	13	651	113	534	1332	2105	8	0
Whitespots	0	0	0	0	0	0	0	0
Scrabo	0	0	0	0	0	0	0	0
Portavogie	41	1834	172	1652	5064	575	852	0
Portaferry	42	2532	683	1773	4937	1704	11636	0
Movilla	0	0	0	0	0	0	0	0
Millisle	32	1172	182	987	2395	299	4	0
Loughries	36	1386	212	1162	2886	1521	1	0
Lisbane	79	2979	692	2249	4065	6620	0	0
Kircubbin	86	3777	726	2995	8184	2147	27	60
Killinchy	64	3306	690	2534	4333	7808	0	9
Gregstown	0	0	0	0	0	0	0	0
Glen	7	235	28	206	463	855	0	0
Donaghadee South	0	0	0	0	0	0	0	0
Donaghadee North	22	916	136	718	1716	456	0	6
Comber West	11	348	189	159	455	663	0	0
Comber North	5	299	265	29	34	30	0	0
Comber East	6	225	194	31	0	135	0	0
Carrowdore	93	4561	698	3745	9727	11684	19	50
Bradshaw's Brae	10	725	129	594	1658	0	0	1
Ballywalter	38	2043	408	1485	4802	2211	15	0

SOA	No. Farms	Area Farmed (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)	Cattle	Sheep	Pigs	Poultry ('000s)
Ballygowan	43	1199	28	1142	2438	654	616	5
Loughview	9	229	58	166	782	39	0	0
Conlig	11	527	124	392	1174	714	0	0
Clandeboye	0	0	0	0	0	0	0	0
Hillsborough	43	1917	341	1556	4160	352	1580	0
Stormont	0	0	0	0	0	0	0	0
Cherryvalley	0	0	0	0	0	0	0	0

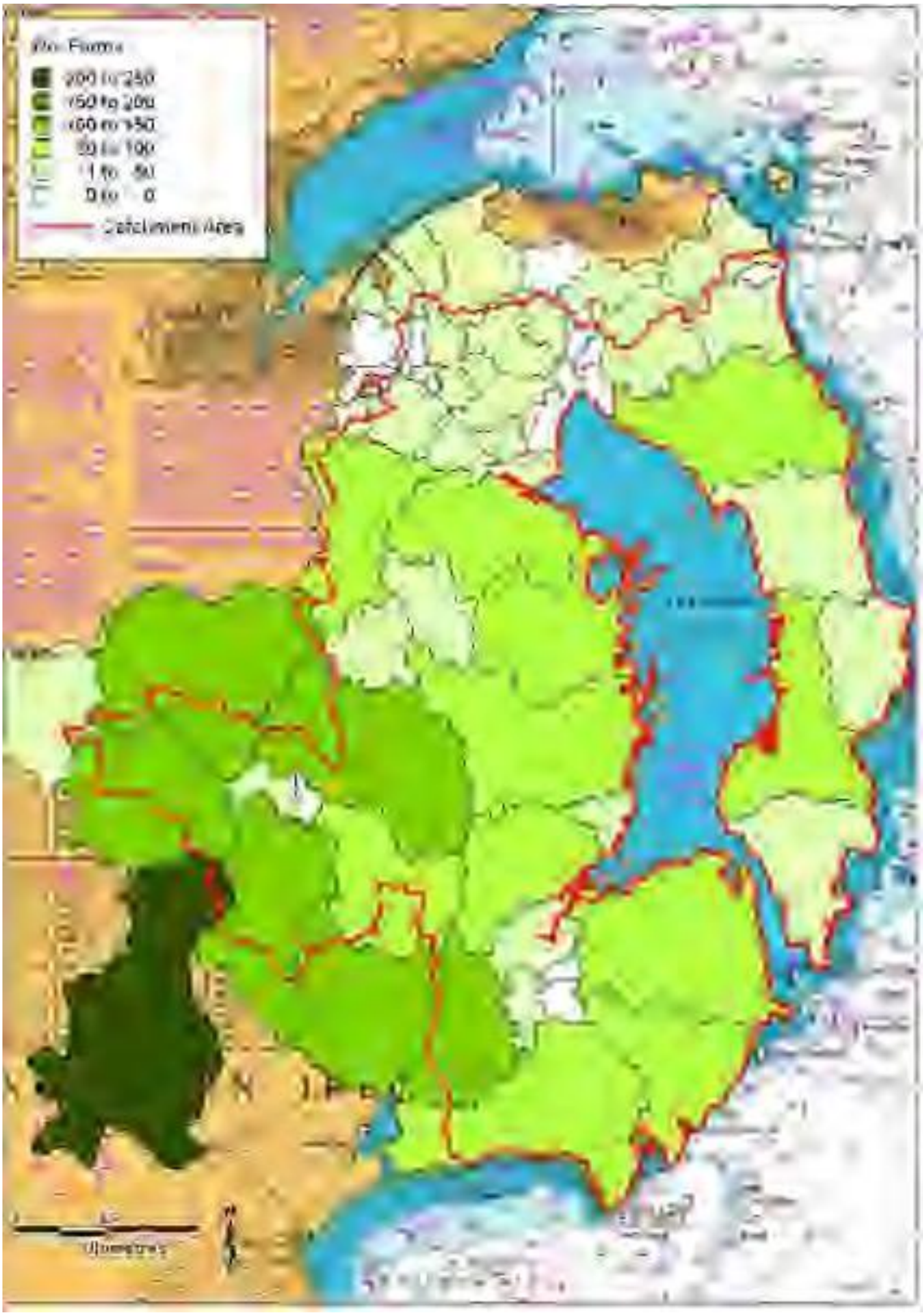


Figure 4.15: Number of farms within the Strangford Lough Catchment Area (Source: DARD, 2009).

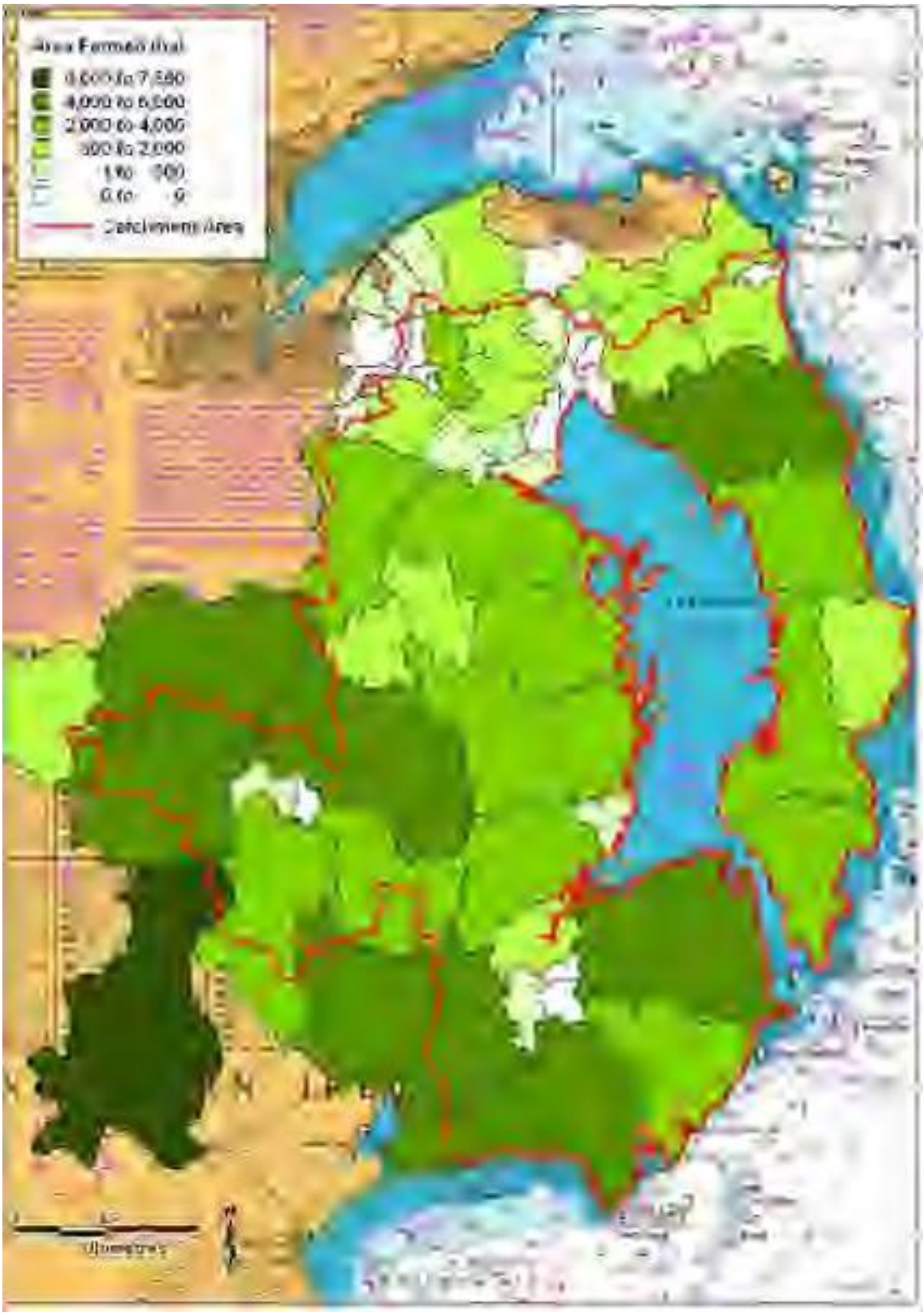


Figure 4.16: Area farmed (ha) within the Strangford Lough Catchment Area (Source: DARD, 2009).

Figure 4.17: Total crops within the Strangford Lough Catchment Area (Source: DARD, 2009).

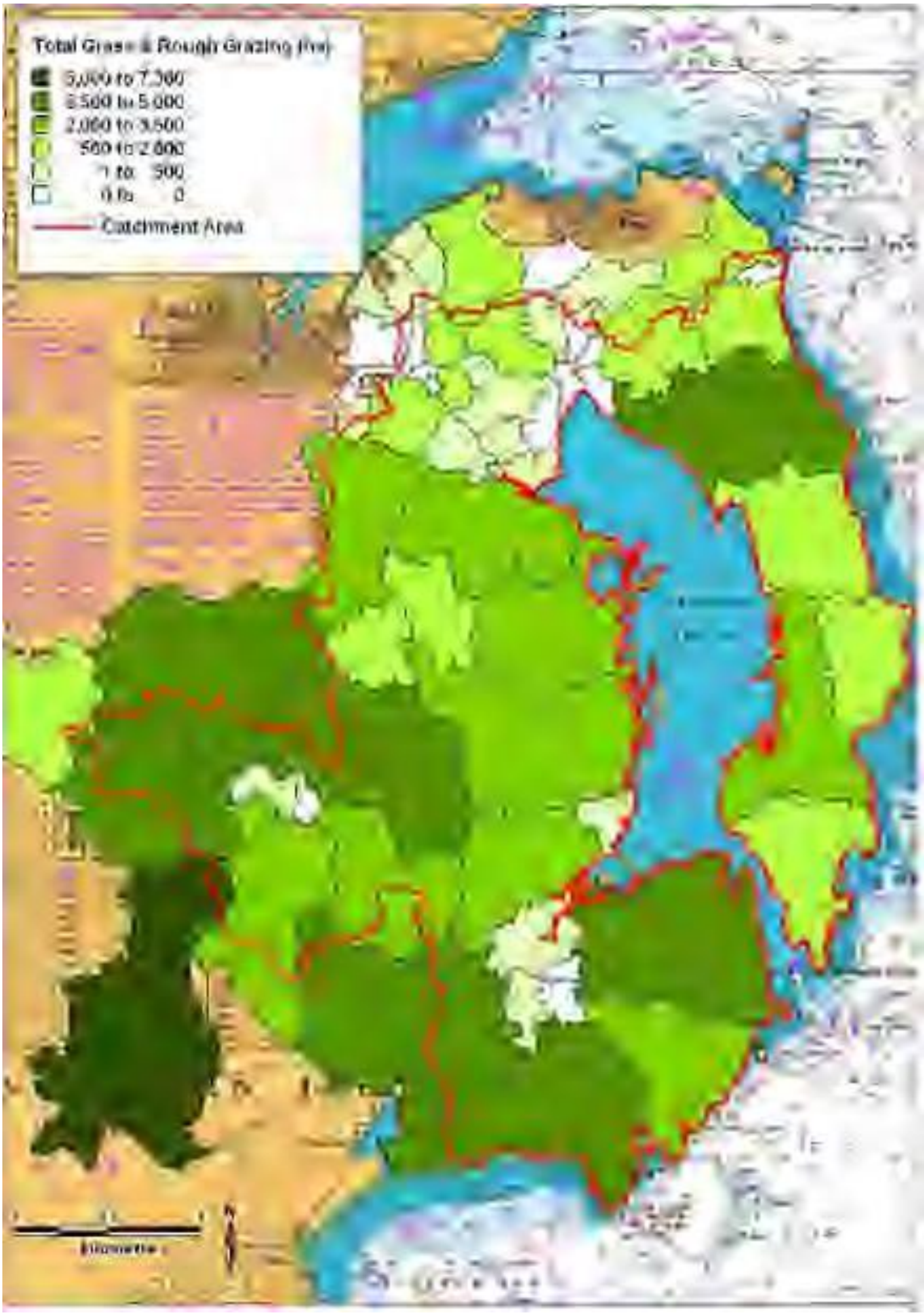


Figure 4.18: Total grass and rough grazing within the Strangford Lough Catchment Area (Source: DARD, 2009).

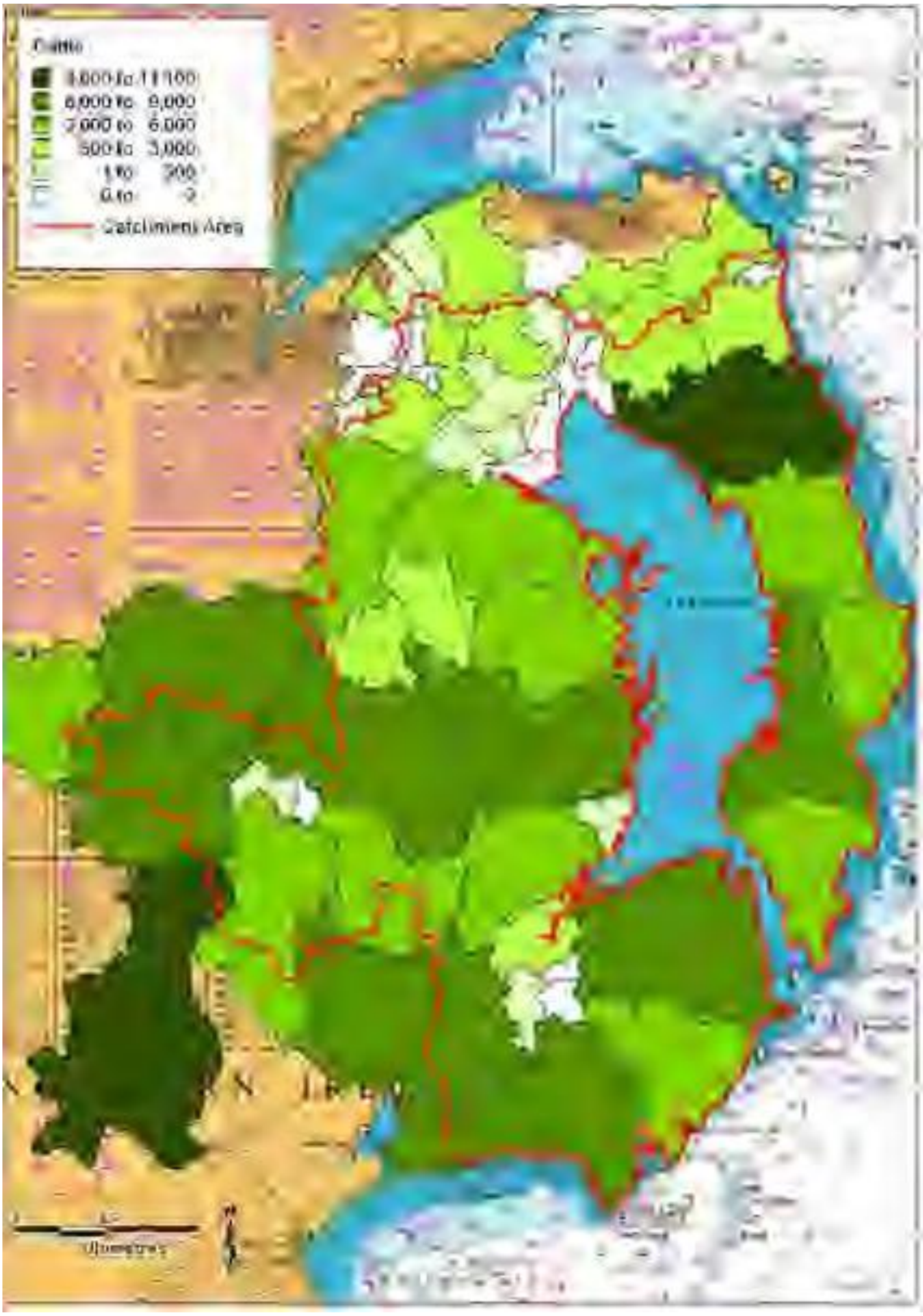


Figure 4.19: Cattle within the Strangford Lough Catchment Area (Source: DARD, 2009).

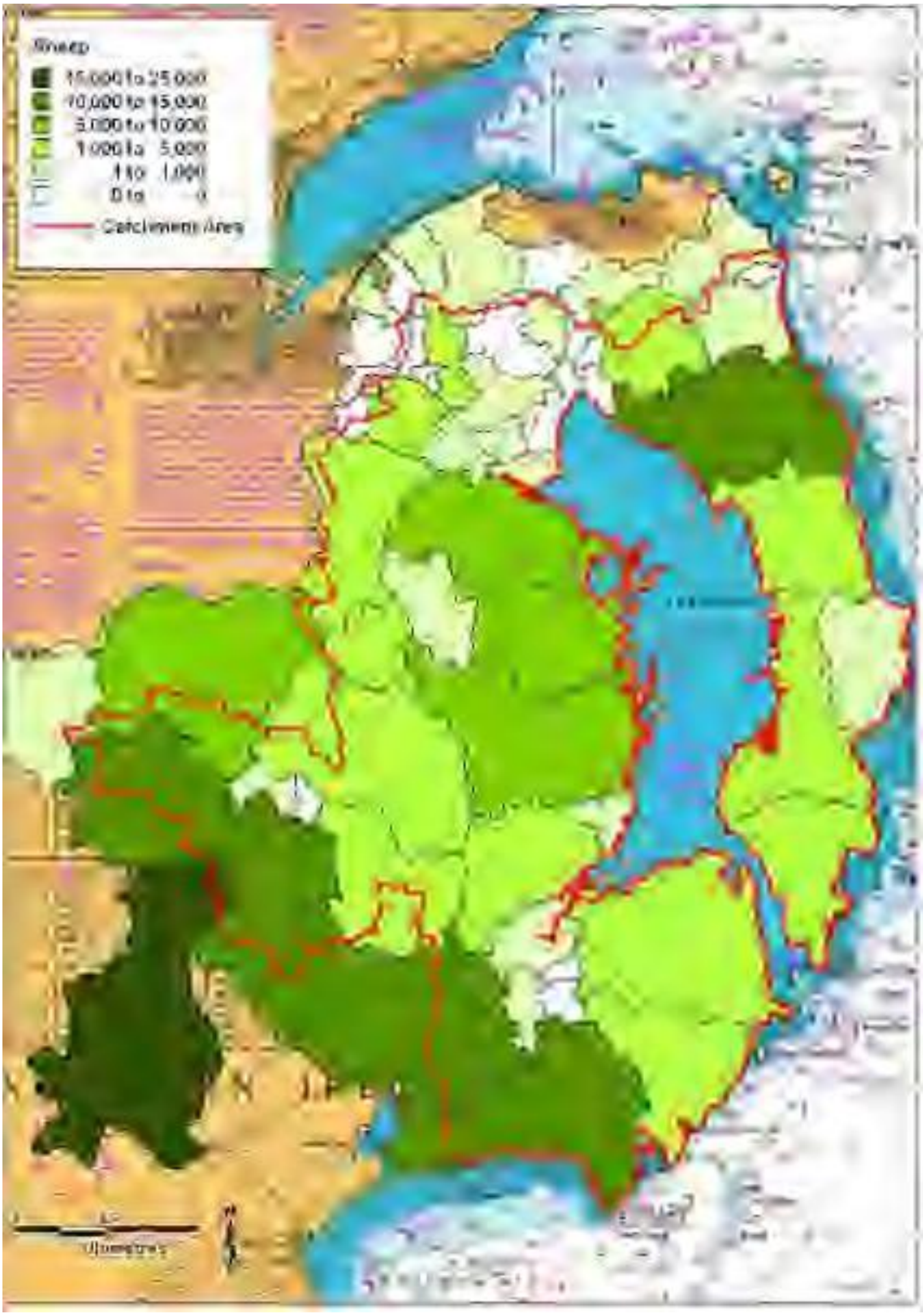


Figure 4.20: Sheep within the Strangford Lough Catchment Area (Source: DARD, 2009).

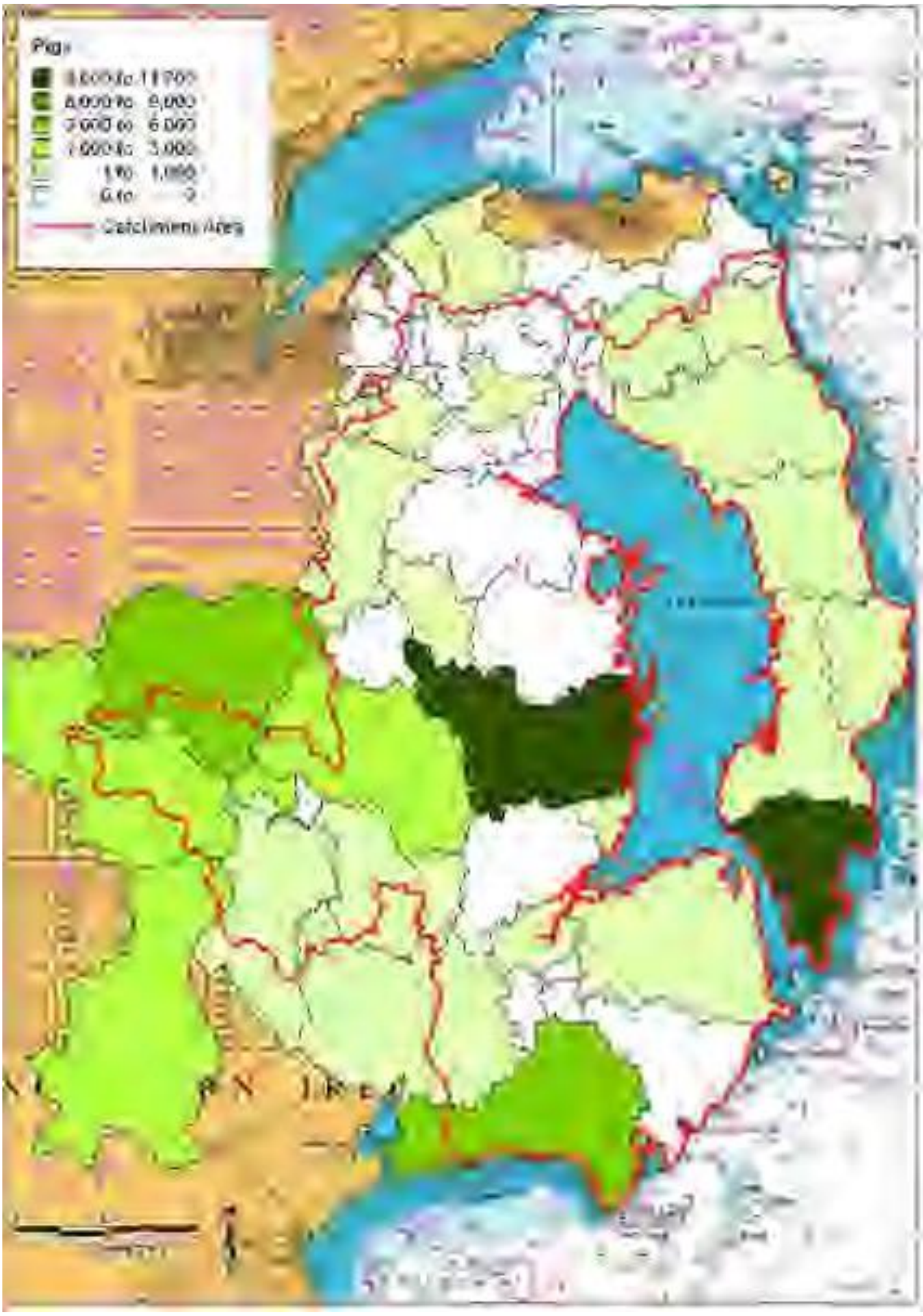


Figure 4.21: Pigs within the Strangford Lough Catchment Area (Source: DARD, 2009).

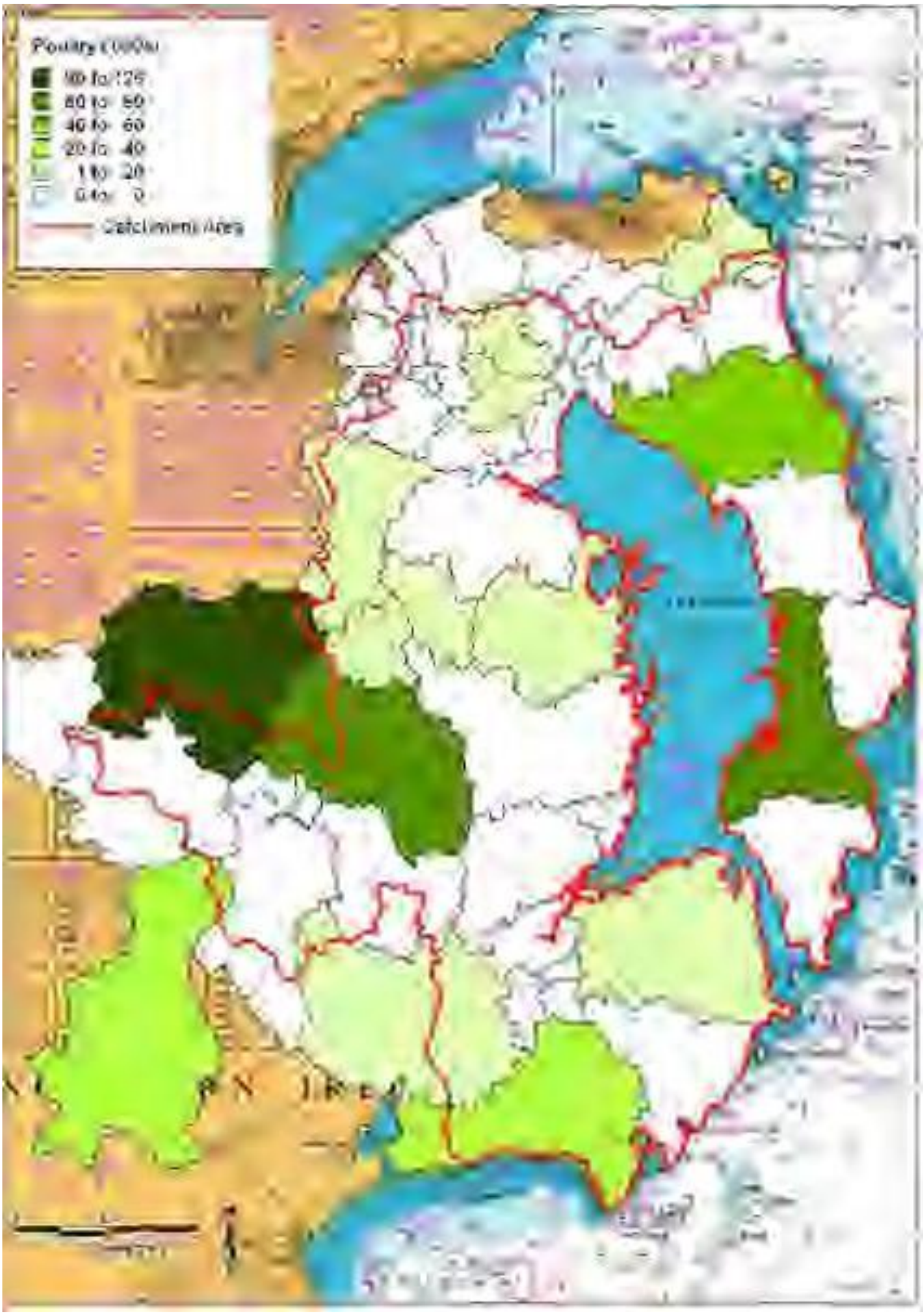


Figure 4.22: Poultry within the Strangford Lough Catchment Area (Source: DARD, 2009).

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 (e.g. Crowther *et al.,* 2002).

The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil; SSAFO) Regulations, which came into effect in Northern Ireland on the 21st July 2003 are designed to stop water pollution from agriculture. The purpose of these regulations are to minimise the risk of water pollution from silage, slurry and agricultural fuel oils by setting minimum standards for the construction and maintenance of structures used to store these substances and improve the environment for rural communities in Northern Ireland.

The Nitrates Action Programme (NAP) Regulations (NI) 2006 was introduced on 1st January 2007 to improve the use of nutrients on farms and as a result improve water quality. While this Directive does not legislate for faecal coliform contamination, they do place restrictions on manure spreading. Farmers can spread manure between 1st February and the 15th October each year, weather and ground conditions permitting:

- $50m^3$/ha is permitted on a single application and no further application for 3 weeks;
- Crop nitrogen requirements must be taken into consideration when the manure is spread;
- The farm nitrogen loading must not exceed 170 kg/ha/yr or 250 kg/ha/yr for a derogated farm;
- The manure must be spread 10m back from waterways (except for a number of exceptions); and
- Manure must be spread in a uniform manner.

In 2006, NIEA carried out an assessment of the microbiological inputs into Strangford Lough. Faecal coliform levels were analysed from six locations which can be seen in Figure 4.23. Water samples were collected in January, July and October of 2006 and the results can be seen in Table 4.10 and graphically in Figure 4.24. It can be seen that the Ganaway Burn contributed the highest levels of faecal coliforms (12,515 total cfu/100ml; 4,172 average cfu/100ml), followed by the Comber River (10,600 total cfu/100ml; 3,533 average cfu/100ml), the Glen Burn (9,460 total cfu/100ml; 3,153 average cfu/100ml), the Cunning Burn (9,100 total cfu/100ml; 3,033 average cfu/100ml), the Blackwater (5,280 total cfu/100ml; 1,760 average cfu/100ml) and finally the Blackstaff (2,640 total cfu/100ml; 880 average cfu/100ml).

The highest levels in July entered through the Glen Burn River (7,400 cfu/100ml), followed by the Comber River (6,000) with the lowest levels from the Blackstaff River (330 cfu/100ml). The highest levels in October entered through the Ganaway Burn River (10,000 cfu/100ml), followed by the Comber River (4,200 cfu/100ml) with the lowest levels entering through the Cunning Burn River and the Blackwater River (700 cfu/100ml). The highest levels in January entered through the Cunning Burn River (2,600 cfu/100ml), followed by the Blackstaff (1,010 cfu/100ml) with the lowest levels from the Ganaway Burn River (15 cfu/100ml).

The highest levels of faecal coliforms entered the system in July (26,230 total cfu/100ml; 4,372 average cfu/100ml), followed by October (18,100 total cfu/100ml; 3,017 average cfu/100ml) and the lowest levels in January (5,265 total cfu/100ml; 878 average cfu/100ml) as would be expected given the restrictions on manure spreading in the winter months.

While details on livestock numbers within each of these river catchments is unavailable, an indication of livestock numbers can be estimated from the SOA figures. The Blackstaff River had the lowest faecal coliform load in 2006 and lowest livestock numbers, while all others had much higher faecal coliform loads and livestock numbers.

Figure 4.23: NIEA faecal coliform sampling sites 2006 (Source: NIEA).

Table 4.10: NIEA faecal coliform results 2006 (Source: NIEA).

Station	31/01/2006	20/7/2006	23/10/2006	Total	Average
Blackstaff	1010	330	1300	2640	880
Glen Burn	860	7400	1200	9460	3153
Cunning Burn	2600	5800	700	9100	3033
Comber River	400	6000	4200	10600	3533
Blackwater @ Ardmillan	380	4200	700	5280	1760
Ganaway Burn	15	2500	10000	12515	4172
Total	5265	26230	18100	-	-
Average	878	4372	3017	-	-

Figure 4.24: Faecal coliform results from 3 sampling periods in 2006 (Source: NIEA).

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[8] Annex IV[9] 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 Strangford Lough. Strangford Lough does not have a commercial port. A ferry service does operate between Portaferry and Strangford crossing the Strangford Narrows. It operates year-round with approximately 30 sailings a day. There are 12 marinas/yacht or sailing clubs in the lough and 12 mooring/anchorage sites (SLLP, 2011b). Strangford Lough Yacht Club (Whiterock) is the largest club. Boats at these clubs range from dinghies to large cruisers. Competitive sailing takes place throughout the summer and annual regattas and other events are held. Portaferry Marina can accommodate up to 50 vessels. The 'nose to tail' berths can only accommodate boats <6m and many are let seasonally to

[8] Marpol is the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978. It is short for Marine Pollution.

[9] Annex IV of Marpol is concerned with preventing marine pollution from ships sewage.

local boat owners. There are approximately 12 'finger berths' reserved for visitor use and most are serviced with electricity. Figure 4.26 shows the major yacht mooring areas[10] within the lough (Roberts *et al.,* 2004c).

While data on sewage discharge levels from shipping activities in Strangford 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.

[10] This is based on data obtained from 2000 and the numbers represent only yacht owners with an expressed interest in regattas. Based on Strangford Lough Management Committee (2001) Report.

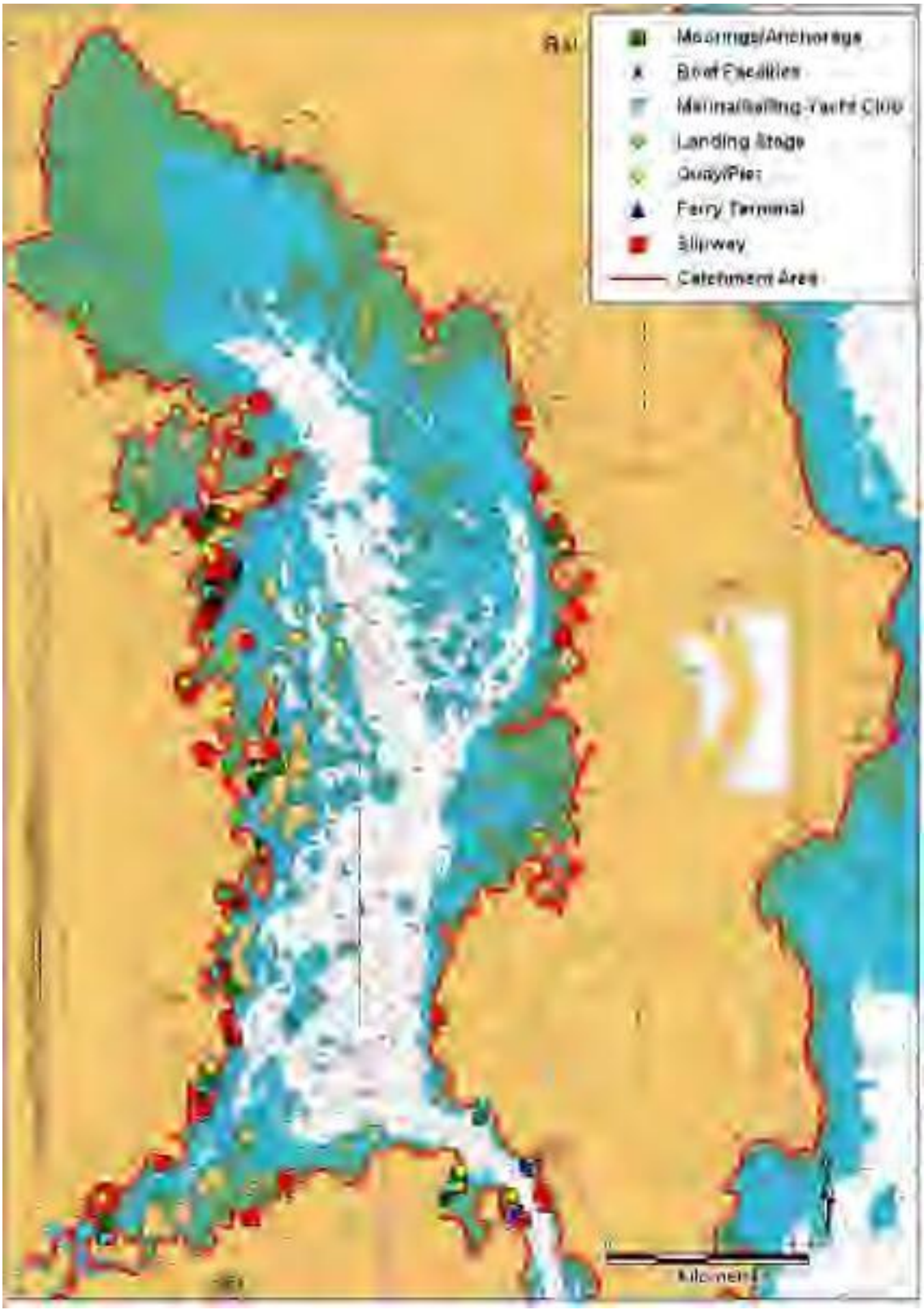


Figure 4.25: Location of all boating facilities and activities in Strangford Lough (Source: www.nimap.net; SLLP, 2011b).

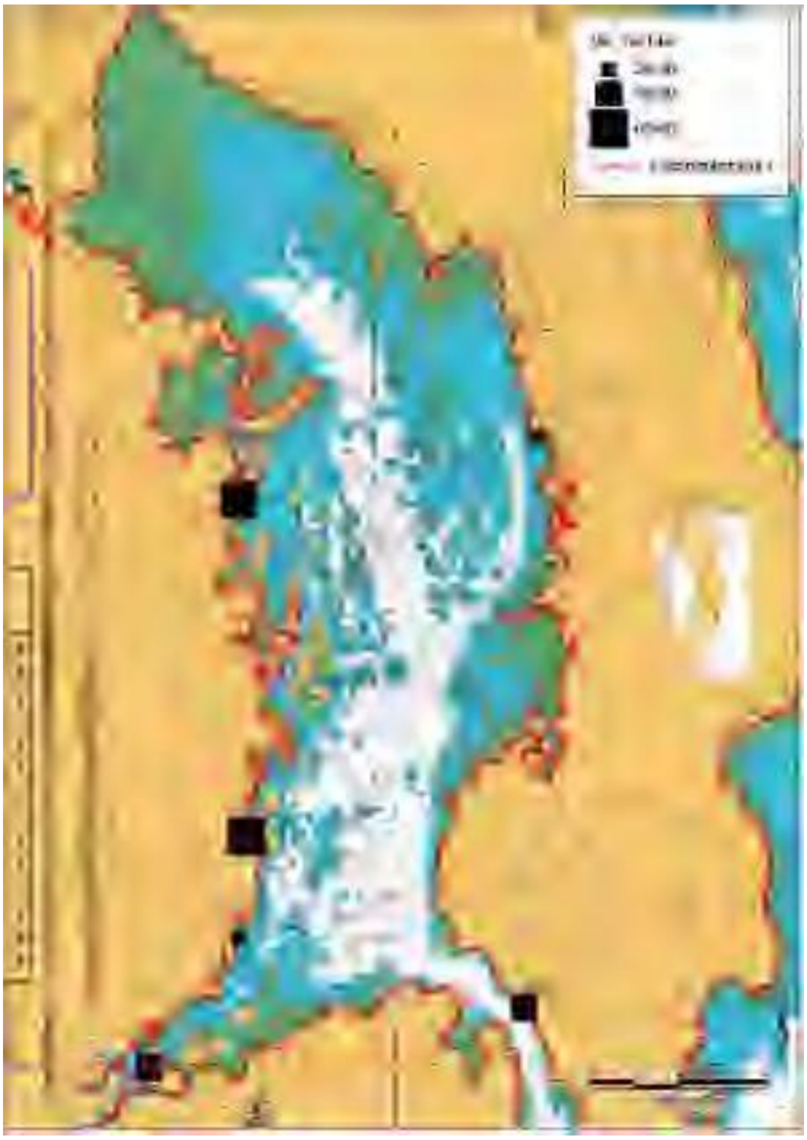


Figure 4.26: Major yacht mooring areas in Strangford Lough.

4.1.6.2. Birds

It is important to document the bird populations in the Strangford 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 4.27a shows the locations of the Strangford Lough Special Protection Areas (SPA) and Ramsar Site and Figure 4.27b shows the 6 Nature Reserves (NR) (North Strangford Lough NR, The Dorn NR, Quoile Pondage NR, Granagh Bay NR, Cloghy Rocks NR and Killard NR) and 1 marine nature reserve which is Strangford Lough. The Strangford Lough SPA (Site Code: UK9020111) and the Strangford Lough Ramsar Site (Site Code: 7UK116) encompass the entire lough. There are 7 species of international importance found within Strangford Lough SPA/Ramsar site: light-bellied Brent goose (mean of 25,771 individuals between 2004/05 and 2008/09), red knot (mean of 6,572 individuals between 2004/05 and 2008/09), shelduck (mean of 4,666 individuals between 2004/05 and 2008/09), common redshank (mean of 4,247 individuals between 2004/05 and 2008/09), black-tailed godwit (mean of 556 individuals between 2004/05 and 2008/09), whooper swan (mean of 272 individuals between 2004/05 and 2008/09) and mute swan (mean of 148 individuals between 2004/05 and 2008/09) (Calbrade *et al*., 2010). In addition, there are numerous other species of national importance present within Strangford Lough (e.g. wigeon (2,503), gadwall (75), Eurasian teal (1,882), mallard (1,834), pintail (466), shoveler (109), scaup (53), eider (547), goldeneye (170), red-breasted merganser (281), little grebe (77), great-crested grebe (145), cormorant (431), grey heron (107), oystercatcher (8,536), ringer plover (315), golden plover (8,241), grey plover (141), northern lapwing (5,337), dunlin (4,865), bar-tailed godwit (1,121), curlew (1,632), greenshank (89) and turnstone (397) (Calbrade *et al*., 2010).

Strangford Lough routinely surveyed by the British Trust for Ornithology (BTO) (Through the WeBS [Wetland Bird Survey] Project). Table 4.11 shows the most recent results from the wetland bird surveys that are carried out each year.

Table 4.11: Total number of waterbirds in Strangford Lough between 2004/05 and 2008/09 (Source: Calbrade *et al*., 2010)

Site Name	2004/05	2005/06	2006/07	2007/08	2008/09	Mean
Strangford Lough	78,452	83,314	74,420	87,104	81,364	80,931

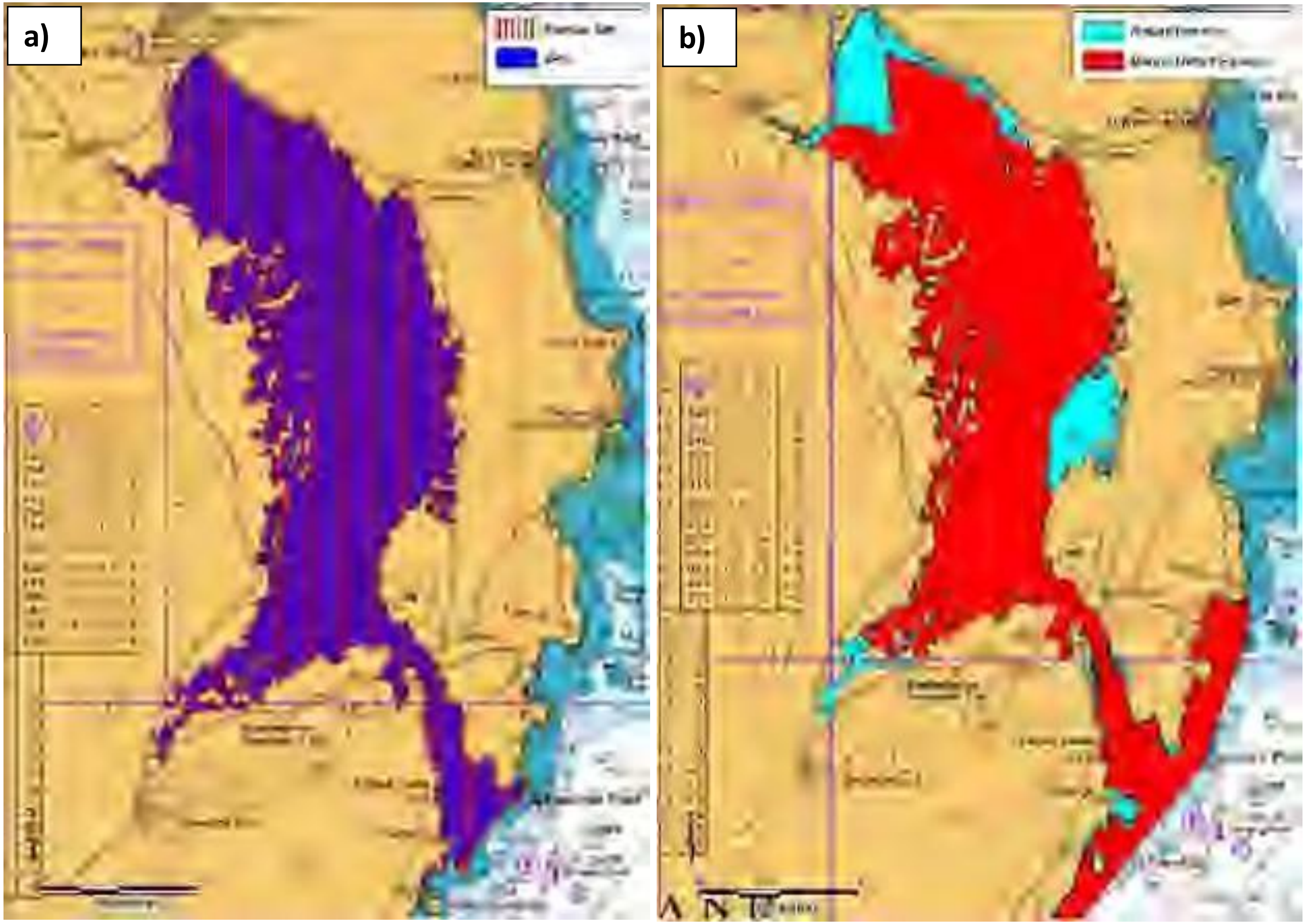


Figure 4.27: Strangford Lough a) SPA and Ramsar Site and b) nature reserve and marine nature reserve.

Bird populations in the Strangford 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 highly probable that the contribution made by wildfowl to pollution levels in Strangford Lough is higher in the winter months. However, it is highly likely that these levels are low when compared with land-based discharges.

4.1.6.3. Pollution Incidences

In 2009, there were 143 substantiated water pollution incidents in the Strangford catchment area (NIEA, 2009). Eleven were from industrial source, 13 from farm sources, 71 were sourced from NI Water Ltd, 27 from domestic sources, 1 from transport sources and 20 from other sources. Twelve of the incidents were agricultural in nature, 90 were sewage related, 18 were oil related, 3 were non agricultural waste discharges, 1 was due to breach of consent and 19 were classified as others. The casuse of the incidents ranged from deliberate dumping (4), a breach of consent (4), an accident/emergency (22), equipment failure (44), inadequate equipment (9), neglilgence (7), poor work practice (21), the weather (10), unknown causes (18) and other causes (4). Of the 143 incidents, 107 were of low severity and 36 were of medium severity. The locations of these incidents were unavailable.

4.2. Shoreline Survey Report

The aim of this shoreline survey was to identify/confirm and mark all discharges, pollution sources, waterways and marinas along the shoreline. A desk-based review of all river/stream discharges, slipways/piers and outfall pipes was carried out using aerial photographs, admiralty charts and OS planning maps accessed through www.nimap.net. Figures 4.28, 4.29, 4.30 and 4.31 show maps detailing the findings of this assessment. A number of these locations were groundtruthed and photographed in the field on the 20th April 2011. Given the scale of Strangford Lough, the shoreline survey was carried out using AQUAFACT's RIB (Rigid Inflatable Boat) by Dr. Mark Costelloe and Gary Ridge (AQUAFACT). All features seen in Figures 4.28 to 4.31 were pre- loaded on to the RIB's plotter and a selection of these were navigated to, confirmed and photographed. In addition, any new features not previously identified were photographed and a GPS reading taken. Figure 4.32 shows the track log of the boat and the locations where photographs were taken from. 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.

Please note that the numbering used for the features identified during the shoreline survey differs from that used during the desk based assessment. All were combined and re-numbered in a logical order for the summary maps shown in Section 4.3 Location of Sources.

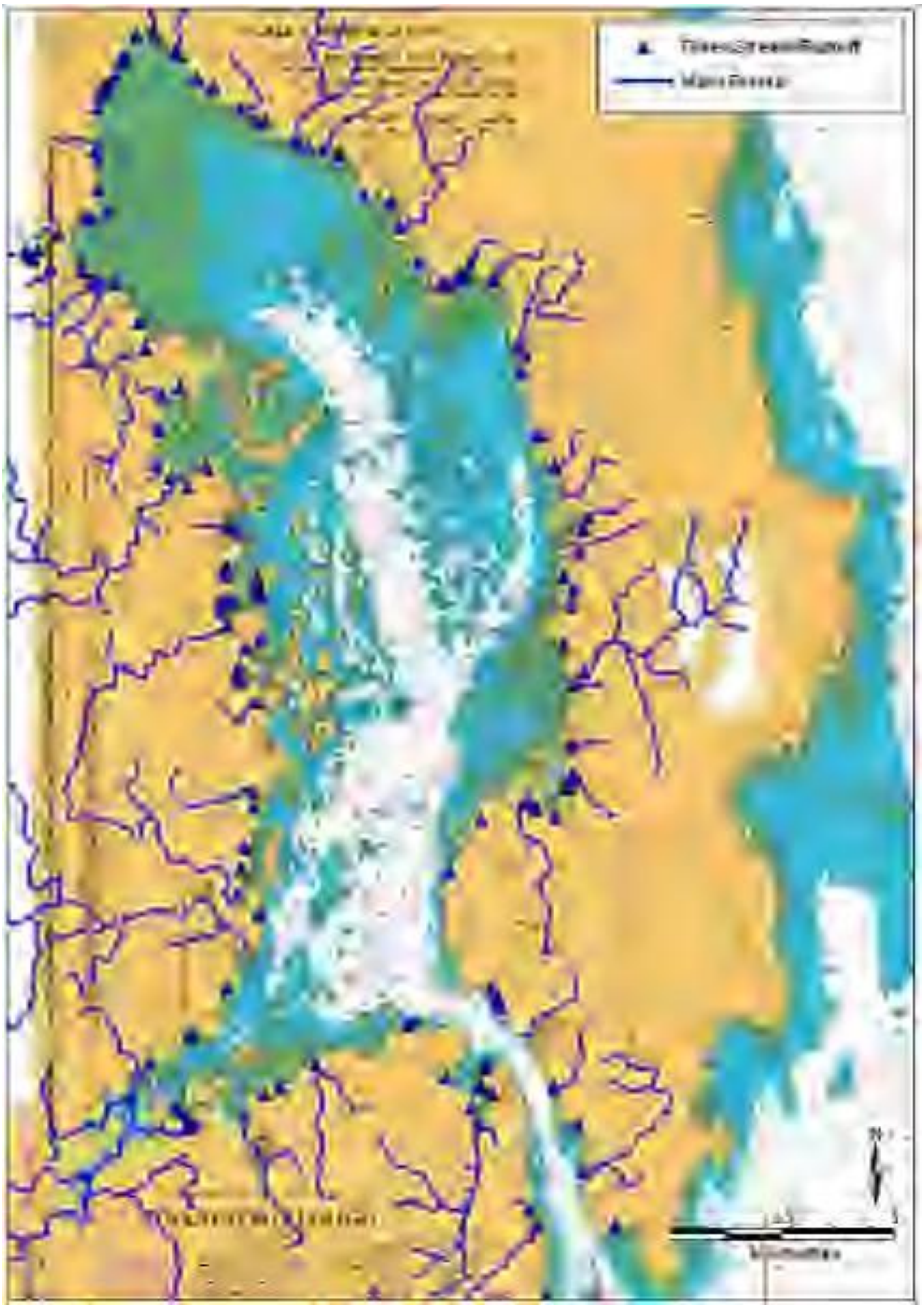


Figure 4.28: Locations of rivers/streams/runoff/drainage channels identified from www.nimaps.net and Admiralty Charts.

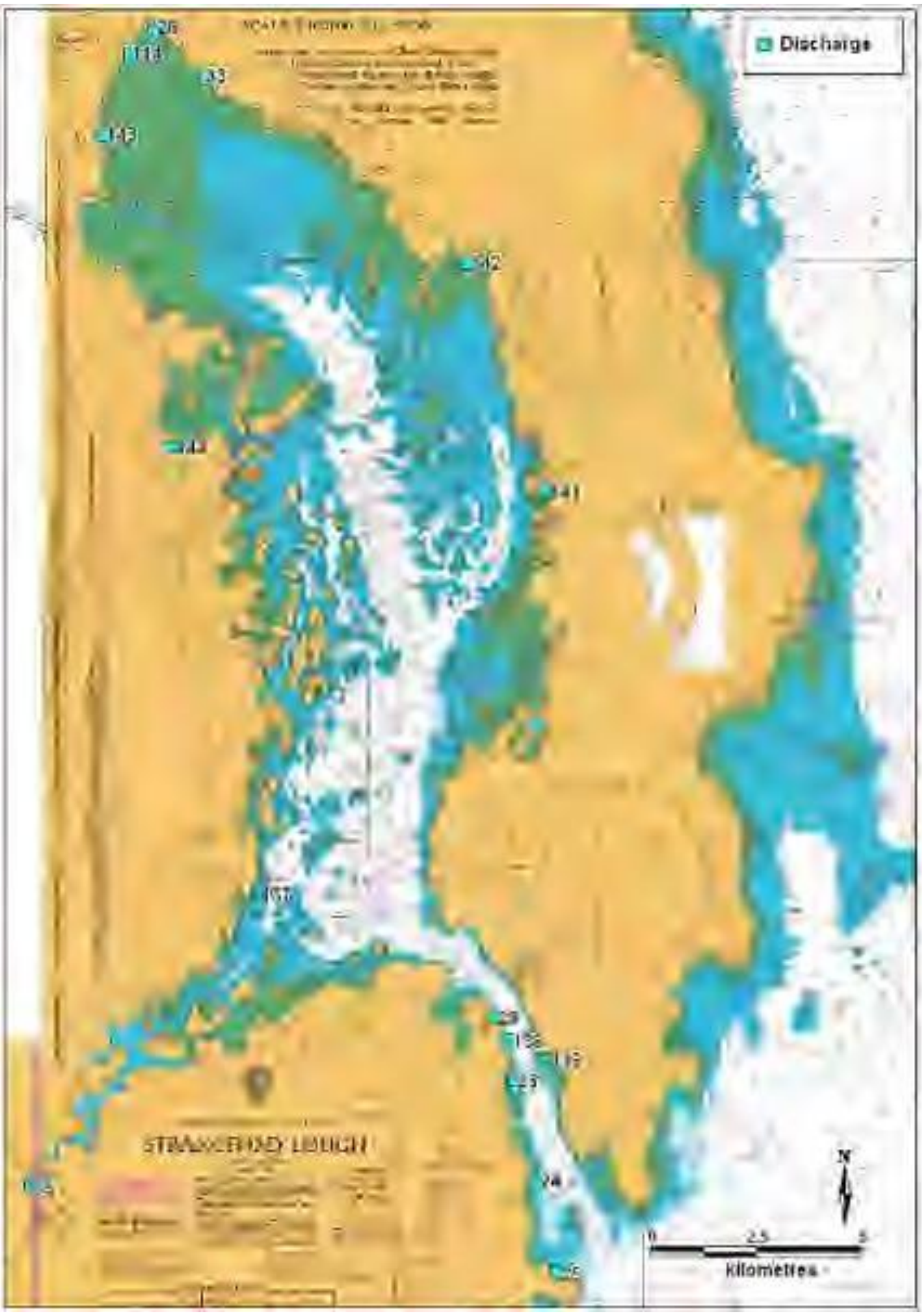


Figure 4.29: Locations of discharge pipes/outfalls identified from www.nimaps.net and Admiralty Charts.

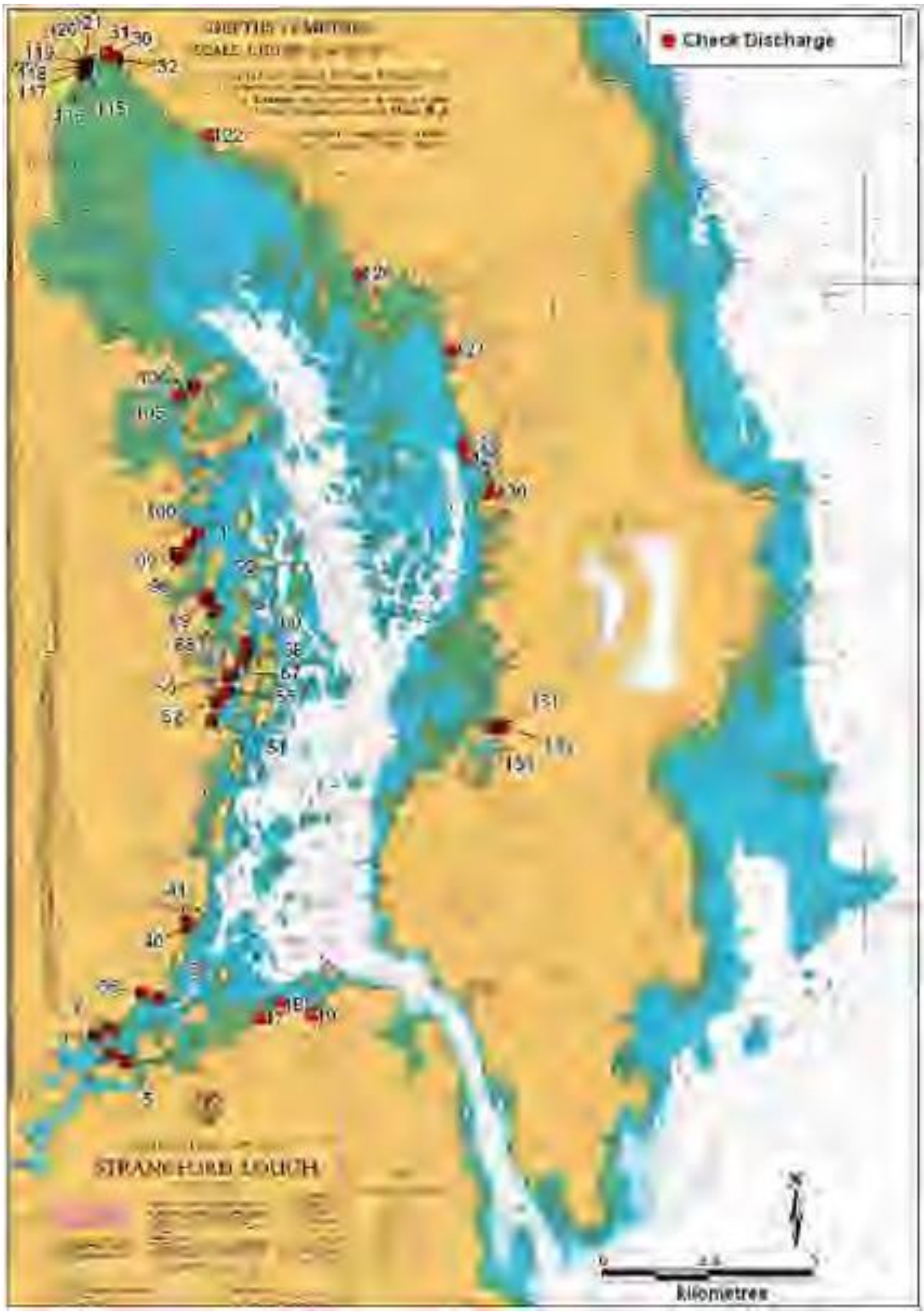


Figure 4.30: Locations of possible discharge pipes/outfalls identified from www.nimaps.net and Admiralty Charts.

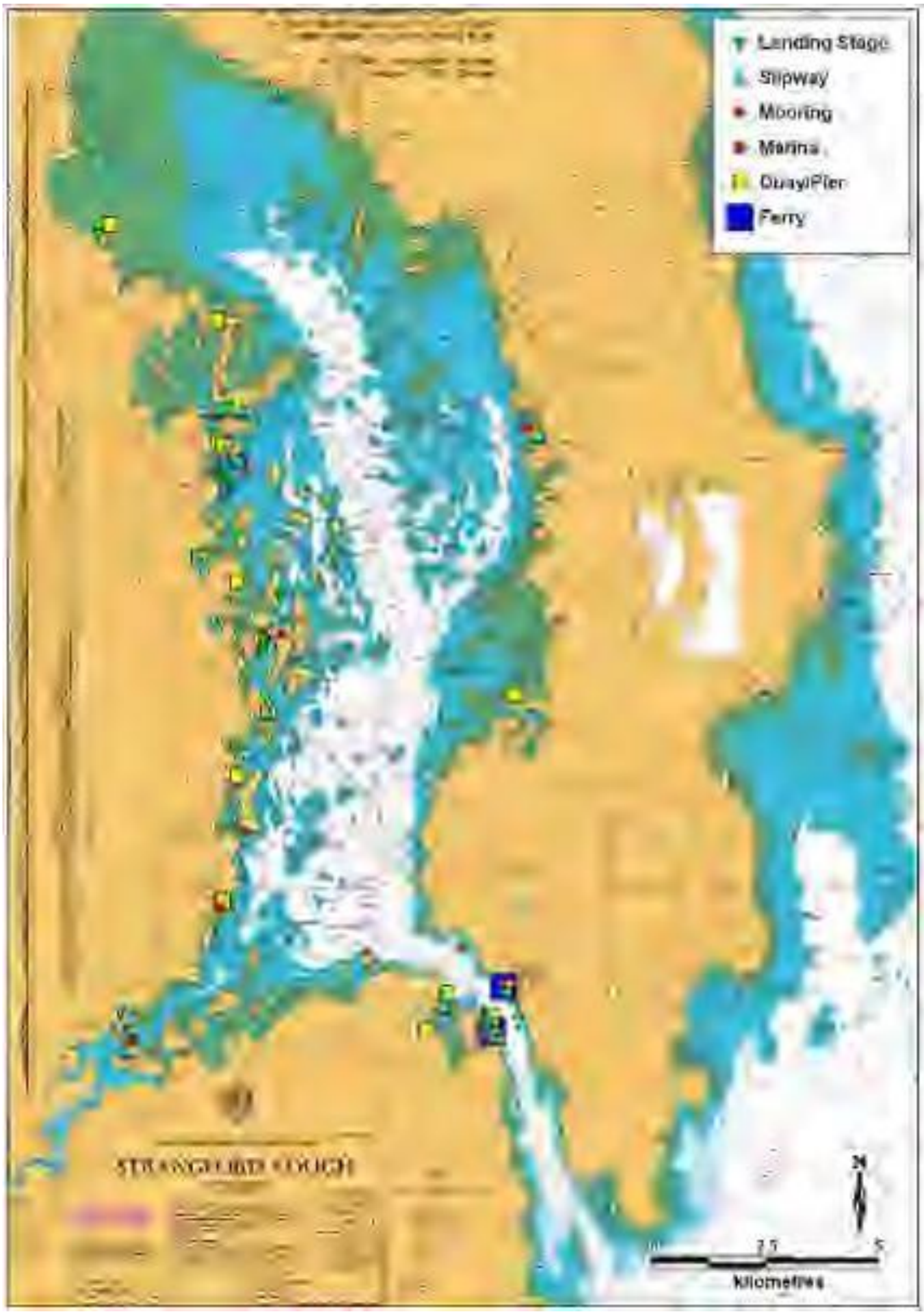


Figure 4.31: Locations of boat access facilities identified from www.nimaps.net and Admiralty Charts.

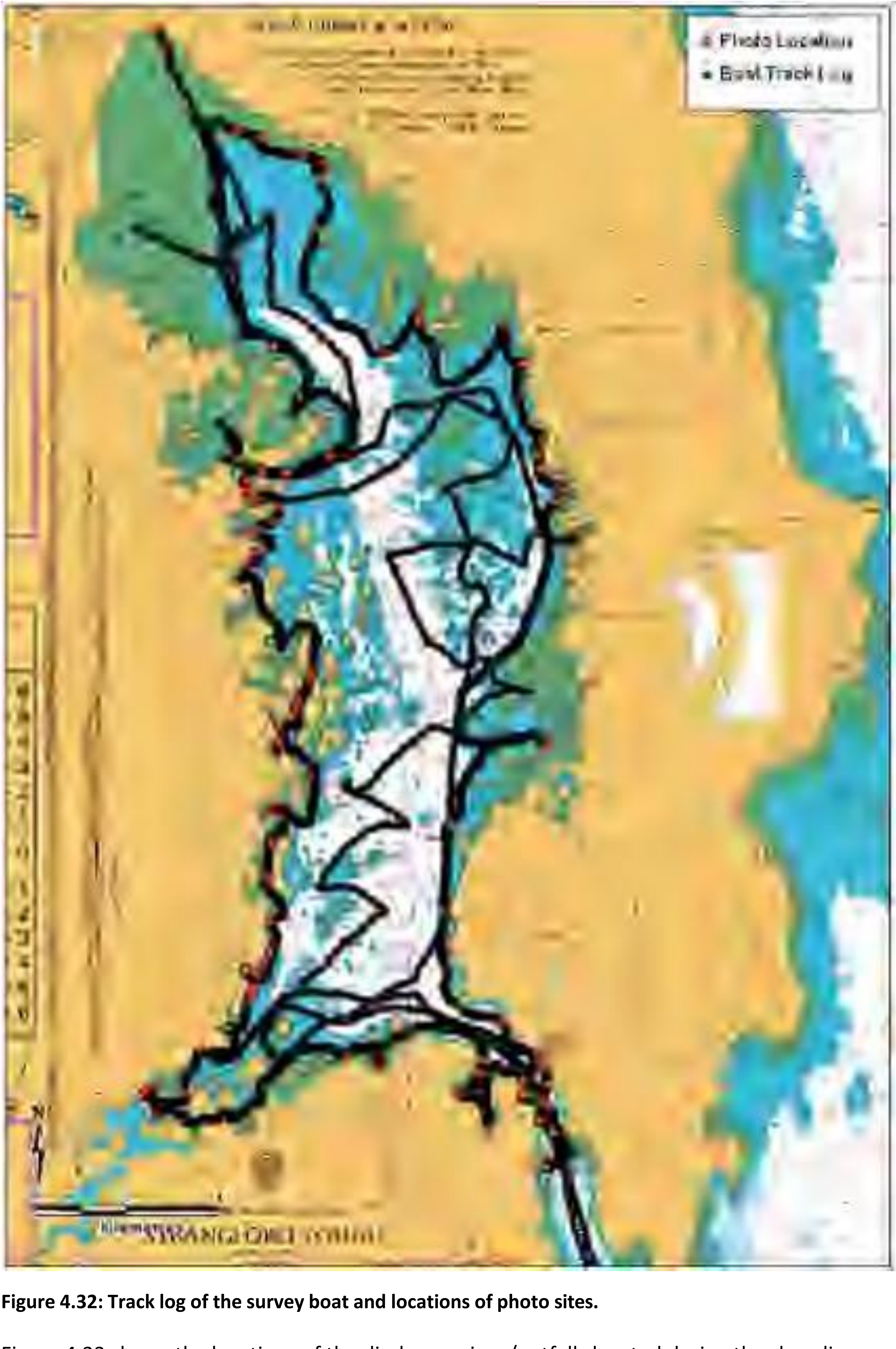


Figure 4.32: Track log of the survey boat and locations of photo sites.

Figure 4.33 shows the locations of the discharge pipes/outfalls located during the shoreline survey. In total, 45 were identified in the field. Figures 4.34 to 4.36 show images of these outfall/discharge locations.

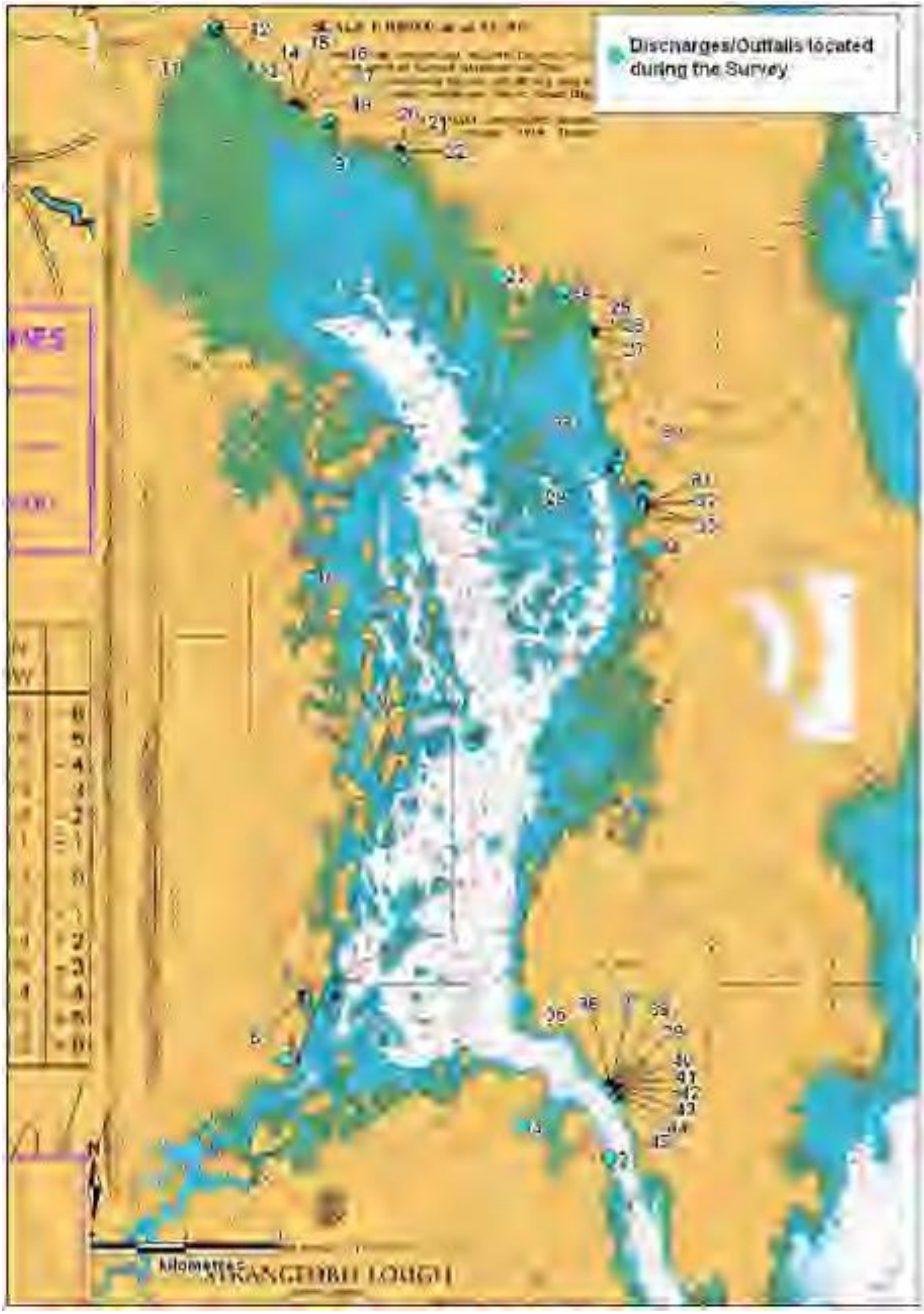


Figure 4.33: Discharges/Outfalls located during the shoreline survey.

Figure 4.34: Discharges/ Outfalls located during the shoreline survey. Refer to Figure 4.32 for site locations.

Figure 4.35: Discharges/ Outfalls located during the shoreline survey. Refer to Figure 4.32 for site locations.

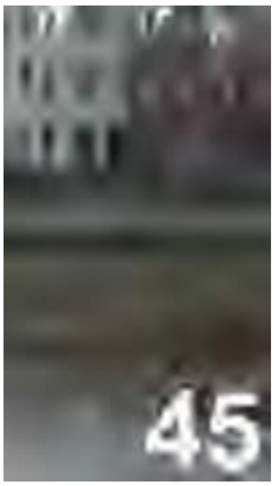


Figure 4.36: Discharges/ Outfalls located during the shoreline survey. Refer to Figure 4.32 for site locations.

Figure 4.37 shows the locations of the rivers/streams/runoff/drainage channels located during the shoreline survey. In total, 4 were identified in the field. Figure 4.38 show images of these sites.

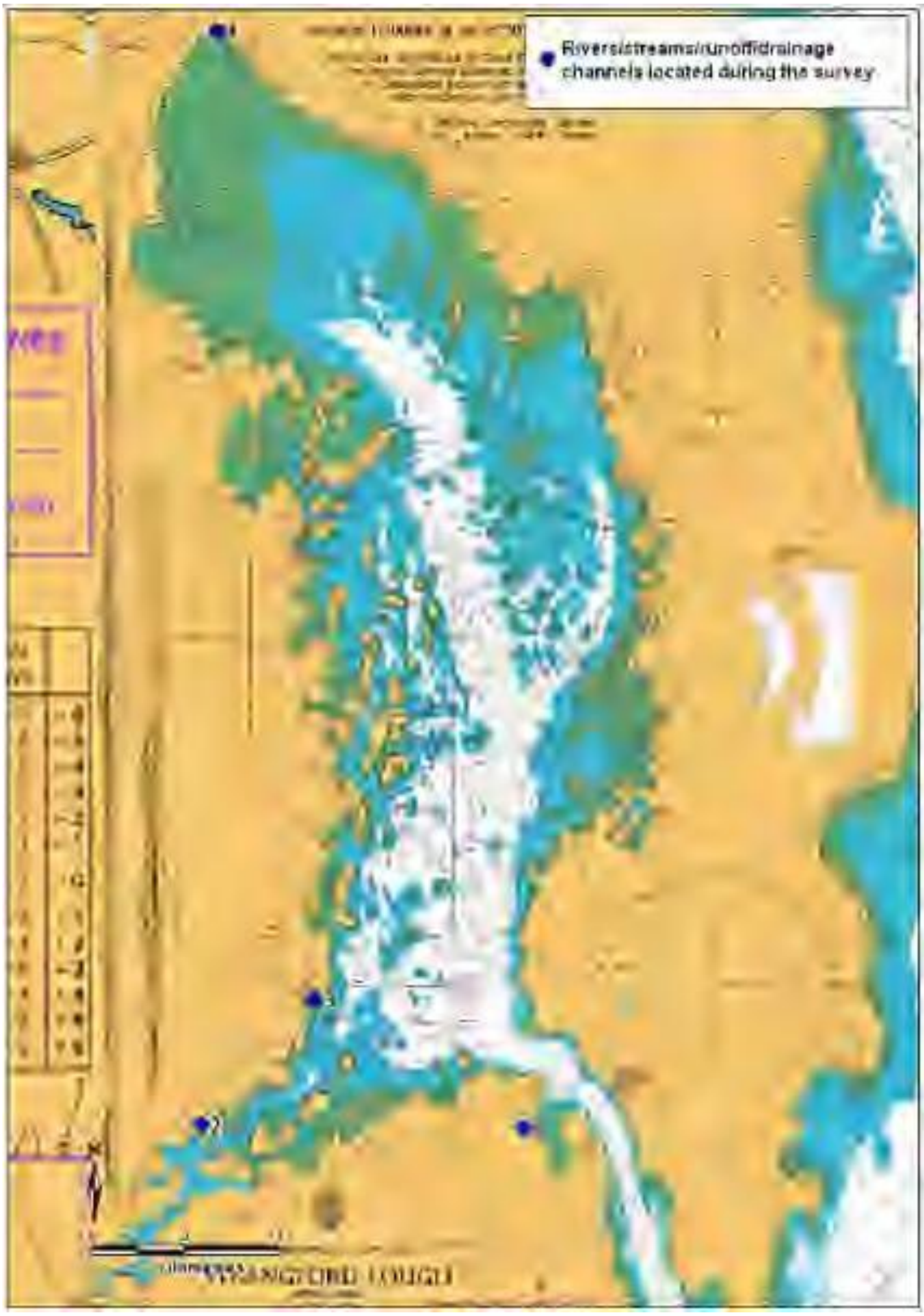


Figure 4.37: Rivers/Streams/ Runoff/Drainage Channels located during the shoreline survey.

Figure 4.38: Rivers/streams/runoff/drainage channels located during the shoreline survey. Refer to Figure 4.36 for site locations.

Figure 4.39 shows the locations of the piers, quays, jetties, marinas, landing stages, moorings and slipways located during the shoreline survey. In total, 80 were identified in the field. Figures 4.40 to 4.44 show images of these sites.

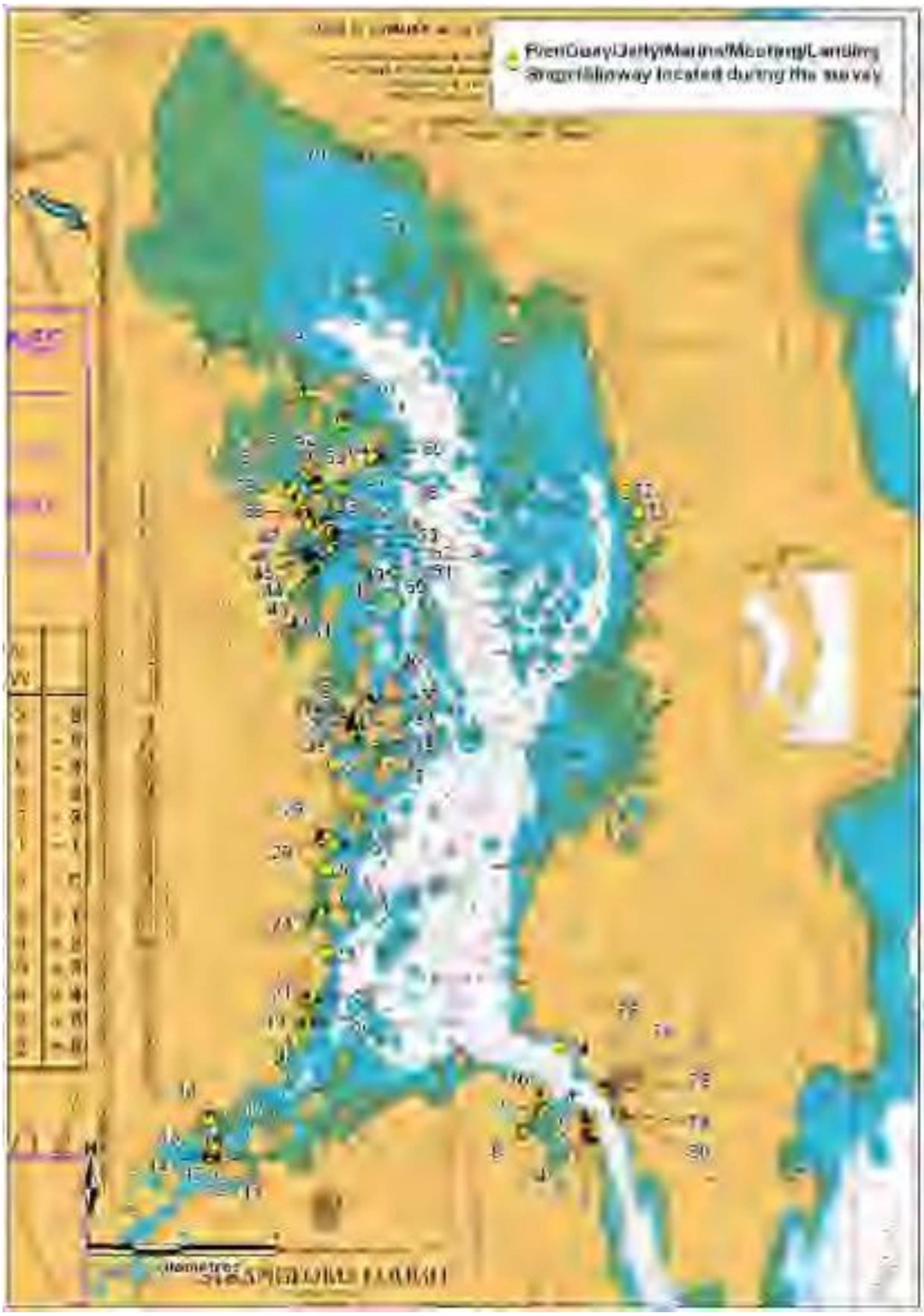


Figure 4.39: Pier/Quay/Jetty/MarinaSlipway/Berths /Pontoons located during the shoreline survey.

Figure 4.40: Piers/Jetties/slipways located during the shoreline survey. Refer to Figure 4.38 for site locations.


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Figure 4.41: Piers/Jetties/slipways located during the shoreline survey. Refer to Figure 4.38 for site locations.

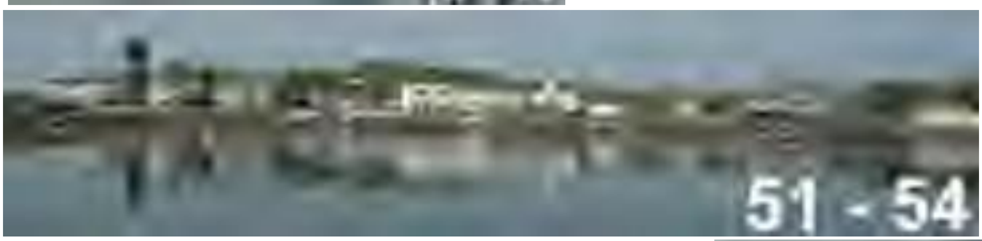



Figure 4.42: Piers/Jetties/slip ways located during the shoreline survey. Refer to Figure 4.38 for site locations.

Figure 4.43: Piers/Jetties/slipways located during the shoreline survey. Refer to Figure 4.38 for site locations.

Figure 4.44: Piers/Jetties/slipways located during the shoreline survey. Refer to Figure 4.38 for site locations.

4.3. Locations of Sources

Figure 4.45 shows all watercourses discharging into Strangford Lough and Table 4.12 provides cross- referenced details for this map. Figure 4.46 shows all WWTWs (Waste Water Treatment Works) and continuous discharges discharging into Strangford Lough and Table 4.13 provides cross-referenced details for this map. Figure 4.47 shows all intermittent discharges discharging into Strangford Lough. As data on a large number of discharges identified from the shoreline survey are aerial photography and mapping were unavailable all of these discharges were assumed to be intermittent and it is these discharges that are shown in Figure 4.47. Table 4.14 provides cross-referenced details for Figure 4.47. Figures 4.48 and Figure 4.49 show all overflows and septic tanks discharging into Strangford Lough and its tributaries, respectively. Tables 4.15 and 4.16 provide cross-referenced details for these maps. Figures 4.50 and 4.51 show all emergency and industrial discharges discharging into Strangford Lough and Tables 4.16 and 4.17 provide cross-referenced details for these maps.

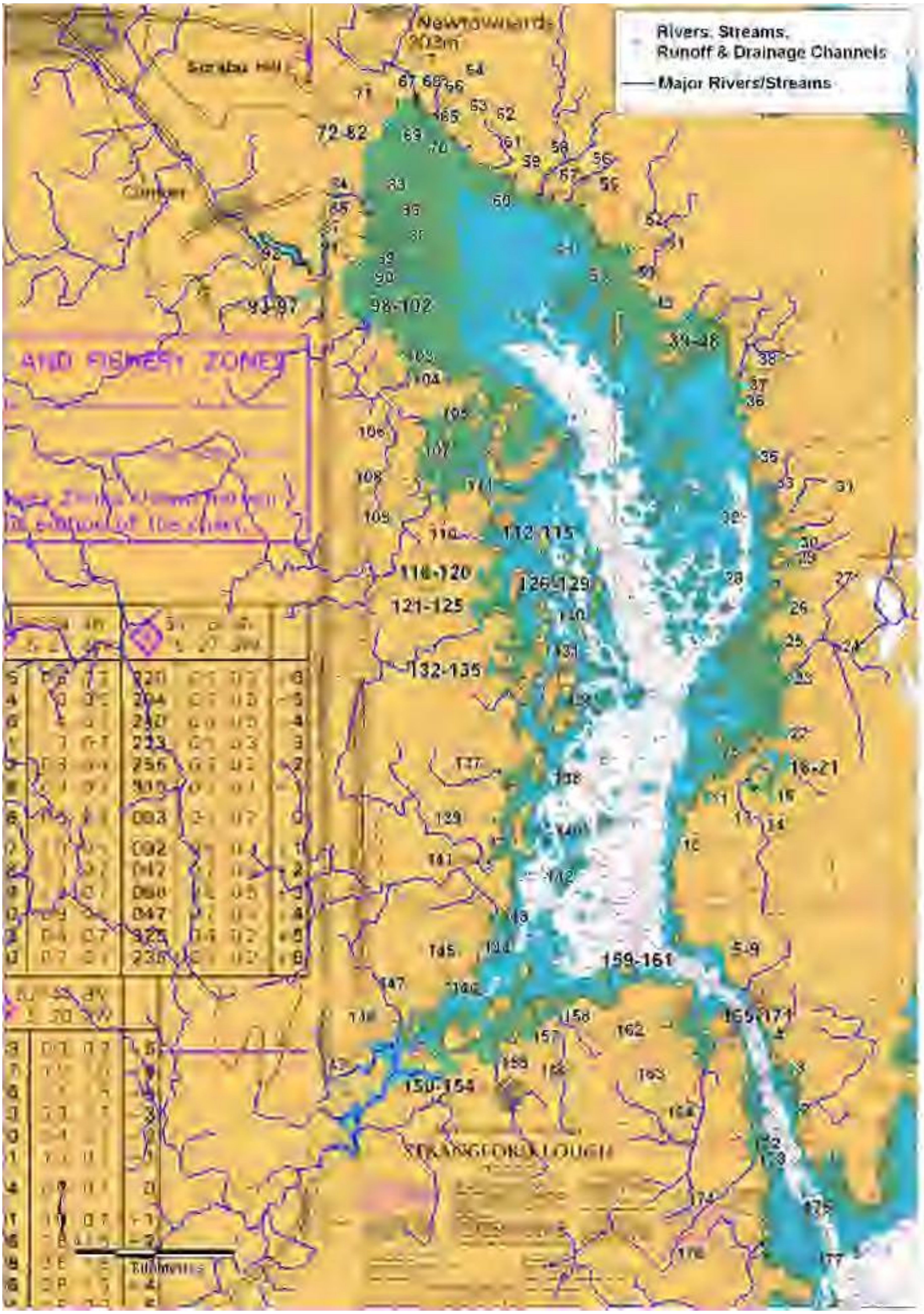


Figure 4.45: Location of all watercourses discharging into Strangford Lough.

Table 4.12: Cross-referenced table for Figure 4.45 Watercourses.

Number	Item	Longitude	Latitude	Easting	Northing
1	Spring	-5.51861	54.3431	361346.4	346667.2
2	Carrstown Burn	-5.52923	54.354	360612.9	347864.4
3	Stream/Runoff	-5.53123	54.3636	360445.8	348918.1
4	Stream/Runoff	-5.53932	54.371	359891.9	349723
5	Stream/Runoff	-5.55778	54.3867	358631.1	351438.3
6	Stream/Runoff	-5.55832	54.3876	358593	351530.1
7	Stream/Runoff	-5.55889	54.3888	358551.8	351659.5
8	Stream/Runoff	-5.55967	54.3899	358496.5	351783.8
9	Stream/Runoff	-5.56126	54.3907	358390.1	351870.1
10	Stream	-5.57528	54.414	357390.6	354429.3
11	River/Stream	-5.56433	54.4245	358061	355627.4
12	River/Stream	-5.54861	54.4283	359066.2	356080.8
13	Stream	-5.54623	54.4272	359224.3	355966.9
14	Stream	-5.54573	54.4269	359258.6	355932.6
15	Stream	-5.53896	54.4252	359704.3	355759.3
16	Stream	-5.5388	54.4252	359714.2	355763.2
17	Stream	-5.53525	54.4309	359922.6	356405.6
18	Stream	-5.53482	54.431	359950.4	356412.4
19	Stream	-5.53397	54.4323	360000.1	356560.1
20	River/Stream	-5.53281	54.433	360072.9	356638.9
21	River/Stream	-5.53292	54.434	360061.3	356756.9
22	River/Stream	-5.53337	54.4394	360011.3	357347.5
23	River/Stream	-5.53199	54.4517	360053	358724
24	Blackstaff River	-5.52883	54.4545	360246.6	359047
25	Stream	-5.53556	54.4599	359789.2	359630.6
26	Stream	-5.53384	54.4678	359870.1	360511.8
27	Stream	-5.53236	54.471	359953.9	360866.1
28	Stream	-5.53578	54.4736	359721.6	361155.8
29	River/Stream	-5.53068	54.4791	360030.8	361771.5
30	Stream	-5.52943	54.4828	360097.5	362186.1
31	Stream	-5.52827	54.4854	360162.2	362482
32	River/Stream	-5.53634	54.4889	359625.9	362859.2
33	Stream	-5.53923	54.4959	359411.5	363624.9
34	Stream	-5.54503	54.502	359012.4	364290.4
35	Stream	-5.54502	54.502	359012.7	364292.4
36	Stream	-5.55037	54.5146	358617.4	365680.7
37	Stream	-5.54934	54.5183	358670.2	366092.8
38	Stream	-5.55215	54.5202	358480.6	366299.8
39	River/Stream	-5.56018	54.5331	357911.1	367721
40	River/Stream	-5.56046	54.5335	357891.4	367757.8
41	Stream	-5.56811	54.5362	357386	368041.7

Number	Item	Longitude	Latitude	Easting	Northing
42	Stream	-5.56857	54.5362	357356.4	368042.5
43	Stream	-5.57036	54.5335	357250.5	367745.2
44	Stream	-5.5722	54.5341	357129.5	367797.5
45	Stream	-5.57244	54.5341	357113.6	367802.4
46	Stream	-5.57285	54.5334	357089.9	367724.1
47	Stream	-5.57678	54.5324	356839.2	367600.1
48	Stream	-5.57842	54.5323	356733.4	367589.8
49	Stream	-5.58572	54.5369	356243.5	368086.1
50	Glen Burn	-5.59311	54.5439	355739	368842.9
51	Stream	-5.59511	54.5488	355590.9	369387
52	Stream	-5.59571	54.5487	355552	369380.4
53	Stream	-5.60517	54.5502	354934.4	369526
54	Stream	-5.60518	54.5503	354934	369526.9
55	Stream	-5.61317	54.5585	354385.8	370431.7
56	Stream	-5.61933	54.5595	353983.9	370528.3
57	Stream	-5.62488	54.5601	353622.4	370584.1
58	Cunning Burn	-5.62899	54.5609	353354	370654.5
59	Stream	-5.63903	54.565	352689.1	371099
60	Stream	-5.64343	54.5657	352402.2	371157.4
61	Stream	-5.64821	54.5674	352086.9	371337.4
62	Stream	-5.65729	54.5719	351483	371827.4
63	Stream	-5.66287	54.5736	351115.6	372002.5
64	Stream	-5.66948	54.5784	350671	372521.4
65	Stream	-5.66979	54.5788	350649.2	372565.8
66	Stream/River	-5.67053	54.5792	350599.8	372606.8
67	Stream	-5.67786	54.5833	350111	373046.7
68	Stream/River	-5.67794	54.5833	350106	373044.2
69	Stream	-5.67805	54.5833	350099.4	373044.1
70	Stream/River	-5.67822	54.5832	350088.4	373034.3
71	Stream	-5.68424	54.5823	349702.5	372924.6
72	Stream	-5.68766	54.5782	349496.8	372452.8
73	Stream	-5.6879	54.5778	349482.2	372415.9
74	Stream	-5.68886	54.5773	349422.3	372351.6
75	River/Stream	-5.6894	54.5772	349387.6	372337.9
76	River/Stream	-5.69061	54.5746	349319	372048.7
77	River/Stream	-5.69287	54.5727	349179.4	371839.5
78	River/Stream	-5.69439	54.5723	349083.1	371789.9
79	Stream	-5.69503	54.5721	349042	371766.8
80	Stream	-5.69568	54.5716	349002.4	371705.8
81	Stream	-5.69606	54.5703	348981.9	371566.5
82	Stream	-5.6976	54.5678	348891.9	371278
83	Newtown Burn	-5.6974	54.5601	348933.2	370421.4
84	Stream	-5.69839	54.559	348873.4	370293.8

Number	Item	Longitude	Latitude	Easting	Northing
85	River/Stream	-5.69703	54.5572	348967.3	370095.9
86	River/Stream	-5.69691	54.5571	348975.3	370089.8
87	Stream	-5.69743	54.5515	348962.2	369471.3
88	Stream	-5.69728	54.5515	348972.2	369468.9
89	River/Stream	-5.69428	54.5469	349182.8	368960.3
90	Stream	-5.70041	54.5457	348791	368809.3
91	Stream	-5.70213	54.5458	348679.5	368816.5
92	River/Stream	-5.71079	54.5425	348131.1	368432.4
93	Stream	-5.71829	54.539	347658.1	368032.8
94	Comber River	-5.72201	54.5388	347418.3	368006.1
95	River/Stream	-5.72171	54.538	347440.4	367913.4
96	Stream	-5.7198	54.5372	347567.2	367833.2
97	River/Stream	-5.71355	54.5355	347977.4	367652
98	River/Stream	-5.70298	54.5355	348661.2	367678.2
99	River/Stream	-5.70197	54.5347	348729.5	367590.3
100	Graffan Burn	-5.69831	54.533	348972.9	367410.9
101	River/Stream	-5.69606	54.5328	349119.5	367383.4
102	Stream	-5.69108	54.5324	349443.2	367349.6
103	River/Stream	-5.68272	54.5247	350011.8	366520.6
104	River/Stream	-5.68068	54.5193	350163.9	365924.1
105	Stream	-5.6688	54.5116	350961.5	365088
106	Stream	-5.67509	54.5097	350561.5	364861.5
107	Stream	-5.6763	54.5031	350507.1	364129.3
108	Stream	-5.67668	54.4966	350506.6	363402.2
109	River Blackwater	-5.67183	54.4935	350832.1	363064.1
110	Stream	-5.66599	54.4913	351218.7	362832.7
111	River/Stream	-5.65926	54.4954	351639	363306.2
112	Stream	-5.65259	54.4836	352115	362009.9
113	Stream	-5.65073	54.4831	352237.5	361953.4
114	Stream	-5.65027	54.4829	352268	361934.2
115	Stream	-5.64826	54.4824	352400.1	361877.2
116	Stream	-5.65257	54.4758	352145.4	361139.5
117	Stream	-5.65339	54.474	352099	360934.2
118	Stream	-5.65338	54.4739	352099.9	360928.4
119	Stream	-5.65302	54.4738	352123.7	360913.8
120	Stream	-5.6529	54.4738	352131.5	360913.8
121	Stream	-5.65	54.4685	352338.7	360329.7
122	Stream	-5.65283	54.4693	352152.5	360411.9
123	Stream	-5.65505	54.4679	352013.5	360259.2
124	Stream	-5.65444	54.4662	352059.7	360068.5
125	Stream	-5.65165	54.4637	352249.7	359799.1
126	Stream	-5.6417	54.4727	352860.8	360818.4
127	Stream	-5.64175	54.4721	352859.9	360749.2

Number	Item	Longitude	Latitude	Easting	Northing
128	Stream	-5.64135	54.4705	352891.9	360575.7
129	Stream	-5.64171	54.4695	352872.6	360461.1
130	Stream	-5.64095	54.461	352953.8	359513
131	Stream	-5.64575	54.4592	352649	359303.6
132	Stream	-5.64817	54.4556	352505.1	358902.3
133	River	-5.64899	54.4538	352458.5	358701.9
134	Stream	-5.64789	54.4528	352534.1	358584.7
135	Stream	-5.64718	54.4526	352580.8	358566
136	River/Stream	-5.64268	54.4484	352888.6	358105.9
137	Stream	-5.64363	54.4304	352893.5	356109.6
138	Stream	-5.64334	54.4272	352924.6	355749.8
139	River/Stream	-5.64637	54.4191	352757.4	354847.8
140	River/Stream	-5.64766	54.415	352689.4	354389.3
141	River/Stream	-5.64834	54.41	352664	353826.8
142	River/Stream	-5.64121	54.4056	353143.3	353352.4
143	Mill Pond Flow	-5.64562	54.3977	352886.6	352459.8
144	River/Stream	-5.65246	54.3909	352467.4	351688.4
145	Stream	-5.66437	54.3822	351725.8	350696.9
146	Stream	-5.66498	54.3814	351689.2	350606.4
147	Stream	-5.6792	54.3757	350787	349941.9
148	Stream	-5.68287	54.3736	350555.6	349705
149	Quoile River	-5.68542	54.3684	350409.2	349112.7
150	Stream	-5.66949	54.3666	351450.9	348948
151	Stream	-5.66696	54.3656	351618.7	348850.1
152	Stream	-5.66621	54.3628	351677.9	348538.3
153	River/Stream	-5.66499	54.363	351756.6	348560.1
154	River/Stream	-5.66269	54.3635	351904.2	348623.1
155	River/Stream	-5.64578	54.3648	352997.9	348802
156	Stream	-5.63895	54.3694	353424.9	349330.3
157	Stream	-5.63333	54.3706	353785.1	349477.7
158	River	-5.6214	54.3754	354542.4	350033.9
159	Stream	-5.58966	54.3832	356574.4	350972.2
160	Stream	-5.58749	54.3839	356712.5	351059
161	Stream	-5.58756	54.3841	356707.7	351073.9
162	Stream	-5.57683	54.3729	357447.4	349860.2
163	Stream	-5.56778	54.367	358057.8	349213.6
164	River	-5.56521	54.3637	358237.6	348860.3
165	Stream	-5.56092	54.3695	358493.8	349517.5
166	Stream	-5.56076	54.3698	358503.1	349545.7
167	Stream	-5.56465	54.3713	358244.4	349706.2
168	Stream	-5.56467	54.3714	358242.9	349718.5
169	Stream	-5.56334	54.3746	358316.8	350079.9
170	Stream	-5.56299	54.375	358338.5	350118.7

Number	Item	Longitude	Latitude	Easting	Northing
171	Stream	-5.56213	54.3758	358391.3	350213.9
172	Stream	-5.54796	54.3466	359424.8	346988.2
173	River/Stream	-5.54566	54.343	359587.9	346595.6
174	Stream	-5.54176	54.3289	359895.8	345042.6
175	Stream	-5.54143	54.3277	359922.3	344903.2
176	Stream	-5.54182	54.3235	359913.3	344440
177	Stream	-5.54184	54.3209	359922.4	344144

Figure 4.46: Location of all WWTW and Continuous Discharges into Strangford Lough and its tributaries.

Table 4.13: Cross-referenced table for Figure 4.46 WWTW and Continuous Discharges.

		WWTW				Discharge			
Map ID	**Name**	**Easting**	**Northing**	**Longitude**	**Latitude**	**Easting**	**Northing**	**Longitude**	**Latitude**
1	Kircubbin	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
2	Killinchy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
3	Strangford	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
4	Barrhall	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
5	Greyabbey	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
6	Ballyrickard	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
7	Killyleagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
8	Ballygowan	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
9	Loughries	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
10	Ringneill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
11	Ballycranbeg	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
12	Moneyreagh	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
13	Abbacy Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
14	Drumaness	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
15	Bells Hill	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
16	Drumhirk	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
17	Ballytrim	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
18	Kilmood	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
19	Lessans	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
20	Glasdrummond Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
21	Lisowen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
22	Portaferry Deerpark	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]

23	Thorney Glen	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
24	Ballyhoran	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]

		WWTW				Discharge			
Map ID	**Name**	**Easting**	**Northing**	**Longitude**	**Latitude**	**Easting**	**Northing**	**Longitude**	**Latitude**
25	Carsons Dam Bridge	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
26	Annahilt	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
27	Downpatrick	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
27	Downpatrick	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
28	Annacloy	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
29	Kilmore Crossgar	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
30	Saintfield	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
31	Ballynahinch	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
32	Tullynakill Rd	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
33	Blackstaff ST	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
34	Craigarusky Rd 66	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
35	Inishargy Rd 2-10	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
36	Portaferry Road 96	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
37	Ringneil Road 1-5	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
38	Tubber Road 10-16	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
39	Inishargy Rd 10-12	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
40	Parsonage Rd 110-120	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]
41	Carrowdore Rd 38-40	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Figure 4.47: Location of all Intermittent Discharges discharging into Strangford Lough and its tributaries.

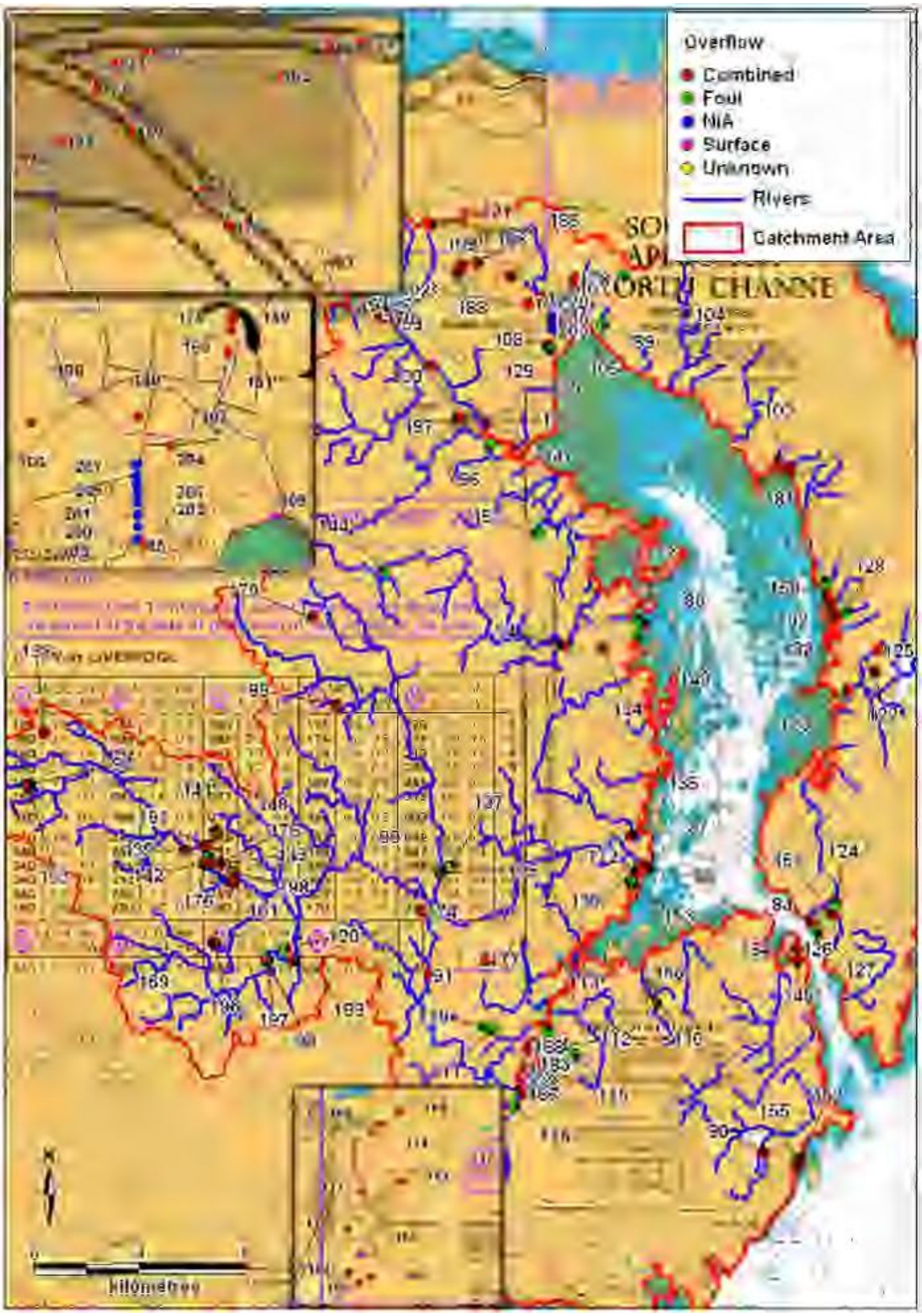


Figure 4.48: Location of all Overflows discharging into Strangford Lough and its tributaries.

Figure 4.49: Location of all Septic Tanks discharging into Strangford Lough and its tributaries.

Table 4.14: Cross referenced table for Figure 4.47 Intermittent Discharges.

Number	Easting	Northing	Longitude	Latitude
1	359422.3	350599.2	-5.54607	54.379
2	359289.4	350760.1	-5.54802	54.3805
3	359288.9	350760.5	-5.54803	54.3805
4	359288.4	350761	-5.54804	54.3805
5	359287.1	350761.5	-5.54806	54.3805
6	359276.9	350767.2	-5.54821	54.3805
7	359274.3	350768.5	-5.54825	54.3805
8	359272.4	350768.9	-5.54828	54.3805
9	359270.6	350770	-5.54831	54.3805
10	359268.7	350771.5	-5.54834	54.3806
11	357743.7	355444.3	-5.56931	54.423
12	359832.7	357574.5	-5.536	54.4414
13	359777.3	362414.5	-5.53424	54.4849
14	359741.7	362308	-5.53485	54.484
15	359546.2	363191	-5.53739	54.492
16	359545.5	363196.7	-5.5374	54.492
17	359544.1	363201.9	-5.53741	54.492
18	359530.1	363564.9	-5.53743	54.4953
19	358932	363925.7	-5.54646	54.4987
20	358981.3	364246.7	-5.54553	54.5016
21	358286.8	366853	-5.55484	54.5252
22	357654	367690	-5.56416	54.5329
23	357672.9	367787.4	-5.56382	54.5338
24	357433.2	368062.6	-5.56737	54.5363
25	356266.9	367958.8	-5.58543	54.5358
26	354046.3	370540.1	-5.61836	54.5596
27	354041.7	370541.6	-5.61843	54.5596
28	354036	370542	-5.61852	54.5596
29	352572.1	371127.1	-5.64082	54.5653
30	351820.3	371440.4	-5.65228	54.5684
31	351815.1	371440.8	-5.65236	54.5684
32	351810	371440.7	-5.65243	54.5684
33	351803.1	371440.4	-5.65254	54.5684
34	351799.1	371440.9	-5.6526	54.5684
35	351794.5	371439	-5.65267	54.5684
36	350167.6	372898.5	-5.67706	54.582
37	350066.3	373029.8	-5.67856	54.5832
38	350045	373014.2	-5.6789	54.583
38	359272.4	350768.9	-5.54828	54.3805
39	348805.3	370511.5	-5.69933	54.5609
40	350132.4	360770.4	-5.68378	54.4731
41	352418.7	361382.8	-5.64823	54.4779

Number	Easting	Northing	Longitude	Latitude
42	352433.1	361368.2	-5.64801	54.4778
43	353861.9	358827.4	-5.62731	54.4545
44	353232.5	352784.8	-5.64013	54.4005
45	353223.5	352532.1	-5.64039	54.3982
46	352673.5	352428	-5.64891	54.3974
47	352658.6	352387.6	-5.64916	54.3971
48	352284.6	351112.8	-5.65557	54.3858
49	351019.6	349719.5	-5.67573	54.3736
50	350601.9	349639.8	-5.68219	54.373
51	351020.6	349197.8	-5.67598	54.3689
52	351353.2	349007	-5.67096	54.3671
53	351909	348775.2	-5.66254	54.3649
54	351925.9	348956.2	-5.66219	54.3665
55	352160.3	348961.1	-5.65858	54.3665
56	352266.2	349031.6	-5.65691	54.3671
57	352533.5	348995.9	-5.65282	54.3667
58	352563.3	348887.1	-5.65242	54.3657
59	353327.3	349366.3	-5.64043	54.3698
60	353402.3	349390.3	-5.63926	54.37
61	353621.1	349524.7	-5.63583	54.3711
62	353687.3	349452.7	-5.63485	54.3704
63	353762.3	349509.8	-5.63367	54.3709
64	354574.4	350161.1	-5.62084	54.3765
65	355002.9	350556.3	-5.61405	54.3799
66	355787.8	350280.6	-5.60212	54.3772
67	357114.7	350848.9	-5.58142	54.3819
68	357893.9	350819.7	-5.56945	54.3814
69	357449.4	349861.7	-5.57679	54.373
70	358409	350234.4	-5.56184	54.376
71	359300	349230	-5.54868	54.3667
72	359447.8	348301.2	-5.5469	54.3583
73	360083	345939.3	-5.53841	54.3369
74	360672.8	343753.7	-5.53053	54.3171
75	348076.6	345375.1	-5.72314	54.3355
76	348144.2	345326	-5.72213	54.335
77	348042.9	345182.8	-5.72376	54.3338
78	338765.5	348639.1	-5.86468	54.3674
79	337443.1	351825.2	-5.88354	54.3964
80	329535.1	354968.8	-6.00386	54.4267
81	330329.1	356156.5	-5.99111	54.4371
82	361558.6	359353.7	-5.50845	54.4569
83	337445.2	351824.7	-5.88351	54.3964
84	358288.1	366848.5	-5.55483	54.5252

Number	Easting	Northing	Longitude	Latitude
85	358290.1	366842.8	-5.5548	54.5251

Table 4.15: Cross-referenced table for Figure 4.48 Overflows.

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
84	Portaferry (2) SPS	359331.01	350721.03	-5.5474	54.3801	Combined	CSO
85	Comber Rd SPS	348932.78	372757.74	-5.69622	54.5811	Combined	CSO
86	White Rock SPS	352556.50	361801.76	-5.64589	54.4816	Combined	CSO
87	Killyleagh CSO	352936.05	352692.97	-5.64473	54.3997	Combined	Works
88	Nat Walk CSO	353058.63	352565.44	-5.64291	54.3986	Combined	In Sewer
89	Lapwing SPS	350651.4	373001.1	-5.66953	54.5827	Foul	N/A
90	Bishopscourt SPS	357861.4	341975.1	-5.57463	54.302	Combined	CSO
91	Annacloy SPS	344991	348269	-5.76914	54.3624	Combined	CSO
92	Ballyhanwood SPS	341151	373407	-5.81618	54.5891	Combined	CSO
93	Millars Lane SPS	342955.6	372850.6	-5.78855	54.5836	Combined	CSO
94	Balloo SPS	349647	360914	-5.69119	54.4745	Combined	CSO
95	Saintfield SPS	341115.9	358363.2	-5.82392	54.4541	Combined	None
96	Ballydrain Road SPS	346614	368368	-5.73424	54.5423	Foul	CSO
97	Poundburn SPS	329540.3	354985.2	-6.00377	54.4268	Combined	None
98	Magheratimpany SPS	338762.8	348632.7	-5.86473	54.3674	Combined	CSO
99	Crossgar SPS	345236	352124.6	-5.76349	54.3969	Combined	CSO
100	Ballystockard SPS	344234	371253	-5.76958	54.5689	Combined	CSO
101	Millbrook Lodge SPS	337409.3	351524.8	-5.8842	54.3937	Combined	CSO
102	The Green SPS	359654.6	362837	-5.53591	54.4887	Combined	None
103	Watermeade SPS	357456	368069	-5.56701	54.5364	Combined	CSO
104	Old Forge SPS	351371.6	374926.4	-5.65741	54.5998	Foul	None
105	Portaferry Road (2) SPS	350028.7	373046.2	-5.67913	54.5833	Surface	None
106	Scrabo Road SPS	347924.7	373767.9	-5.71129	54.5904	Combined	CSO
107	South Street SPS	349132.1	373609.6	-5.69271	54.5886	Combined	CSO
108	West Winds SPS	348717	372182	-5.69985	54.576	Combined	N/A

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
109	Bradshaws Brae SPS	345305	375061	-5.75115	54.6028	Combined	CSO
110	Raholp Village SPS	353536	347463.9	-5.6382	54.3526	Combined	CSO
111	IDB Lands 2 SPS	347382.2	346312.8	-5.73335	54.3441	Foul	None
112	Ardenlee SPS	349927.3	345655.4	-5.69457	54.3375	Foul	CSO
113	Quoile SPS	349504.8	346270.5	-5.70075	54.3431	Foul	CSO
114	Strangford Road SPS	348758.4	345611.5	-5.71255	54.3374	Combined	N/A
115	Ardfern SPS	350544	345416.1	-5.68522	54.3351	Foul	N/A
116	Racecourse Road SPS	348339.5	343375.6	-5.7201	54.3175	Foul	CSO
117	Church Street Downpatrick SPS	348700	344923	-5.71379	54.3312	Combined	N/A
118	Market Street SPS	348556.1	344517.9	-5.7162	54.3277	Combined	N/A
119	IDB Lands 1 SPS	347074.8	346394.7	-5.73803	54.3449	Foul	N/A
120	Cumber Drive SPS	339418.8	349090.1	-5.85442	54.3713	Foul	None
121	Craigantlet South SPS	344095	376599	-5.7691	54.6169	Combined	CSO
122	Rubane 2 SPS	361403.3	360354.1	-5.5103	54.4659	Combined	CSO
123	Blackstaff SPS	360425	359554	-5.52581	54.459	Combined	None
124	Cloughy Road SPS	360235.2	351457.7	-5.5331	54.3864	Foul	None
125	Rubane 1 SPS	361555	361132	-5.50754	54.4728	Combined	None
126	Strangford Village Green SPS	358871	349735	-5.555	54.3714	Combined	None
127	Shore Road Portaferry 1 SPS	359558	350371	-5.5441	54.3769	Foul	None
128	Long Island Drive SPS	360200.7	362518.7	-5.52766	54.4857	Foul	N/A
129	Landsdowne Road Storm SPS	348752	372076.9	-5.69936	54.575	Surface	N/A
130	Landsdowne Road Foul SPS	348748	372082.7	-5.69942	54.5751	Foul	N/A
131	Upper Newtonards Road SPS	341651	373974	-5.80818	54.5941	Combined	None
132	Comber Road Dundonald SPS	342197.1	373256.7	-5.80008	54.5875	Combined	CSO
133	Rolls Royce SPS	343089.1	374134.5	-5.78587	54.5951	Combined	N/A
134	Whiterock Road SPS	351091	360883	-5.66895	54.4738	Combined	None
135	Maymore SPS	352411	353818	-5.65224	54.41	Combined	CSO
136	Inishmore Killyleagh SPS	352447.5	352077.2	-5.65257	54.3944	Foul	N/A

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
137	Cochranes SPS	345648.6	352414	-5.757	54.3994	Foul	CSO
138	Annahilt (2) SPS	330079.7	357018.2	-5.99458	54.4449	Combined	CSO
139	Clanwilliams Court SPS	335549.8	352684.5	-5.91228	54.4046	Combined	None
140	Down Business SPS	336385	352460	-5.89953	54.4024	Foul	None
141	Glass Factory SPS	336679.4	353440.4	-5.89455	54.4111	Combined	None
142	Antrim Road SPS	336406	352251	-5.8993	54.4005	Combined	CSO
143	Town Ballynahinch SPS	336864.4	352250.8	-5.89225	54.4003	Combined	CSO
144	Ravara SPS	342778	363517.4	-5.79582	54.4999	Foul	N/A
145	The Links SPS	358858	349307	-5.55543	54.3675	Combined	CSO
146	Crossnacreevy SPS	339464	369467	-5.84413	54.5542	Combined	CSO
147	Comber Combined SPS	346331.3	369209.2	-5.73819	54.55	Combined	CSO
148	Comber Storm SPS	346344	369187	-5.73801	54.5498	Surface	None
149	Inisharoan SPS	352418.1	361383.4	-5.64824	54.4779	Foul	CSO
150	Shore Road SPS	359474	363602	-5.53828	54.4957	Foul	None
151	Rockfield SPS	360134	351055	-5.53488	54.3828	Combined	None
152	Ballyhoran 1 SPS	359225	341760	-5.55382	54.2997	Combined	CSO
153	The Moorings SPS	352516.1	351994.4	-5.65155	54.3936	Foul	N/A
154	Russell Park SPS	348580.9	344031.2	-5.71607	54.3233	Combined	N/A
155	Ballyhoran 2 SPS	359127.6	341468.2	-5.55547	54.2971	Combined	CSO
156	Raholp SPS	353409.6	347497.9	-5.64013	54.353	Unknown	CSO
157	Lisbarnet SPS	348542.7	365124.5	-5.7061	54.5126	Foul	CSO
158	Shore Road Kircubbin CSO	359545	363248	-5.53737	54.4925	Combined	In Sewer
159	Bangor Road Newtownards CSO	349627.2	374725.2	-5.68449	54.5985	Combined	In Sewer
160	91 Bangor Road Newtownards CSO	349602	374621	-5.68493	54.5976	Combined	In Sewer
161	Bangor Road Newtownards CSO	349585	374434	-5.68529	54.5959	Combined	In Sewer
162	Brooklands Avenue CSO	342612.3	373926.7	-5.79334	54.5934	Combined	In Sewer
163	Poundburn CSO	329522.9	354963.5	-6.00405	54.4266	Combined	Works
164	Down Council Strangford Road CSO	349038	345822	-5.70815	54.3392	Combined	In Sewer

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
165	Stream Street One CSO	348806	343988	-5.71263	54.3228	Combined	In Sewer
166	Folly Lane Downpatrick CSO	348699	344229	-5.71415	54.325	Surface	In Sewer
167	Stream Street Two CSO	348698	343912	-5.71433	54.3222	Combined	In Sewer
168	Malone Park CSO	348861	345680	-5.71094	54.338	Combined	In Sewer
169	Dunmore Road One CSO	336734.7	349247.1	-5.89563	54.3734	Combined	In Sewer
170	Comber Road Enler CSO	342361.9	373034.1	-5.79764	54.5854	Combined	In Sewer
171	Comber Road Shopping Centre CSO	341564.9	373812.3	-5.80959	54.5926	Combined	In Sewer
172	Seaview CSO	352663	352433.4	-5.64907	54.3975	Combined	In Sewer
173	Whiterock Bay CSO	352422	361866	-5.64793	54.4822	Foul	In Sewer
174	Teconnaught Road CSO	344588.4	350658.6	-5.77417	54.3839	Combined	In Sewer
175	Town CSO	336860.2	352255.5	-5.89231	54.4004	Combined	In Sewer
176	Dromore Road CSO	336299	352208	-5.90097	54.4001	Combined	In Sewer
177	Bells Hill CSO	347071.3	348921.7	-5.73684	54.3676	Combined	Works
178	97 Bangor Road Newtownards CSO	349609	374706	-5.68478	54.5983	Combined	In Sewer
179	Lessans CSO	340094.8	361674.9	-5.83809	54.4841	Combined	Works
180	John Street Police Station CSO	348836	373857	-5.69716	54.591	Combined	In Sewer
181	Greyabbey Square CSO	357912	367902	-5.56006	54.5347	Combined	In Sewer
182	Boyd Avenue CSO	359807	362502	-5.53374	54.4857	Combined	In Sewer
183	Saul Street CSO	349101	345064	-5.70756	54.3324	Combined	In Sewer
184	The Slip CSO	358875	349718	-5.55495	54.3712	Combined	In Sewer
185	Killysuggan CSO	347182	374725	-5.72229	54.5992	Combined	In Sewer
186	Ballybarnes Meadow CSO	345884	375229	-5.74211	54.6041	Combined	In Sewer
187	Pound Bridge CSO	345423	369365	-5.75214	54.5516	Combined	In Sewer
188	Ballyrogan Park CSO	345142	374870	-5.75376	54.6011	Combined	In Sewer
189	Grand Prix Mews CSO	341774	373567	-5.80647	54.5904	Combined	In Sewer
190	Mill Street John CSO	348396	373971	-5.7039	54.5921	Combined	In Sewer
191	Downhill Terrace CSO	336294	352902	-5.90073	54.4063	Combined	In Sewer
192	Brooklands Crescent CSO	342907	374085	-5.78871	54.5947	Combined	In Sewer

Map ID	Name	Easting	Northing	Longitude	Latitude	Function	Type
193	Upper Newtownards Road CSO	341832	374044.1	-5.80535	54.5946	Combined	In Sewer
194	Cumberland Road CSO	341368.7	373506.2	-5.81277	54.5899	Combined	In Sewer
195	Crossgar CSO	345226.6	352142.5	-5.76363	54.3971	Combined	Works
196	Dunmore Road Two CSO	336784.3	349191.5	-5.89489	54.3729	Combined	In Sewer
197	Magheratimpiny CSO	338750.6	348632	-5.86491	54.3673	Combined	In Sewer
198	Carlisle Park CSO	337401	351899	-5.88415	54.397	Combined	In Sewer
199	Greenview CSO	339755.9	348693.5	-5.84943	54.3676	Combined	In Sewer
200	CSO 03	348866	372917	-5.69717	54.5825	N/A	N/A
201	CSO 04	348862	373012	-5.69719	54.5834	N/A	N/A
202	CSO 05	348855	373120	-5.69724	54.5843	N/A	N/A
203	CSO 06	348863	372804	-5.69728	54.5815	N/A	N/A
204	CSO 07	348840	373352	-5.69735	54.5864	N/A	N/A
205	CSO 08	348844	373278	-5.69733	54.5858	N/A	N/A
206	CSO 09	348854	373206	-5.69721	54.5851	N/A	N/A
207	CSO 10	348826	373443	-5.69752	54.5872	N/A	N/A

Table 4.16: Cross-referenced table for Figure 4.49 Septic Tanks.

Map ID	Name	Easting	Northing	Longitude	Latitude
208	Tubber Road (10-16)	360086	363268	-5.52902	54.4925
209	Lisbane Road (38-40)	361468	358700	-5.51021	54.451
210	Ravara Road (9-19)	342540	363399	-5.79956	54.4989
211	Ballygowan Road (41-47)	344197	367572	-5.77195	54.5359
212	Clattering Ford	344908	368371	-5.76058	54.5428
213	The Demesne	340409	359305	-5.83437	54.4627
214	Moneyreagh Road (51-55)	340601	367825	-5.82735	54.5392
215	Inishargy Road (10-12)	360100.3	364784.4	-5.52798	54.5061
216	Movilla Road (136-140)	352174.5	374855.1	-5.64504	54.5989
217	Ballymiscaw Road (33-37)	341097.2	376056.1	-5.81574	54.6129
218	Upper Ballygelagh Road (12-18)	361175.1	357625.9	-5.5153	54.4415
219	Ballykeel Cottages (1-4)	341558.6	376353.4	-5.80846	54.6155
220	Carrowdore Road (38-40)	357396.4	370817.6	-5.56647	54.5611
221	Ballyeasborough Road (15-17)	364243.9	361404	-5.46595	54.4744
222	Blackstaff (ST)	360440	359445	-5.52564	54.458
223	Newcastle Road (58-66)	339524.9	347328.2	-5.85362	54.3554
224	Drumaroad Draper Hill - Chapel Hill	336825.4	344679.8	-5.89633	54.3324
225	Parsonage Road (110-120)	361166.6	363202.9	-5.51239	54.4915
226	Ballyrainey Road (65-67)	345535.7	372141.2	-5.74903	54.5765
227	Ringneill Road (1-5)	350132.9	365844.3	-5.6812	54.5186
228	Kilcarn Road	344926	360391.2	-5.76422	54.4712
229	Moss Road (76-78)	346117.8	362744.5	-5.74469	54.492
230	Lisbarnett Road (47-53)	346622.2	362973.2	-5.7368	54.4939
231	Tullyhubbert Road (75-81)	342012.9	365344.6	-5.80675	54.5165
232	Ballylone Road	337643	352724	-5.88005	54.4044
233	Ballycreely Road	342541.1	366281.4	-5.79814	54.5248
234	Jacksons Cresent (7-8)	342747.2	359437.3	-5.79827	54.4633
235	Jacksons Cresent (9-10)	342778.8	359470.2	-5.79777	54.4635
236	Station Road (155-157)	344433.7	360404.1	-5.77181	54.4715
237	Moneyreagh Road (139-141)	341590.9	366387.3	-5.81276	54.526
238	Comber Road (102-106)	349294.9	362298.2	-5.69592	54.4871
239	Craigarusky Road (66-68)	350772.6	362664.2	-5.67295	54.4899
240	Killinchy Road (96-100)	347184.8	366640.4	-5.72629	54.5267
241	Kirkland Road (6-12)	351786	355668.8	-5.66091	54.4268
242	Moss Road (36-38)	344204.4	363347.9	-5.7739	54.498
243	Ballyalton Road (20-22)	346960.3	371980.1	-5.72709	54.5747
244	Portaferry Road (96-100)	351270.9	371930.4	-5.66051	54.5729
245	Ballybarnes Road (80-82)	346237.6	376310.3	-5.73611	54.6137
246	Gransha Road (26-28)	340716.6	368874.7	-5.82507	54.5485
247	Ballydrain Road (39-43)	348269.3	367255.5	-5.70925	54.5319
248	Jacksons Cresent (1-6)	342720.2	359420.8	-5.79869	54.4631

Map ID	Name	Easting	Northing	Longitude	Latitude
249	Drumreagh Road (9-11)	346059.9	362483.6	-5.74571	54.4897
250	Ballygowan Road Comber (102-104)	343544.1	364427.1	-5.78356	54.5078
251	Inishargy Road (2-10)	359653.3	364412.1	-5.53508	54.5029

Figure 4.50: Location of all Emergency Discharges into Strangford Lough and its tributaries.

Figure 4.51: Location of all Industrial Discharges into Strangford Lough and its tributaries.

Table 4.17: Cross-referenced tables for Figure 4.50 Emergency Discharges.

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
252	Portaferry (1) SPS	350055.57	373053.54	-5.67872	54.5834	Foul
253	Kilclief 2 Shore SPS	359780.96	345506.25	-5.54328	54.3331	Foul
254	Leathem Square SPS	341622.1	373694	-5.80876	54.5916	Foul
255	Ballydugan Road Ind Est SPS	348500.2	343600.4	-5.71752	54.3194	Foul
256	Lissara Close SPS	345351.3	352357.3	-5.76161	54.399	Foul
257	Oakdale SPS	342892.8	363758	-5.79394	54.502	Foul
258	Carsons Road SPS	343703.9	364005.4	-5.7813	54.504	Foul
259	Station Lane SPS	342963.9	363762.9	-5.79284	54.502	Combined
260	Gransha LaMon SPS	341439.8	368958.4	-5.81386	54.5491	Foul
261	Killinchy Road SPS	346190	368649	-5.74065	54.545	Foul
262	The Old Mill Race SPS	345297.8	368694.6	-5.75441	54.5456	Foul
263	Kinedale SPS	335694	352808.4	-5.91001	54.4057	Foul
264	Limpey SPS	340585.6	367683.7	-5.82766	54.5379	Foul
265	Darragh Cross West SPS	343793.9	357693.4	-5.78298	54.4473	Foul
266	Spa SPS	337151	348893.4	-5.88939	54.3701	Combined
267	Lisburn Road SPS	336265.7	352769.3	-5.90123	54.4052	Foul
268	Churchview SPS	336230	352681.8	-5.90182	54.4044	Foul
269	Cooks Cove SPS	359858	362466	-5.53297	54.4853	Combined
270	Ryan Park SPS	338394	370502	-5.86017	54.5638	Foul
271	Teal Rocks SPS	350342	372865	-5.67439	54.5816	Foul
272	Sunderland Park SPS	348596	372620	-5.70149	54.5799	Foul
273	Glenford Way SPS	348289.7	374678.4	-5.70519	54.5985	Foul
274	Braeside SPS	347387.1	374719.9	-5.71912	54.5991	Foul
275	Kilclief 1 SPS Ballycotton SPS	359123.3	345499.4	-5.55339	54.3333	Foul
276	Raholp Village SPS	353536	347463.9	-5.6382	54.3526	Combined
277	Ardenlee SPS	349927.3	345655.4	-5.69457	54.3375	Foul

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
278	Quoile SPS	349504.8	346270.5	-5.70075	54.3431	Foul
279	Mearne Road SPS	349700.4	346428.6	-5.69767	54.3445	Foul
280	Racecourse Road SPS	348339.5	343375.6	-5.7201	54.3175	Foul
281	IDB Lands 3 SPS	346776.3	345935.9	-5.74284	54.3409	Foul
282	Cumber Road SPS	339557.4	349482.7	-5.85211	54.3748	Foul
283	Drumaness Village SPS	339577.8	349067	-5.85199	54.371	Foul
284	Kerries Glen SPS	349859	360951	-5.68791	54.4748	Foul
285	Annsfield SPS	351945	352353	-5.66016	54.397	Foul
286	Oaklands Darragh Cross SPS	344973.1	358273.4	-5.76453	54.4522	Foul
287	Darragh Cross 3 SPS	345209.8	358742.9	-5.76066	54.4563	Foul
288	Darragh Cross 1 SPS	344926.1	358161.5	-5.76531	54.4512	Foul
289	Orchard Annahilt SPS	329735.5	356211.5	-6.00023	54.4378	Foul
290	Meadowvale SPS	343454.9	363474	-5.7854	54.4993	Foul
291	Loughside Drive SPS	337013	352268	-5.88996	54.4005	Foul
292	The Links SPS	358858	349307	-5.55543	54.3675	Combined
293	Lisleen SPS	340475.4	368800	-5.82883	54.5479	Foul
294	Lynnehurst Drive SPS	344615	369332	-5.76464	54.5516	Foul
295	Glencroft SPS	344503	369352	-5.76636	54.5518	Foul
296	Hillside Park SPS	345831	369106	-5.74597	54.5492	Foul
297	Glen Park SPS	344561	368906	-5.76568	54.5477	Foul
298	Carnesure Manor SPS	345794.6	368612.9	-5.74677	54.5448	Foul
299	Carnesure Terrace SPS	345531	368940	-5.75068	54.5478	Foul
300	Annahilt (1) SPS	330332	357583	-5.99044	54.4499	Foul
301	Killinchy Street SPS	345940	369137	-5.74427	54.5494	Foul
302	Darragh Cross 2 SPS	345158.9	358270.8	-5.76167	54.4521	Foul
303	Raholp SPS	353409.6	347497.9	-5.64013	54.353	Unknown
304	Cathedral View SPS	348537.7	343761.3	-5.71686	54.3209	Foul
305	Thornleigh SPS	349960	365793	-5.68389	54.5182	Foul

Map ID	Name	Easting	Northing	Longitude	Latitude	Function
306	Lisbarnet SPS	348542.7	365124.5	-5.7061	54.5126	Foul
307	Poundburn CSO	329524.3	354978.9	-6.00402	54.4268	Combined
308	O' Hagan Construction Ltd	352480	352000	-5.65211	54.3937	Private Sewage : Emergency Overflow
309	Eastonville Traders Ltd	349570	346370	-5.6997	54.344	Private Sewage : Emergency Overflow

Table 4.18: Cross-referenced tables for Figure 4.51 Industrial Discharges.

Map ID	Station	File Ref	Company	Easting	Northing	Longitude	Latitude	Industry
310	62164	TC80/03	The National Trust (NI) Region	355270	369540	-5.59998	54.5503	Private Sewage : Unspecified
311	60919	TC75/89	Alan Dunlop Ltd	350800	363100	-5.6723	54.4938	Private Sewage : Unspecified
312	60935	TC33/94	Environment & Heritage Service	359600	360400	-5.53806	54.4669	Herbicides
313	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
314	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
315	60937	TC84/97	Roy Lyttle Limited	350720	372680	-5.66864	54.5798	Food Processing : Unspecified
316	60942	TC109/97	R J M Farms	348400	370500	-5.70559	54.5609	Food Processing : Unspecified
317	60943	TC108/97	Sparky Pac	348300	370600	-5.70709	54.5619	Food Processing : Unspecified
318	60944	TC39/94	The Wildfowl and Wetlands Trust	349200	367300	-5.69486	54.532	Private Sewage : Unspecified
319	60945	TC145/88	Cuan Sea Fisheries Ltd	352700	362600	-5.64326	54.4888	Food Processing : Shell Fishery
320	61816	TC14/99	Unknown	359000	356100	-5.54962	54.4285	Food Processing : Shell Fishery
321	62783	TC296/05	Down Cruising Club	352350	362800	-5.64856	54.4907	Private Sewage : Unspecified
322	63688	TC206/07	Laing O'Rouke	348630	370520	-5.70203	54.5611	Site Drainage : Unspecified
323	64325	TC100/09	Unknown	352680	362280	-5.64374	54.4859	Private Sewage : Unspecified
324	64339	TC68/08	Queens University Belfast	359280	350790	-5.54815	54.3807	Site Drainage : Unspecified

5. Shellfish and Water Sampling

5.1. Historical Data

5.1.1. Shellfish Water Quality

The Northern Ireland Environment Agency (NIEA) Water Management Unit collects water samples for analysis from various locations around Strangford Lough (See Figure 5.1). These water samples are analysed routinely for pH, temperature, suspended solids, salinity, dissolved oxygen, faecal coliforms (*E. coli*), heavy metals, organochlorides, Polychlorionated Biphenyls (PCB), Polycyclic Aromatic Hydrocarbons (PAHs), Pentachlorophenol (PCP) and Tributyl Tin Oxide (TBTO). As faecal coliforms are the main indicators of sanitation levels in water bodies such as Strangford Lough, these results are shown in Figure 5.2 (and Table 5.1) below for all 7 sampling points from 2005 to 2009 (Note the change in cfu/100ml range for Skate Rock and Ardmillan 2). Faecal coliforms were below 50 cfu/100ml at all sites in all years with the exception of December 2007 when levels of 350 cfu/100ml were recorded at Skate Rock and levels of 150 cfu/100ml at Ardmillan 2 and in December 2005 levels of 73 cfu/100ml were recoded at Ardmillan 3. The Guide value for faecal coliforms in designated shellfish waters, which should be observed by Environment Agencies, under the Shellfish Waters Directive (79/923/EEC) is <300 cfu/100ml. This figure applies not only to the shellfish flesh and intervalvular fluid but also to the waters in which they live. The guide value was only exceeded once (at Skate Rock in December 2007), a similar peak was observed at Ardmillan 2 at the same time but this did not exceed the guide value.

The averaged and totalled faecal coliform results can be seen in graphical form in Figure 5.3 (and Table 5.1) and Figure 5.4 (and Table 5.2) shows the averaged and total seasonal faecal coliform results. However, it should be noted that not all seasons from 2005 to 2009 were equally represented (i.e. spring was only sampled once in the 4 year period) and the sampling sites were not representative of the entire Lough. Figure 5.3 shows that the Skate Rock site had the highest faecal coliform levels (514.9 total cfu/100ml; 34.3 average cfu/100ml) over the sampling period and Marlfield Bay 1 the lowest (42 total cfu/100ml; 3 average cfu/100ml). Figure 5.4 shows that total and average winter levels of faecal coliforms were higher than during all other seasons and highest at Skate Rock (403 total cfu/100ml; 67.2 average cfu/100ml). Ardmillan 2 had the second highest winter faecal coliform levels (181.8 total cfu/100ml; 30.3 average cfu/100ml) and Marlfield Bay had the lowest (21 total cfu/100ml; 3.5 average cfu/100ml). Total faecal coliform levels during spring, summer and autumn were 8.5 to 16 times lower than the winter levels. Based on the average faecal coliform data, autumn had the lowest average and spring the second highest (winter having the highest as mentioned above). The data for spring must be interpretated with caution as spring was only sampled once in the 4 year period.

Figure 5.1: Locations of NIEA water sampling points.

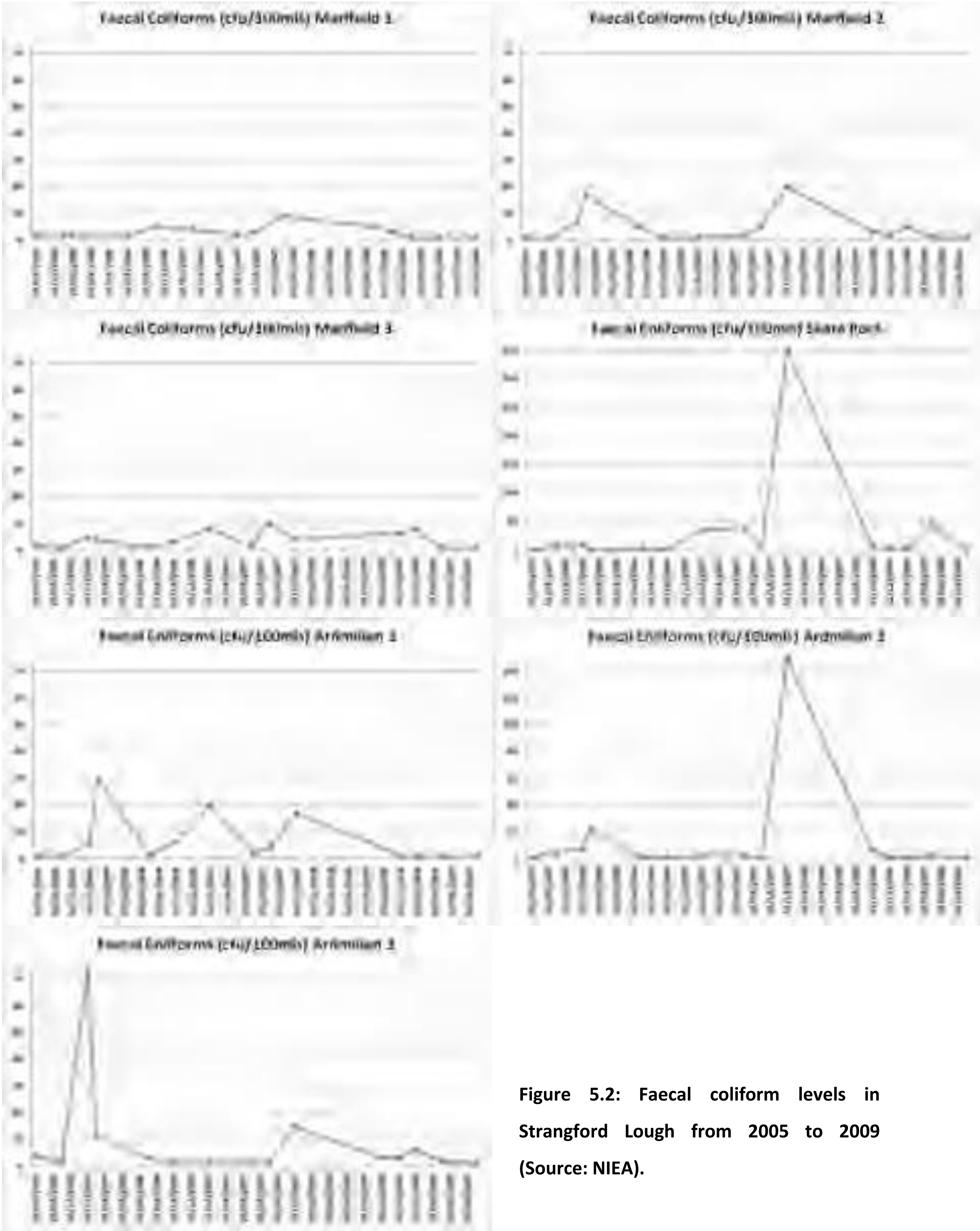


Figure 5.2: Faecal coliform levels in Strangford Lough from 2005 to 2009 (Source: NIEA).

Table 5.1: Faecal coliforms at Marlfield Bay, Skate Rock and Ardmillan from 2005-2009 (Source: NIEA).

Date	Marlfield 1	Marlfield 2	Marlfield 3	Skate Rock	Ardmillan 1	Ardmillan 2	Ardmillan 3
23/06/2005	NR	1	2	1	<1	<1	4
15/09/2005	2	<1	<1	7	1	5	<1
12/12/2005	2	7	5	11	6	7	73
31/01/2006	2	17	4	1	30	21	12
20/07/2006	2	5	1	3	1	<1	3
24/10/2006	5	<1	3	2	6	1	1
14/02/2007	4	1	8	34	20	2	<1
10/07/2007	2	2	2	41	2	2	<1
12/09/2007	3	5	10	4	4	<1	1
11/12/2007	9	20	4	350	17	150	15
14/10/2008	5	3	6	6	4	6	3
10/12/2008	3	2	6	4	<1	<1	3
10/02/2009	1	5	8	3	1	<1	6
20/05/2009	1	<1	1	47	<1	2	<2
30/09/2009	<1	1	<1	<1	1	<1	<1
Average	3	4.78	4.12	34.3	6.38	13.4	8.4
Total	42	71.7	61.8	514.9	95.7	201.4	126.5

NR = Not Recorded

Table 5.2: Averaged and totalled seasonal faecal coliforms levels (cfu/100ml) from 2005 – 2009 (Source: NIEA).

Station	Marlfield 1	Marlfield 2	Marlfield 3	Skate Rock	Ardmillan 1	Ardmillan 2	Ardmillan 3
Spring Avg	1	0.9	1	47	0.9	2	1.9
Summer Avg	2	2.7	1.7	15	1.3	1.3	2.6
Autumn Avg	3.18	2.16	4.16	3.98	3.2	2.76	1.36
Winter Avg	3.5	8.7	5.83	67.2	12.5	30.3	18.3
Spring Sum	1	0.9	1	47	0.9	2	1.9
Summer Sum	4	8	5	45	3.9	3.8	7.9
Autumn Sum	15.9	10.8	20.8	19.9	16	13.8	6.8
Winter Sum	21	52	35	403	74.9	181.8	109.9

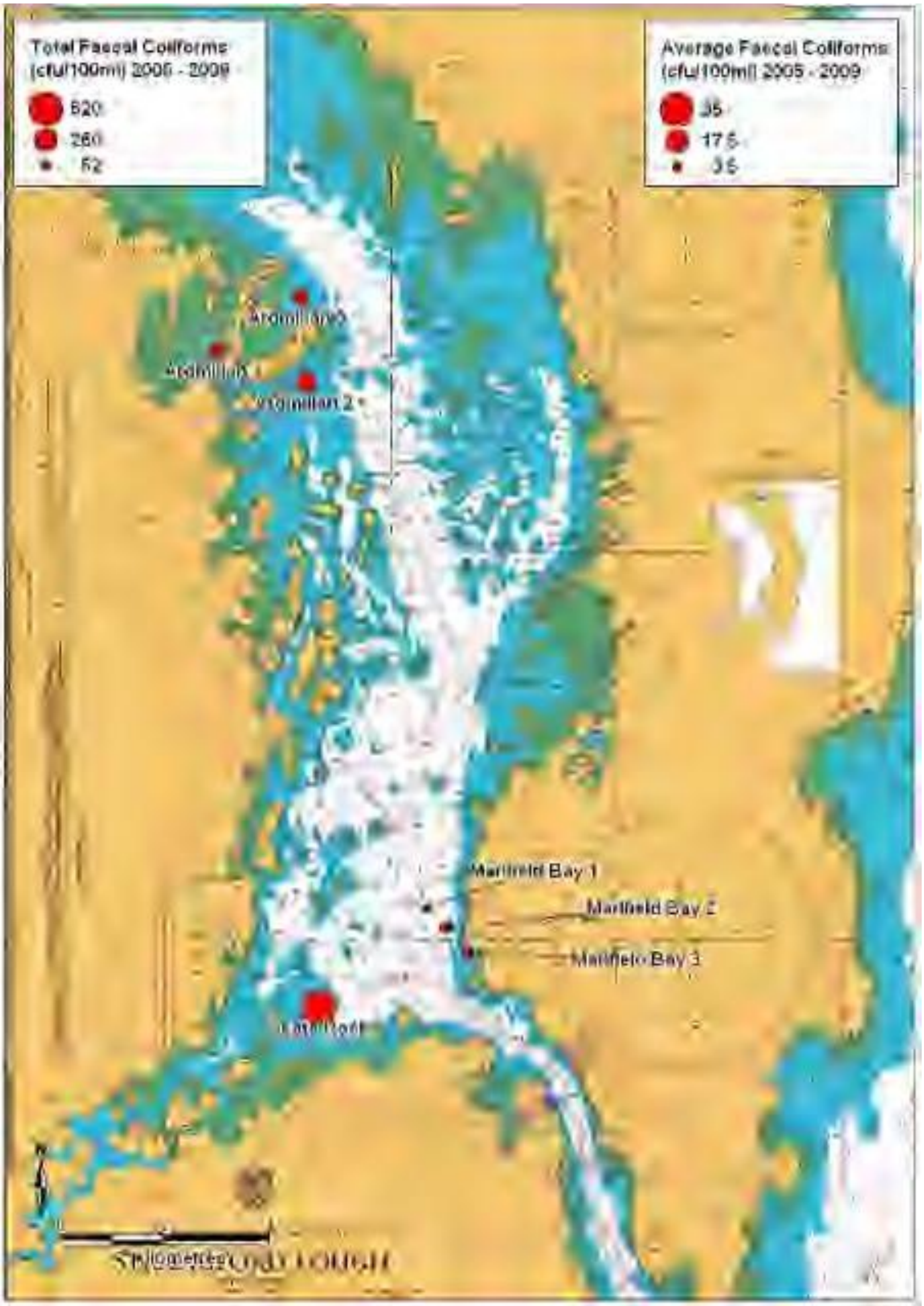


Figure 5.3: Total and average faecal coliform results from 2005 – 2009 (Source: NIEA).

Figure 5.4: Averaged

and totalled seasonal faecal coliform results from 2005 to 2009.

5.1.2. Shellfish Flesh Quality

In accordance with Annex II of the EU Hygiene Regulation 854/2004, the Food Standards Agency in Northern Ireland (FSA in NI) is required to establish the location and fix the boundaries of shellfish harvesting areas in Northern Ireland. The process involves regular sampling of shellfish from each area to be classified in order to establish levels of microbiological contamination which subsequently determines which classification should be awarded for that particular area.

According to the sample results, the classification of the area will be 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. Strangford Lough has historically always been classified as a mixture of A and B harvesting areas. Table 5.3 summarises this system. Table 5.4 shows the current and historical (back to 2003) classifications within Strangford Lough.

Table 5.3: Classification system for shellfish harvesting areas.

Classification			Permitted Levels	Outcome
	A	<230	Less than 230 *E. coli*100g flesh	May go direct for human consumption if end product standard met.
	B	<4600	Less than 4,600 *E. coli*100g flesh	Must be subject to purification, relaying in Class A area (to meet Category A requirements) or cooked by an approved method.
	C	<46000	Less than 46,000 *E.coli*100g flesh	Must be subject to relaying for a period of at least 2 months or cooked by an approved method.
	Above 46,000 *E.coli*/100g flesh			Prohibited. Harvesting not permitted

The Regulations stipulate that the competent authority must periodically monitor the levels of E.*coli* within harvesting areas once they have been classified. FSA in NI currently sample shellfish flesh from the Dorn, Marlfield Bay, Reagh Bay and Skate Rock harvesting areas. Figure 5.5 shows the locations of all monitoring sites.

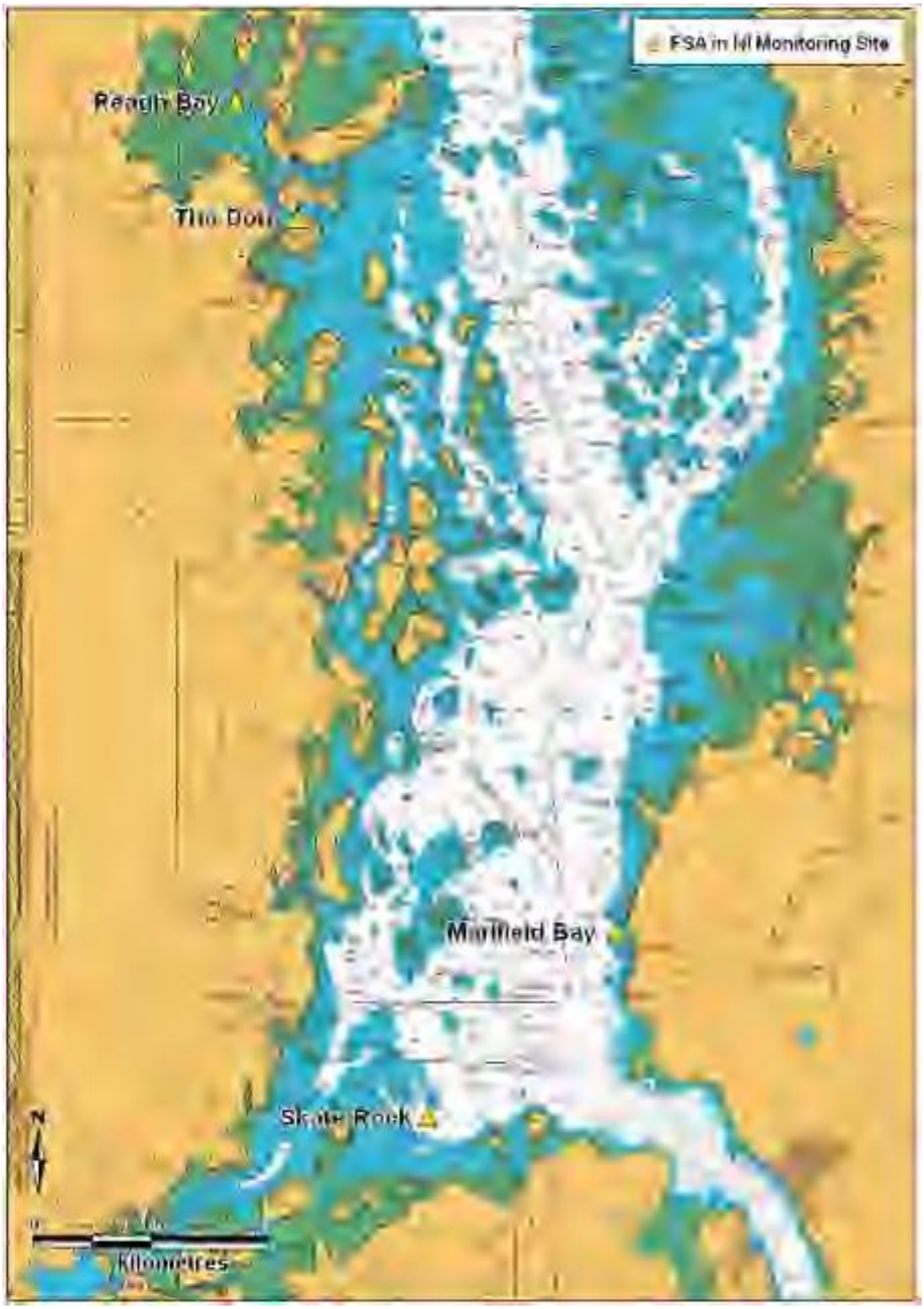


Figure 5.5: **Locations of FSA in NI shellfish monitoring points for classification purposes.**

Table 5.4: Current and historical classification of shellfish beds in Strangford Lough (2003 – 2011).

Bed Name	Species	Classification								
		2003	2004	2005	2006	2007	2008	2009	2010	2011
The Dorn	Oysters	A provisional	A provisional	A	A	A	A	A	A provisional	A
Marlfield Bay	Scallops	A	B	A	A	B	B	B	B	B
Reagh Bay	Oysters	A	A	A	A	A	A	A	A	A
Skate Rock	Mussels	B	A	A	A	A	A	B	A	B
Paddy's Point	Oysters	A	B	A	A	A	A	A	-	-
	Cockles		A provisional	A provisional	A provisional	A provisional	-	-	-	-
Ardmillan Bay	Cockles	A provisional	A	A provisional	A provisional	A provisional	-	-	-	-
Castle Espie	Cockles	B provisional	B	B	B	B provisional	-	-	-	-

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.

In addition to *E. coli* monitoring, FSA in NI conducts monitoring for the presence of toxin producing phytoplankton in shellfish waters, including *Alexandrium spp* and *Dinophysis spp.* and for marine biotoxins (including DSP, PSP and ASP) in shellfish flesh. Shellfish flesh is also monitored for chemical contaminants (e.g. metals, PAH's and dioxins).

Tables 5.5 to 5.8 list the *E. coli* results for mussels, oysters and scallops from The Dorn, Marlfield Bay, Reagh Bay and Skate Rock from 2005 to 2010. ND in these tables means that *E. coli* levels were Not Detectable. Figures 5.6 to 5.9 show these data in graphical form.

As seen in Table 5.4 above The Dorn has always had an **A** classification, although in 2003, 2004 and 2010 it was **A provisional**. Since 2005, the Dorn oyster harvesting bed had an **A** result 93% of the time and a **B** result 7% of the time (See Figure 5.6). *E. coli* counts ranged from 310 to 2400 MPN/100g during these **B** result periods. The most recent data from The Dorn (June 2011) gave an **A** result. The Dorn is classified as **A** for 2011.

Reagh Bay has had an **A** classification since 2003. There was one instance of a **C** result for the Reagh Bay oyster harvesting bed which occurred in May 2005 (9,100 MPN/100g). There was 1 instance of a B result and it occurred in April 2005 (2,200 MPN/100g). Since 2005, the Reagh Bay oyster harvesting bed had an **A** result 97.5% of the time, a **B** result 1.25% of the time and a **C** result 1.25% of the time (See Figure 5.7). The most recent data from Reagh Bay (June 2011) gave an **A** result. Reagh Bay is classified as **A** for 2011.

Skate Rock had a **B** classification in 2003 and 2009 and an **A** classification from 2004 to 2008 and in 2010. Since 2005, the Skate Rock mussel harvesting bed had an **A** result 92.2% of the time and a **B** result 7.8% of the time (See Figure 5.8). *E. coli* counts during these **B** periods ranging from 310-1,300 MPN/100g The most recent data from Skate Rock (June 2011) gave an **A** result. Skate Rock is classified as **B** for 2011.

Marlfield Bay had an **A** classification in 2003, 2005 and 2006 and a **B** classification in 2004 and from 2007. Since 2005, the Marlfield Bay scallop harvesting bed had an **A** result 85.5% of the time and a **B** result 14.5% of the time (See Figure 5.9). *E. coli* counts during these B periods ranging from 310-1,300 MPN/100g. The most recent data from Marlfield Bay (June 2011) was an **A** result. Marlfield Bay is classified as **B** for 2011.

Table 5.5: ***E. coli*** **results from oysters from The Dorn from 2005 to June 2011 (Source: FSA in NI).**

Date	E.coli (MPN/100g)	Category	Date	E.coli (MPN/100g)	Category
11-Jan-11	<20	A	05-Nov-08	<20	A
02-Feb-11	20	A	03-Dec-08	<20	A
08-Mar-11	20	A	09-Jan-07	<20	A
06-Apr-11	50	A	06-Feb-07	ND	A
10-May-11	80	A	06-Mar-07	<20	A
08-Jun-11	80	A	02-Apr-07	ND	A
12-Jan-10	<20	A	06-Jun-07	40	A
10-Feb-10	50	A	04-Jul-07	<20	A
09-Mar-10	<20	A	14-Aug-07	110	A
14-Apr-10	20	A	10-Sep-07	<20	A
12-May-10	<20	A	03-Oct-07	<20	A
09-Jun-10	<20	A	14-Nov-07	20	A
07-Jul-10	<20	A	04-Dec-07	<20	A
05-Aug-10	<20	A	25-Jan-06	40	A
15-Sep-10	<20	A	22-Feb-06	ND	A
14-Oct-10	<20	A	21-Mar-06	20	A
11-Nov-10	50	A	12-Apr-06	ND	A
07-Jan-09	<20	A	09-May-06	220	A
04-Feb-09	<20	A	13-Jun-06	70	A
04-Mar-09	<20	A	18-Jul-06	ND	A
08-Apr-09	<20	A	08-Aug-06	40	A
05-May-09	40	A	19-Sep-06	40	A
03-Jun-09	<20	A	18-Oct-06	<20	A
04-Aug-09	40	A	29-Nov-06	ND	A
02-Sep-09	2200	B	12-Dec-06	<20	A
07-Oct-09	<20	A	26-Jan-05	20	A
04-Nov-09	2400	B	23-Feb-05	20	A
02-Dec-09	<20	A	09-Mar-05	<20	A
09-Jan-08	40	A	18-Apr-05	750	B
06-Feb-08	70	A	04-May-05	220	A
05-Mar-08	<20	A	28-Jun-05	110	A
08-Apr-08	20	A	19-Jul-05	70	A
07-May-08	40	A	16-Aug-05	310	B
11-Jun-08	1700	B	07-Sep-05	70	A
08-Jul-08	200	A	11-Oct-05	130	A
06-Aug-08	200	A	29-Nov-05	40	A
09-Sep-08	<20	A	13-Dec-05	70	A
07-Oct-08	40	A			

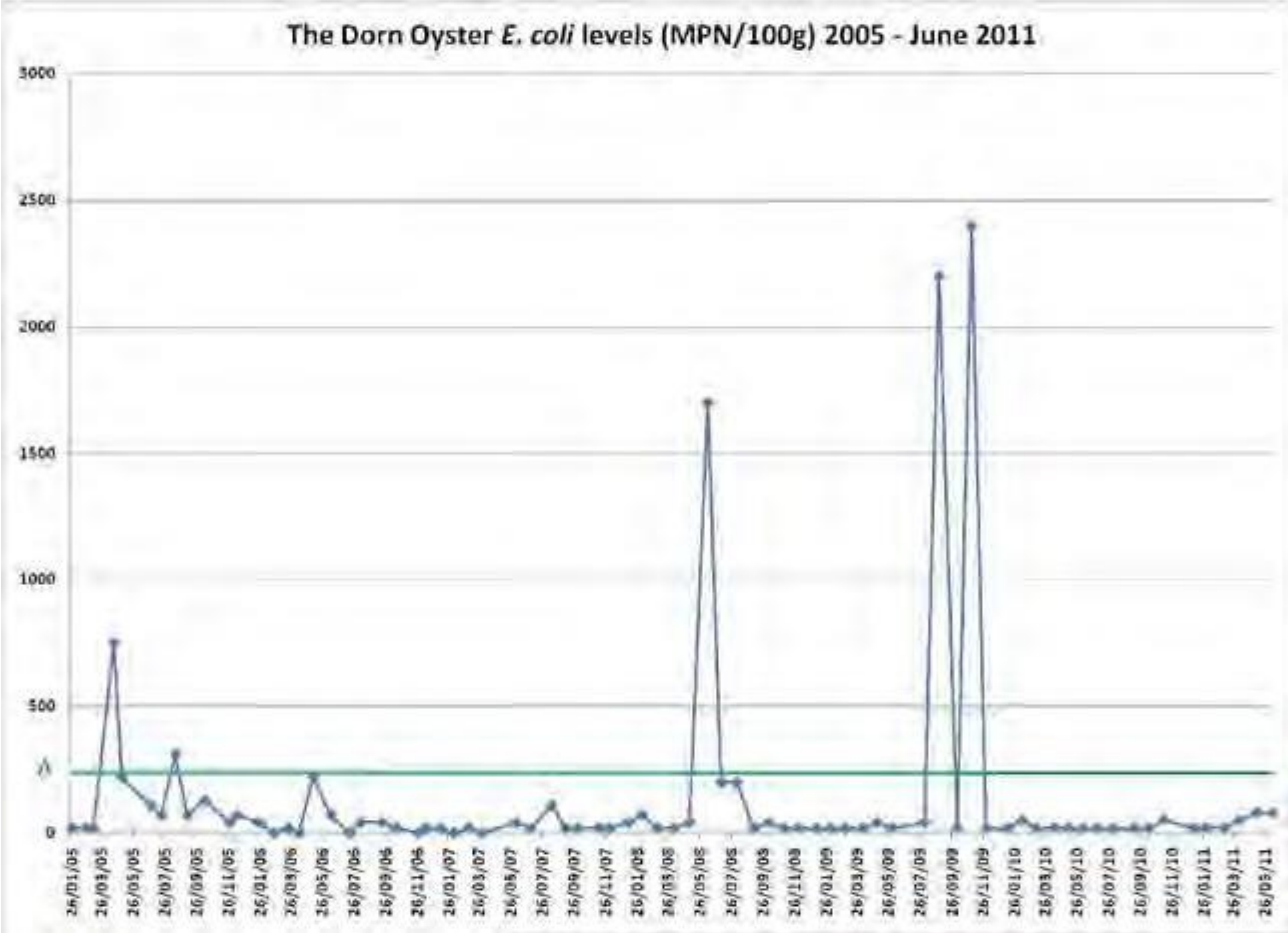


Figure 5.6: ***E.*** **coli results from oysters at The Dorn from 2005-June 2011 (Source: FSA in NI).**

Table 5.6: *E. coli* results from oysters from Reagh Bay from 2005 to June 2011 (Source: FSA in NI).

Date	E.coli (MPN/100g)	Category	Date	E.coli (MPN/100g)	Category
26-Jan-11	<20	A	16-Dec-08	<20	A
16-Feb-11	<20	A	09-Jan-07	20	A
24-Mar-11	<20	A	06-Feb-07	50	A
20-Apr-11	20	A	06-Mar-07	70	A
24-May-11	<20	A	02-Apr-07	20	A
21-Jun-11	50	A	17-Apr-07	ND	A
26-Jan-10	80	A	23-May-07	<20	A
24-Feb-10	<20	A	20-Jun-07	40	A
24-Mar-10	20	A	18-Jul-07	20	A
27-Apr-10	<20	A	29-Aug-07	40	A
25-May-10	<20	A	19-Sep-07	<20	A
29-Jun-10	110	A	16-Oct-07	<20	A
20-Jul-10	<20	A	28-Nov-07	<20	A
23-Aug-10	20	A	19-Dec-07	<20	A
27-Sep-10	<20	A	25-Jan-06	20	A
25-Oct-10	<20	A	22-Feb-06	ND	A
23-Nov-10	<20	A	21-Mar-06	ND	A
21-Jan-09	<20	A	12-Apr-06	ND	A
18-Feb-09	<20	A	09-May-06	220	A
18-Mar-09	<20	A	13-Jun-06	20	A
21-Apr-09	<20	A	18-Jul-06	ND	A
19-May-09	<20	A	08-Aug-06	ND	A
16-Jun-09	<20	A	19-Sep-06	<20	A
27-Jul-09	40	A	18-Oct-06	<20	A
18-Aug-09	20	A	29-Nov-06	ND	A
15-Sep-09	40	A	12-Dec-06	160	A
10-Oct-09	40	A	26-Jan-05	70	A
17-Nov-09	40	A	23-Feb-05	220	A
17-Dec-09	<20	A	09-Mar-05	110	A
22-Jan-08	<20	A	18-Apr-05	2200	B
19-Feb-08	<20	A	03-May-05	9100	C
19-Mar-08	20	A	17-May-05	40	A
23-Apr-08	<20	A	28-Jun-05	90	A
20-May-08	<20	A	28-Jul-05	ND	A
24-Jun-08	<20	A	15-Aug-05	<20	A
8-Jul-08	70	A	07-Sep-05	ND	A
18-Aug-08	70	A	11-Oct-05	70	A
23-Sep-08	<20	A	29-Nov-05	40	A
20-Oct-08	<20	A	13-Dec-05	220	A
18-Nov-08	<20	A			

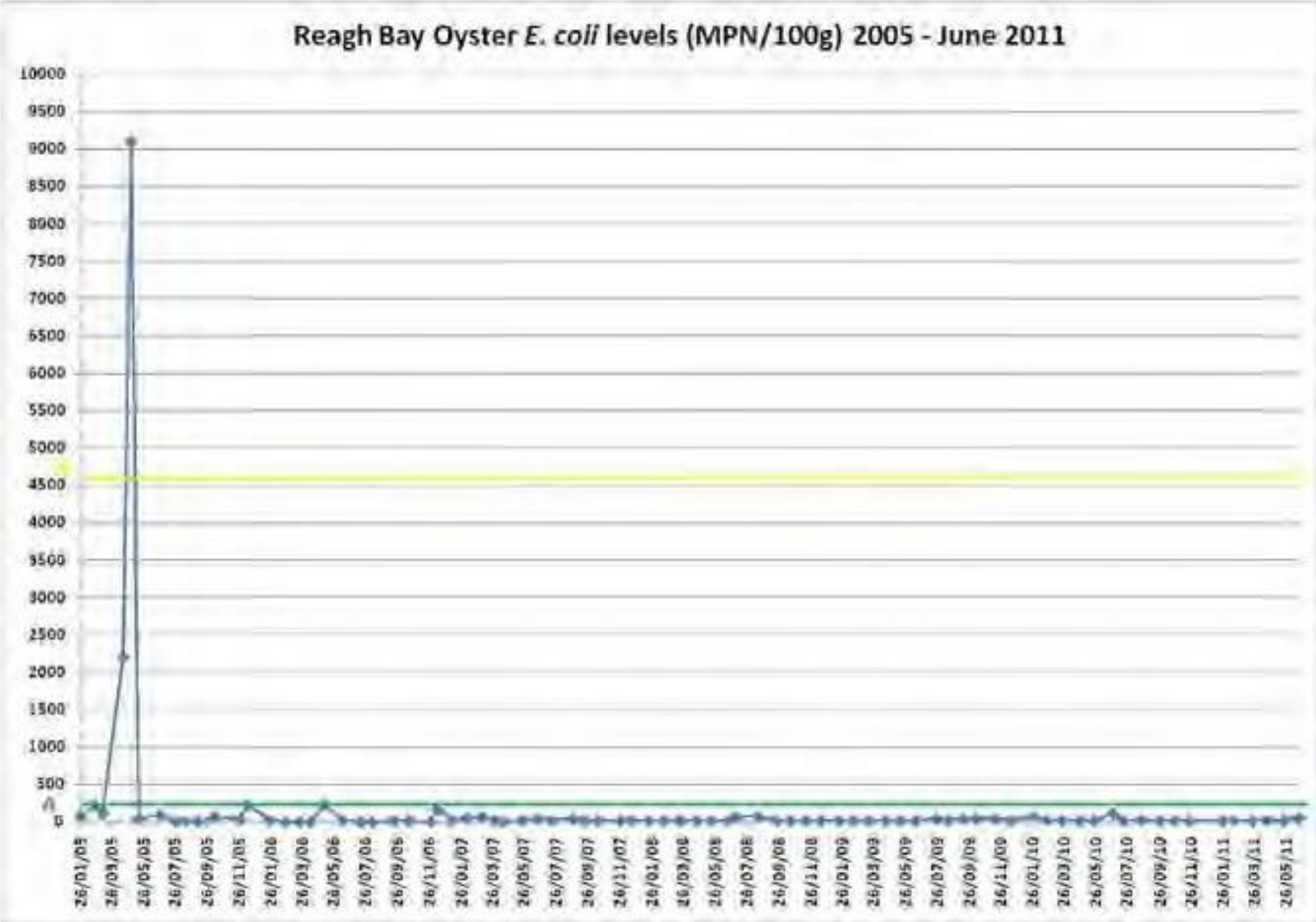


Figure 5.7: *E. coli* levels from oysters at Reagh Bay from 2005 to June 2011 (Source: FSA in NI).

Table 5.7: *E. coli* results from mussels from Skate Rock from 2005 to June 2011 (Source: FSA in NI)

Date	E.coli (MPN/100g)	Category	Date	E.coli (MPN/100g)	Category
10-Jan-11	<20	A	06-Oct-08	20	A
01-Feb-11	20	A	04-Nov-08	<20	A
07-Mar-11	<20	A	02-Dec-08	70	A
5-Apr-11	<20	A	08-Jan-07	40	A
9-May11	50	A	05-Feb-07	ND	A
14-Jun-11	<20	A	05-Mar-07	40	A
11-Jan-10	<20	A	02-Apr-07	20	A
08-Feb-10	20	A	05-Jun-07	40	A
08-Mar-10	<20	A	03-Jul-07	750	B
13-Apr-10	<20	A	13-Aug-07	40	A
11-May-10	<20	A	18-Sep-07	310	B
08-Jun-10	<20	A	15-Oct-07	<20	A
06-Jul-10	330	B	03-Dec-07	<20	A
03-Aug-10	460	B	23-Jan-06	110	A
21-Sep-10	20	A	20-Feb-06	20	A
12-Oct-10	<20	A	21-Mar-06	20	A
09-Nov-10	80	A	10-Apr-06	50	A
06-Jan-09	<20	A	08-May-06	70	A
17-Feb-09	200	A	12-Jun-06	20	A
03-Mar-09	<20	A	17-Jul-06	20	A
07-Apr-09	<20	A	07-Aug-06	20	A
05-May-09	<20	A	04-Sep-06	ND	A
02-Jun-09	40	A	16-Oct-06	20	A
06-Jul-09	70	A	27-Nov-06	20	A
07-Jul-09	<20	A	11-Dec-06	40	A
02-Aug-09	<20	A	25-Jan-05	50	A
01-Sep-09	70	A	27-Jan-05	70	A
06-Oct-09	220	A	21-Feb-05	20	A
03-Nov-09	220	A	07-Mar-05	20	A
30-Nov-09	<20	A	21-Apr-05	110	A
08-Jan-08	110	A	03-May-05	110	A
05-Feb-08	40	A	29-Jun-05	ND	A
03-Mar-08	<20	A	18-Jul-05	50	A
07-Apr-08	<20	A	15-Aug-05	40	A
07-May-08	<20	A	08-Sep-05	ND	A
09-Jun-08	20	A	12-Oct-05	50	A
21-Jul-08	20	A	28-Nov-05	70	A
05-Aug-08	1300	B	14-Dec-05	70	A
08-Sep-08	1300	B			

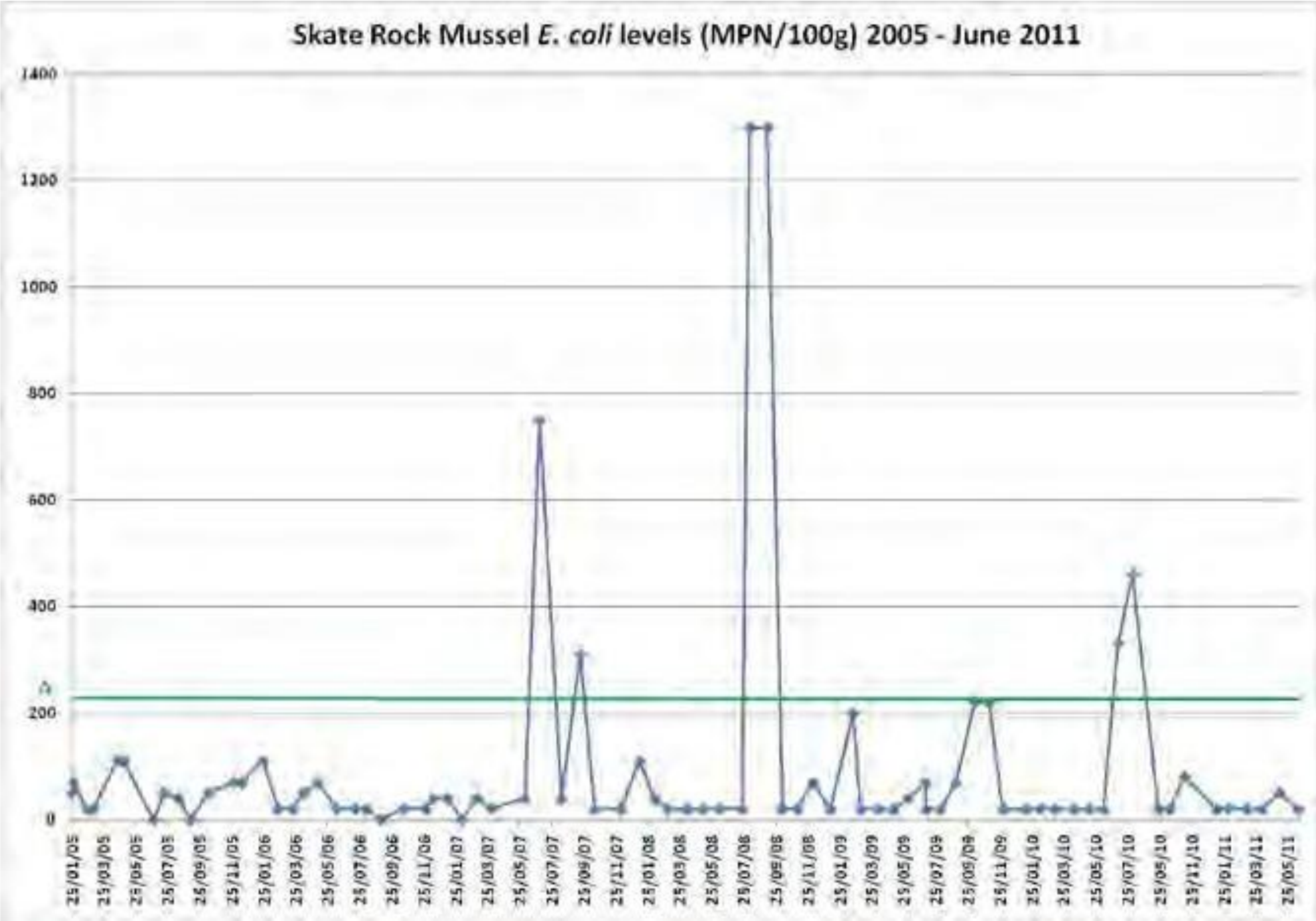


Figure 5.8: ***E. coli*** **levels in Skate Rock mussels from 2005 to June 2011 (Source: FSA in NI).**

Table 5.8: *E. coli* results from scallops from Marlfield Bay site from 2005 to June 2011 (Source: FSA in NI).

Date	E.coli (MPN/100g)	Category	Date	E.coli (MPN/100g)	Category
10-Jan-11	<20	A	06-Oct-08	<20	A
01-Feb-11	<20	A	04-Nov-08	40	A
07-Mar-11	20	A	02-Dec-08	20	A
5-Apr-11	<20	A	08-Jan-07	310	B
10-May-11	<20	A	05-Feb-07	ND	A
14-Jun-11	<20	A	02-Apr-07	500	B
11-Jan-10	<20	A	05-Jun-07	40	A
08-Feb-10	<20	A	03-Jul-07	20	A
08-Mar-10	<20	A	28-Aug-07	220	A
13-Apr-10	200	A	18-Sep-07	310	B
11-May-10	<20	A	15-Oct-07	20	A
08-Jun-10	<20	A	25-Jan-06	500	B
06-Jul-10	230	A	22-Feb-06	320	B
03-Aug-10	350	B	21-Mar-06	ND	A
07-Sep-10	130	A	10-Apr-06	220	A
12-Oct-10	<20	A	08-May-06	ND	A
09-Nov-10	40	A	12-Jun-06	40	A
06-Jan-09	160	A	17-Jul-06	110	A
17-Feb-09	70	A	07-Aug-06	310	A
03-Mar-09	<20	A	04-Sep-06	70	A
07-Apr-09	20	A	16-Oct-06	110	A
05-May-09	<20	A	27-Nov-06	140	A
02-Jun-09	20	A	27-Jan-05	20	A
06-Jul-09	20	A	21-Feb-05	20	A
03-Aug-09	20	A	07-Mar-05	40	A
01-Sep-09	700	B	21-Apr-05	500	B
06-Oct-09	500	B	03-May-05	50	A
03-Nov-09	200	A	29-Jun-05	110	A
30-Nov-09	20	A	18-Jul-05	130	A
01-Apr-08	110	A	15-Aug-05	70	A
21-May-08	20	A	08-Sep-05	40	A
09-Jun-08	20	A	12-Oct-05	90	A
21-Jul-08	20	A	28-Nov-05	20	A
05-Aug-08	1300	B	14-Dec-05	40	A
08-Sep-08	110	A			

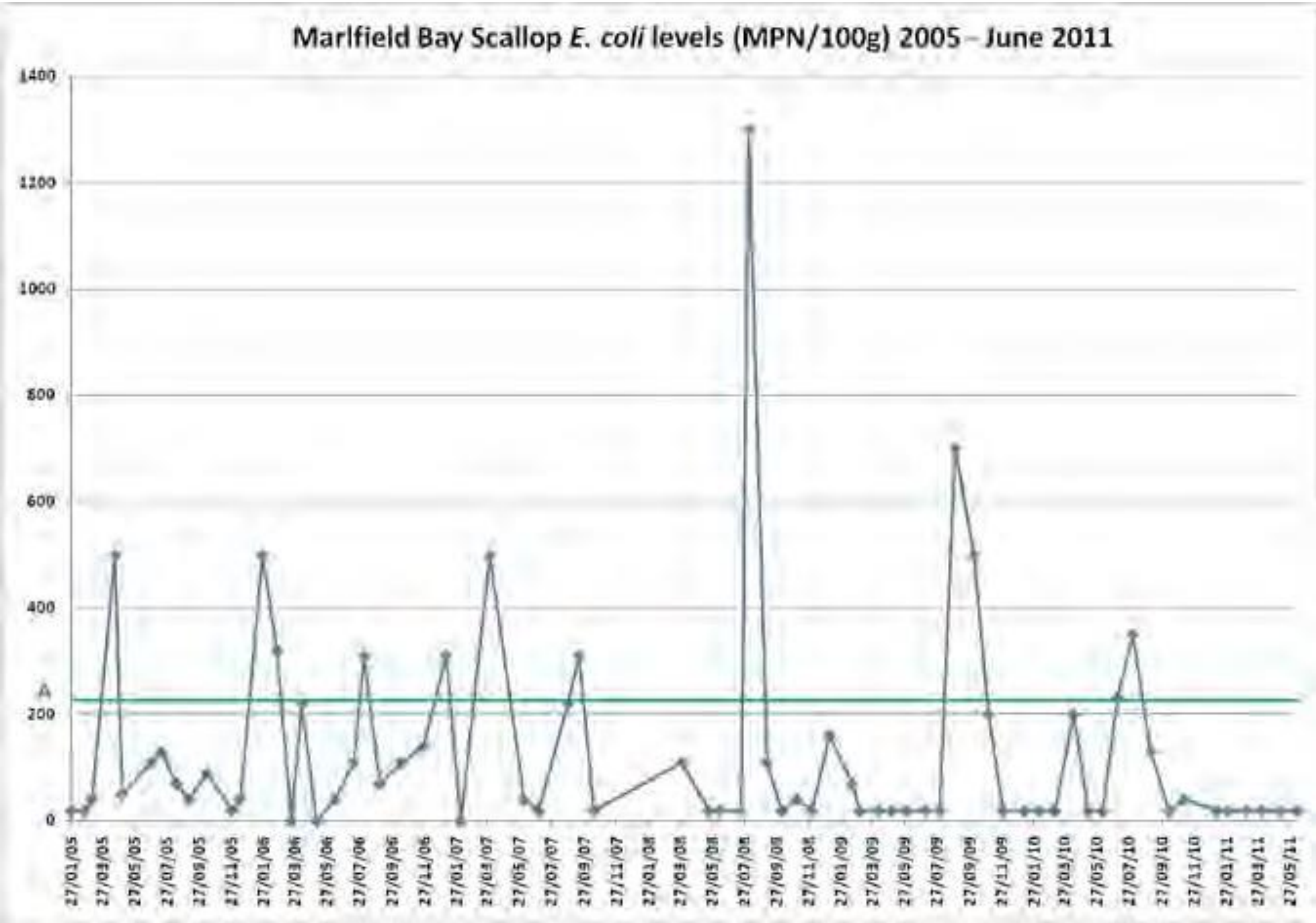


Figure 5.9: ***E. coli*** **levels in scallops from Marlfield Bay from 2005 – June 2011 (Source: FSA in NI).**

Table 5.9 shows the summary statistics for the *E. coli* historical data (2005 to 2010) from the 4 shellfish beds classified for 2011.

The geometric mean of *E. coli* levels was highest for scallops at Marlfield Bay (41.38 MPN/100g), followed by mussels at Skate Rock (27.06 MPN/100g) and oysters at The Dorn (21.84 MPN/100g). The lowest geometric mean was for oysters at Reagh Bay (13.65 MPN/100g).

Table 5.9: Summary statistics of historical *E. coli* data monitored from shellfish beds in Strangford Lough.

Site	Species	Date 1st Sample	Date last Sample	Min *E. coli* (MPN/100g)	Ma *E. coli* (MPN/100g)	Median *E. coli* (MPN/100g)	Geometric Mean *E. coli* (MPN/100g)
The Dorn	**Oysters**	26/01/2005	08/06/2011	ND	2400	20	21.84
Reagh Bay	**Oysters**	26/01/2005	21/06/2011	ND	9100	19	13.65
Skate Rock	**Mussels**	25/01/2005	14/06/2011	ND	1300	20	27.06
Marlfield Bay	**Scallops**	27/01/2005	14/06/2011	ND	1300	40	41.38

ND =Not Detectable

Table 5.10 shows the variations of the annual geometric means of *E. coli* for the shellfish beds monitored in Strangford Lough. Figure 5.10 shows the trend in geometric mean from 2005 to June 2011 for all 4 shellfish beds. It can be clearly seen that the geometric mean was highest in oysters from The Dorn in 2005 (80.7 MPN/100g) and the lowest was 0.6 MPN/100g from oysters in Reagh Bay in 2006. For all beds since 2005, the geometric mean was below 81 MPN/100g for oysters, below 54 MPN/100g for mussels and below 57 MPN/100g for scallops.

Table 5.10: Variation of annual geometric means of *E. coli* from shellfish beds monitored in Strangford Lough.

Site	Species	2005	2006	2007	2008	2009	2010	2011
The Dorn	Oysters	80.7	2.50	6.10	55.20	52.00	22.80	36.67
Reagh Bay	Oysters	35.5	0.60	14.40	23.70	24.50	25.60	22.52
Skate Rock	Mussels	14.1	51.50	23.10	53.40	43.00	37.90	22.52
Marlfield Bay	Scallops	56.9	26.80	33.80	49.90	55.80	49.00	19.33

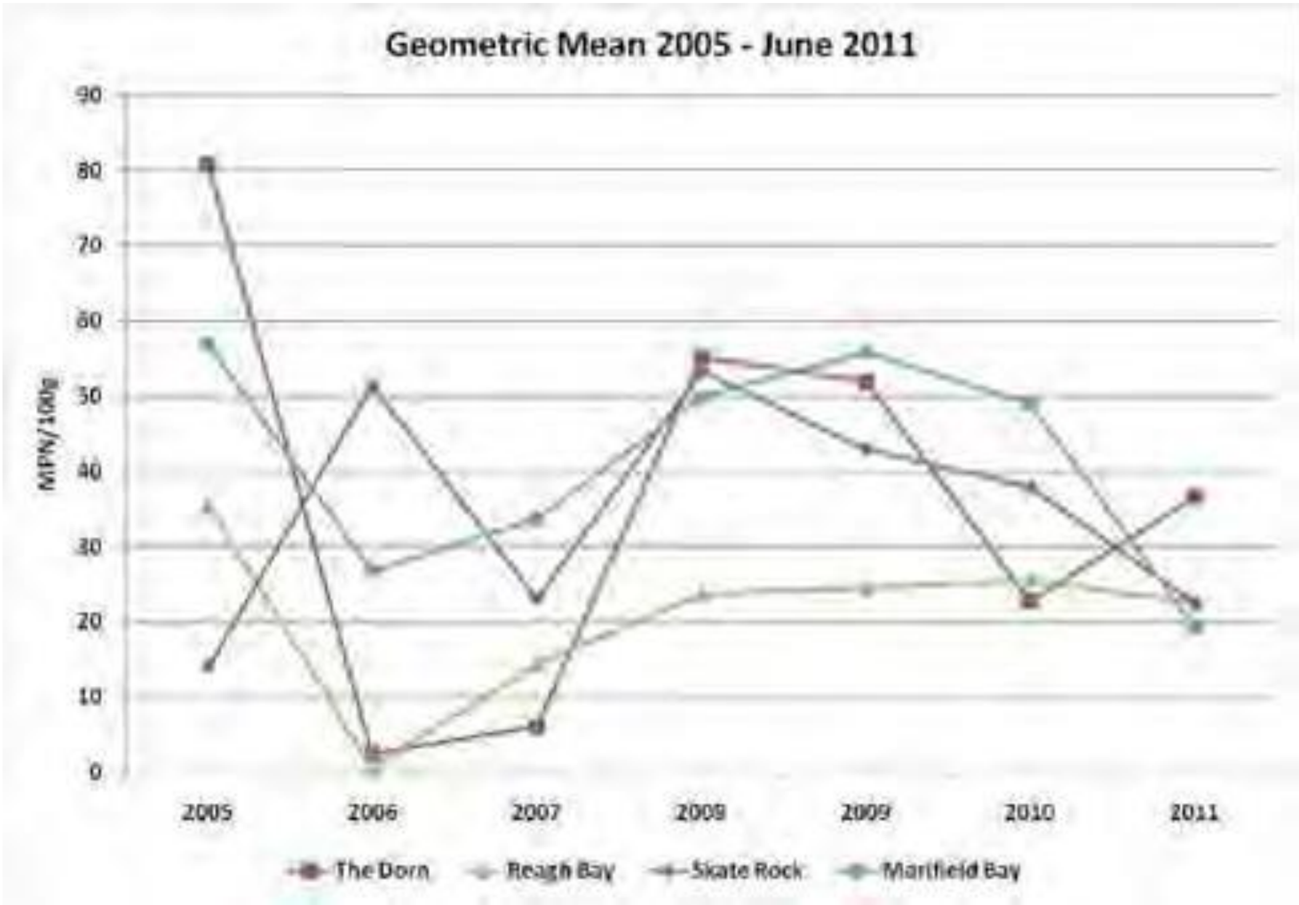


Figure 5.10: Trend in geometric mean of *E. coli* levels from 2005 to June 2011 for all 4 beds.

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 (4 classified) harvesting beds. For this analysis, all shellfish flesh results that returned a less than value (i.e. <X) were given a value of X-1 (e.g. <20 becomes 19) and all samples that returned a ND (Not Detectable) result were given a value of 0.01. All beds had ≥6 results per year and all were included in this analysis. This analysis revealed that there was a significant difference between the the Marlfield bed and the other 3 beds in 2006 and between the Marlfield bed and the Reagh and Dorn beds in 2007. A one-way ANOVA was also carried out on the seasonal differences within each harvesting bed. All seasons had ≥12 results and all were included in the analysis, which revealed that there was no significant seasonal difference within each harvesting bed.

A one-way ANOVA was also carried out on the seasonal *E. coli* counts between each harvesting location. All beds had ≥12 results per season and all beds were included in this analysis. This analysis revealed that in autumn, there were significant differences between the Marlfield Bay scallop bed and the Reagh Bay oyster bed and in winter there were significant differences between The Dorn oyster bed and the Marlfield scallop bed. Refer to Section 4.1.2 'Tourism' for further details on the seasonal data.

5.2. Current Data

5.2.1. Sampling Sites & Methodology

Ten shellfish sampling points and 30 water sampling points were sampled within Strangford Lough on the 19th April 2011. The weather on the sampling days was fine, sunny and dry with approximately 1/8th cloud cover. The predicted high water level on the 19th April was at 13:30pm at Strangford (3.8m) and predicted low water on the 19th was at 19:45pm at Strangford (0.2m).

The weather conditions for the 2 week period preceding the sampling were mostly dry with light rain on occasion (0-25mm on average) and average temperature ranged from 10-12°C (Met Office, 2011c).

The ten shellfish sampling points were initially made up of 3 mussel sites (M1 to M3), 3 scallop sites (S1 to S3) and 4 oyster sites (O1 to O4). However, mussels not oysters were retrieved at one of the oyster sites as no oysters could be found (O2) and scallops could not be found at 2 of the scallop sites (S1 and S2) and no shellfish at all could be found at one of the oyster sites (O4). Therefore in total, 7 shellfish samples were collected and sent for analysis (2 oysters, 1 scallop and 4 mussels). All sampling took place on the ebbing tide and began approximately 1hr 20min after high water and finished 2hr 20min before low water.

Of the 30 water samples collected, 5 were taken from river/stream outflows, 3 were taken from discharge pipes and the remainder were taken from throughout the lough. All water samples were collected on the same day (19/04/2011) in approximately 2 hours either side of high water. Sampling began at Station W1 and ended at Station D141. Figure 5.11 shows the shellfish sampling sites and Figure 5.12 shows the water sampling sites. The coordinates of these stations can be seen in Tables 5.11 and 5.12.

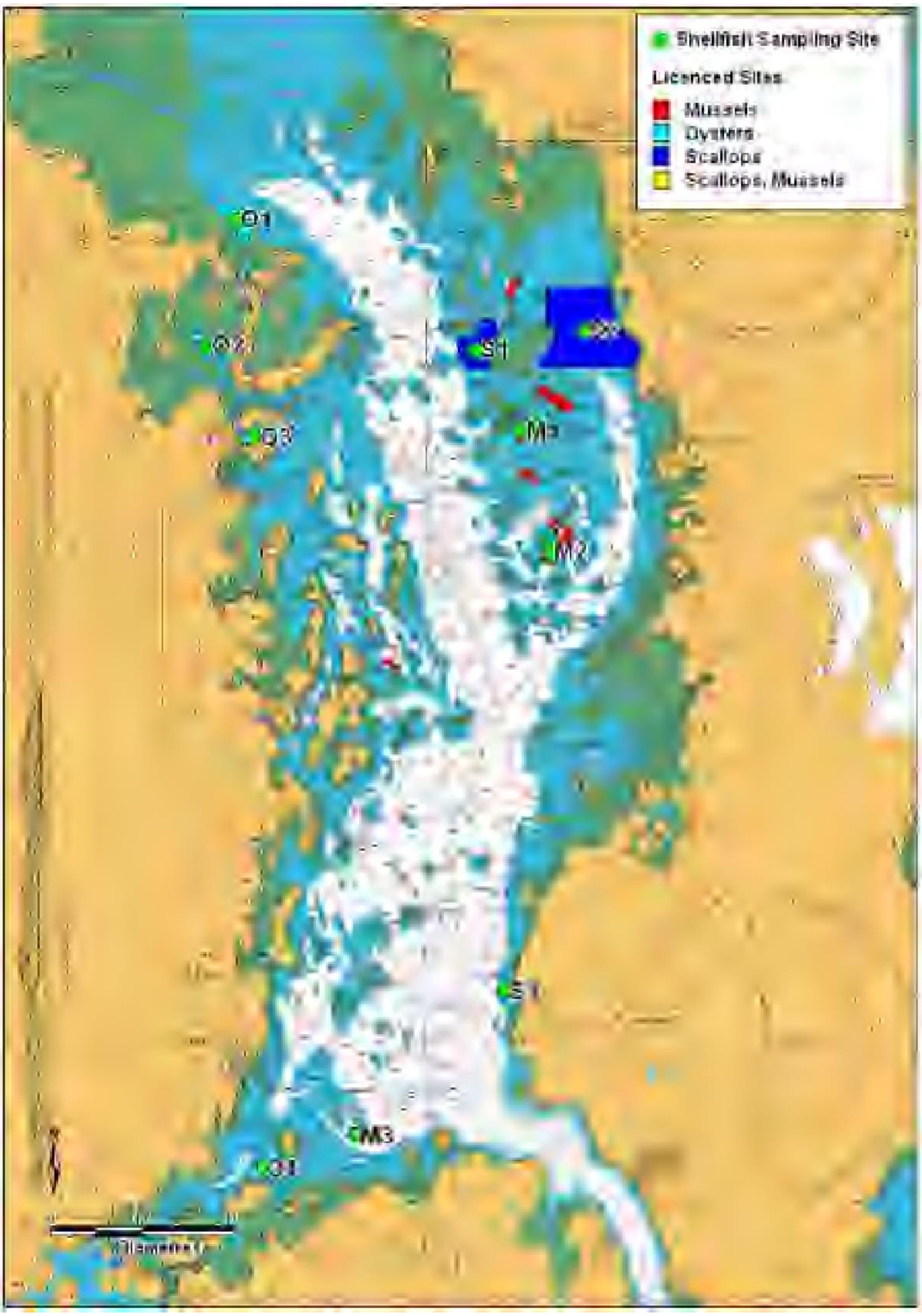


Figure 5.11: Location of all shellfish sites sampled in Strangford Lough on 19th April 2011.

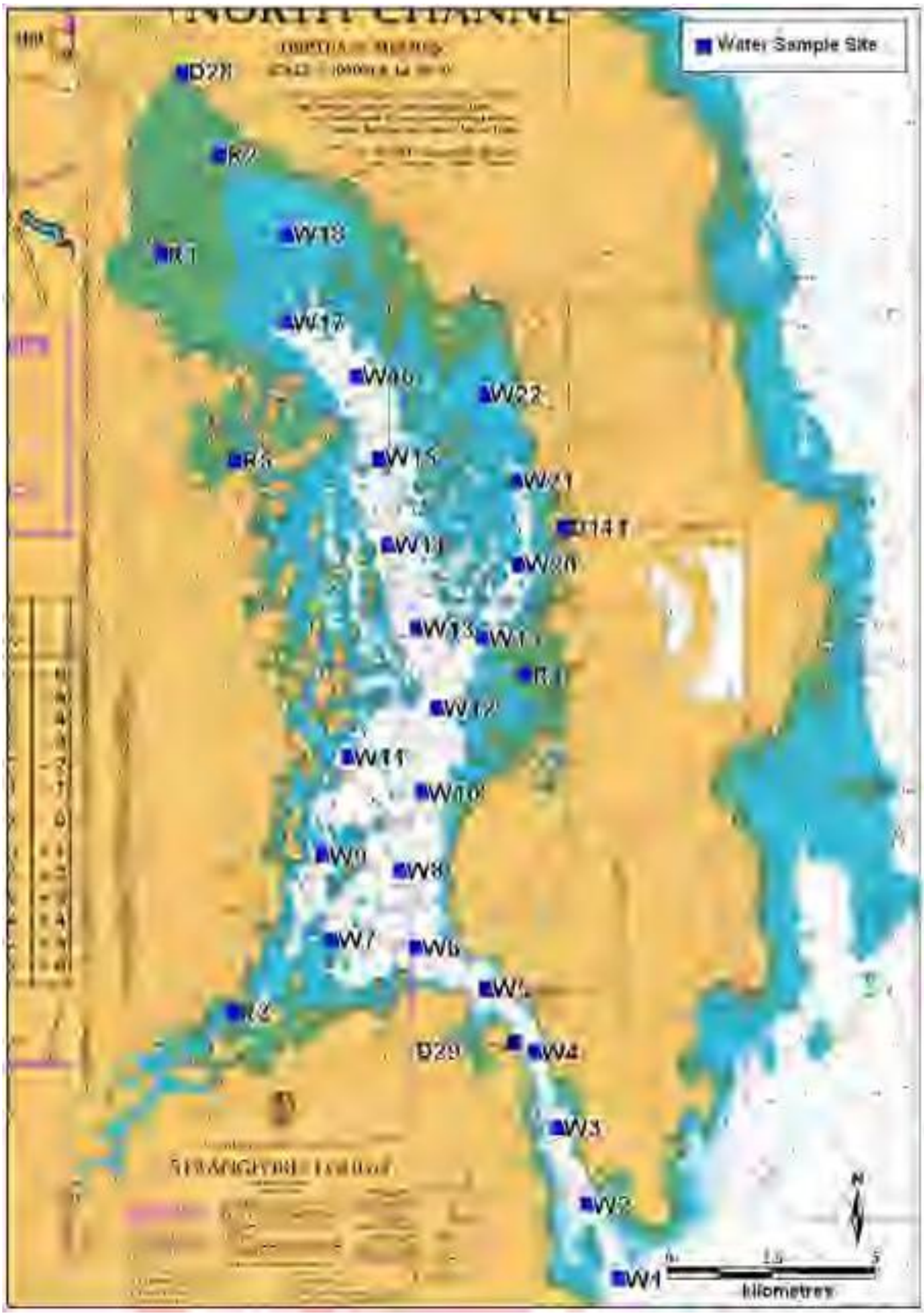


Figure 5.12: Location of all water sites sampled in Strangford Lough on 19th April 2011.

Table 5.11: Shellfish sample coordinates.

Station	Longitude	Latitude	Easting	Northing
O1	-5.64954	54.522	352242	366277.4
O2	-5.6567	54.5035	351846.6	364203.8
O3	-5.64431	54.4901	352698.9	362735.3
O4	-5.64227	54.382	353234.2	350712.3
M1	-5.5769	54.491	357063.2	362987.6
M2	-5.56981	54.4729	357591.9	360994.3
M3	-5.61842	54.3868	354765.3	351306
S1	-5.5887	54.5028	356253.3	364276.8
S2	-5.56131	54.5058	358016.1	364668
S3	-5.5813	54.4083	357094.4	353770.5

Table 5.12: Water sample site coordinates

Station	Longitude	Latitude	Easting	Northing
W1	-5.51546	54.3204	361713.1	344145.7
W2	-5.52729	54.3367	360880.1	345933.1
W3	-5.53862	54.3533	360078.7	347754.5
W4	-5.54676	54.3697	359485.6	349561
W5	-5.5652	54.3836	358234.5	351058.6
W6	-5.59128	54.3926	356505.7	352010.8
W7	-5.62244	54.394	354477.2	352093.8
W8	-5.59722	54.4095	356056	353873.7
W9	-5.62619	54.4125	354163.9	354148.7
W10	-5.58894	54.4264	356529	355772.7
W11	-5.61675	54.4341	354695.7	356567.2
W12	-5.58339	54.4448	356819.2	357834.4
W13	-5.59104	54.4622	356256.7	359752.2
W14	-5.60175	54.4804	355493.1	361751
W15	-5.60535	54.4991	355189	363832
W16	-5.6137	54.5172	354579.7	365825.2
W17	-5.63955	54.5288	352863.4	367053
W18	-5.63975	54.5479	352778.6	369181.8
W19	-5.56628	54.4599	357870.8	359555.5
W20	-5.55288	54.476	358676.7	361378.2
W21	-5.5534	54.4942	358572.8	363400.1
W22	-5.56564	54.5131	357707.5	365472.5
R1	-5.68649	54.5434	349771.4	368584.8
R2	-5.6648	54.5652	351093.9	371053.1
R3	-5.65973	54.3784	352113.6	350271.9
R4	-5.55023	54.4521	358941.4	358714
R5	-5.65889	54.4986	351722.8	363657.1
D28	-5.67912	54.5832	350101.9	373024.6

Station	Longitude	Latitude	Easting	Northing
D29	-5.55482	54.3717	358954.3	349764.8
D141	-5.53597	54.4841	359741.7	362308

All mussel samples were hand-picked from islands and rocks as none were found on the suspension ropes. All oysters were hand-picked from tressles and the scallops were also hand-picked. Only individuals within the normal commercial size range (*Ostrea edulis* 60g, *Crassostrea gigas* 40-50g, *Mytilus edulis* 12.5 - 14g, *Pecten maximus* 10cm shell size) were selected. All samples were stored in food grade plastic bags and stored in a cool box (containing freezer packs) and delivered to AQUALAB within 24hrs of collection. All water samples were collected in sterile plastic water bottles. These samples were stored in a cool box until delivery to Northern Ireland Water (within 24hrs of collection). *E. coli* analysis was carried out on both the shellfish and water samples (AQUALAB: ISO 16649-3; NI Water: Colilert method). AQUALAB is an INAB (Irish National Accreditation Board) certified laboratory and Northern Ireland Water is a UKAS (United Kingdom Accreditation Service) certified laboratory.

5.2.2. Microbial Analysis Results

Table 5.13 shows the results of the shellfish *E. coli* analysis (Refer to Appendix 2 for result certificates). Figure 5.13 shows this data in graphical form. All sampled shellfish sites had very low *E. coli* levels (20 MPN/100g or <20 MPN/100g) which is indicative of an A classification. These results closely match the results from the FSA in NI monitoring programme for April 2011.

Table 5.13: Shellfish *E. coli* results for Strangford Lough.

Station	Species	MPN/100g
M1	Mussel	20
M2	Mussel	20
M3	Mussel	20
O1	Oyster	<20
O2	Mussel	<20
O3	Oyster	<20
O4	No Sample	
S1	No Sample	
S2	No Sample	
S3	Scallop	<20

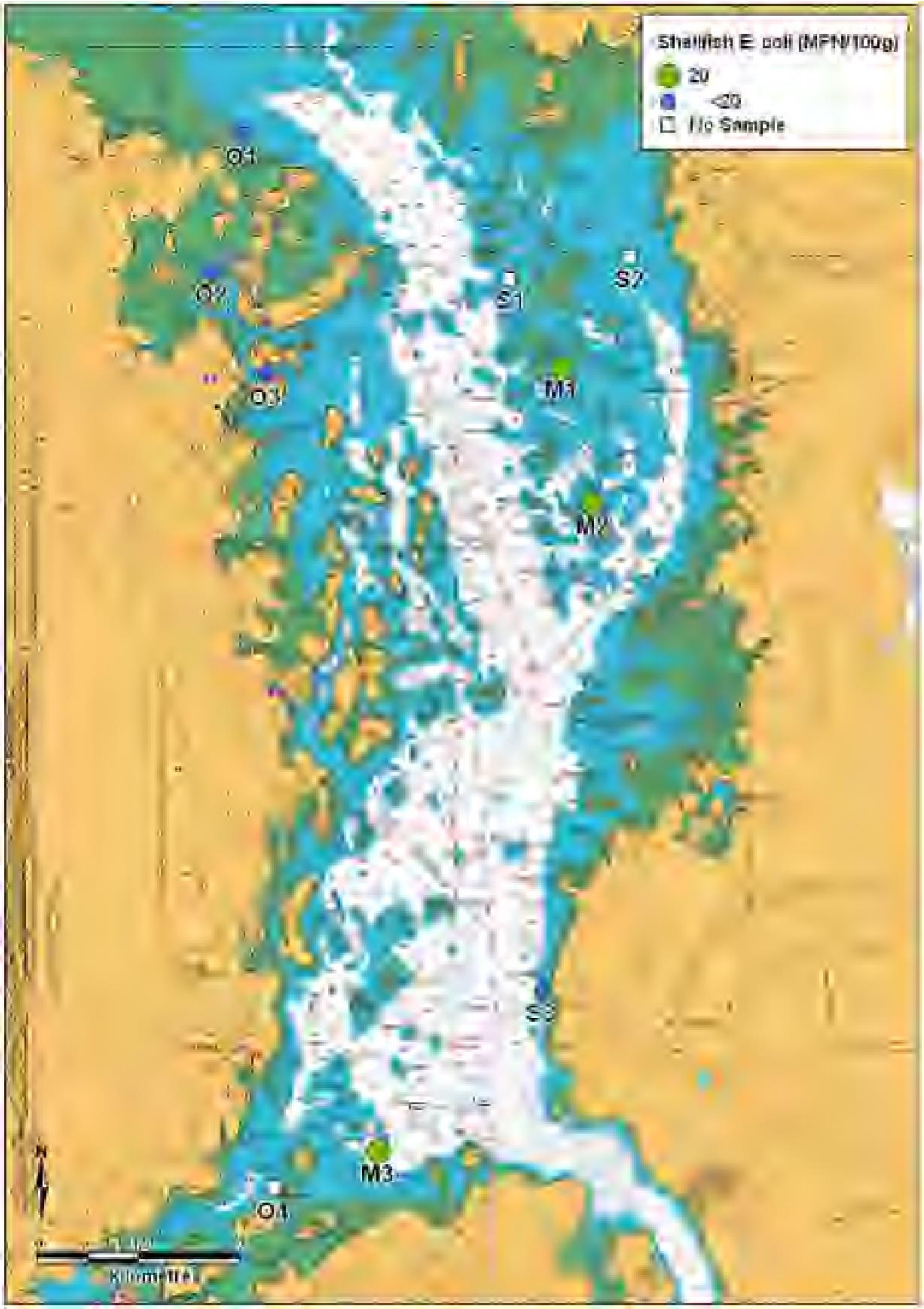


Figure 5.13: Shellfish *E. coli* results from Strangford Lough (sampled on 19th April 2011).

All of the *E. coli* concentrations from all of the water samples analysed returned a 0 MPN concentration. However a number of samples did return Total Coliform concentrations (see Table 5.14). Refer to Appendix 3 for result certificates. Sample R3 (located at the Quoile River) had a total coliform count of 300 MPN and sample D28 (collected in the area of a discharge pipe at Newtownards) had a total coliform count of 200 MPN.

Figure 5.14: E. coli and total coliform results from water samples collected from Strangford Lough on 19th April 2011.

Station	*E. coli* MPN	Total Coliforms MPN
W1	0	0
W2	0	0
W3	0	0
W4	0	0
W5	0	0
W6	0	0
W7	0	0
W8	0	0
W9	0	0
W10	0	0
W11	0	2.0
W12	0	0
W13	0	0
W14	0	0
W15	0	0
W16	0	0
W17	0	0
W18	0	0
W19	0	0
W20	0	0
W21	0	0
W22	0	0
R1	0	0
R2	0	0
R3	0	300
R4	0	2.0
R5	0	2.0
D28	0	200
D29	0	0
D141	0	0

With regards to *E. coli* concentrations, levels were very low throughout the entire lough. This is to be expected given the strong to moderate currents flowing through the lough resulting in flushed well mixed waters.

6. Expert Assessment of the Effect of Contamination on Shellfish

Strangford Lough is located within a predominately rural catchment, with approximately 90% of the land used for agricultural purposes. Newtownards, located in the northern part of the Lough, has the highest human population, followed by Downpatrick, which is located in the southwestern part end of the lough. The remaining surrounds containing smaller towns and villages typical of a rural settlement.

While no tourism data was available for the immediate area, it is safe to say that the local population does increase due to tourists mainly in the summer months. The information collated and assessed during the production of this report reveal a total of 41 continuous discharges flowing into the Lough or a tributary of the lough. Of these, the Ballyrickard WWTW (located in the northwestern region of the Lough) has the highest discharge volume. In addition, 85 intermittent discharges were identified in the field flowing into the Lough along with rainfall dependent discharges, emergency discharges and industrial discharges. There are also various other non-point sources associated with agricultural land use, tourism and wildfowl.

Sewage has been known to lead to deterioration of water quality, alter floral and faunal assemblages near large outfalls and has been responsible for disease outbreaks attributed to faecal coliforms (Clarke, 2001). Faecal coliforms entering the marine environment from industrial discharges, wastewater and sewage discharges, contaminated freshwater input, agricultural run-off, wild fowl and shipping discharges can accumulate in bivalves that filter organic matter from the water column to feed. Varying levels of faecal coliforms in bivalve flesh determine the classification of shellfish harvesting waters. Strangford Lough has historically always been classified as a mixture of A and B harvesting areas.

The geometric mean of *E. coli* levels (from 2005 – mid 2011) was highest for scallops at Marlfield Bay, followed by mussels at Skate Rock and oysters at The Dorn. The lowest geometric mean was for oysters at Reagh Bay.

Analysis to determine the differences in *E. coli* contamination levels based on location and seasonality was carried out. This analysis revealed that there was a significant difference between the the Marlfield bed and the other 3 beds in 2006 and between the Marlfield bed and the Reagh and Dorn beds in 2007. No significant seasonal differences within each harvesting bed were identified.

It was also revealed that in autumn, there were significant differences between the Marlfield Bay scallop bed and the Reagh Bay oyster bed and in winter there were significant differences between The Dorn oyster bed and the Marlfield scallop bed. No significant increases in *E. coli* levels during the summer months were evident from this analysis, implying that in Strangford Lough the effects of increased rainfall and subsequent run-off has more of an effect on *E. coli* levels than from any increase in population during the summer months.

Depending on the bathymetric characteristics, current speeds, tidal conditions, prevailing wind direction and riverine input the fate of contaminants within the Lough can vary. Areas of deeper water and strong current flows favour the physical dispersion and dilution of contaminants, whereas areas with shallower depths, weaker current speeds and higher riverine input may have a lower ability to disperse and dilute contaminants and therefore have the potential to accumulate contaminants.

Based on hydrodynamic conditions, suspended sediment levels, freshwater influence, contamination sources and historical classifications, the lough was divided into 5 Production Areas. Representative Monitoring Points (RMPs) were selected for each Production Area which contains currently licenced aquaculture sites.
In the selection of these RMPs, it was important to maintain as many of the existing monitoring points as possible to continue the long-term datasets. Further details on the Production Areas and the sampling sites can be seen in Section 7: Sampling Plan. This sampling plan is designed to properly reflect the control of the likely risk of pathogen contamination on the shellfish and will ensure that effective monitoring is carried out with respect to the potential polluting impacts and that public health is prioritised.

7. Sampling Plan

7.1. Identification of Production Area Boundaries & RMPs

The proposed production areas were 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. Figures 7.1 to 7.6 show the base data used for the identification of production areas, i.e. spring and neap surface and bottom ebb and flood flows, the spring tide ebb and flow tidal streams, residence times and the shellfish *E. coli* results. In addition, analysis carried out on FSA in NI monitoring data was also taken into consideration when determining production areas and Figures 7.7 to 7.9 show the historical classifications in Strangford Lough from 2003.

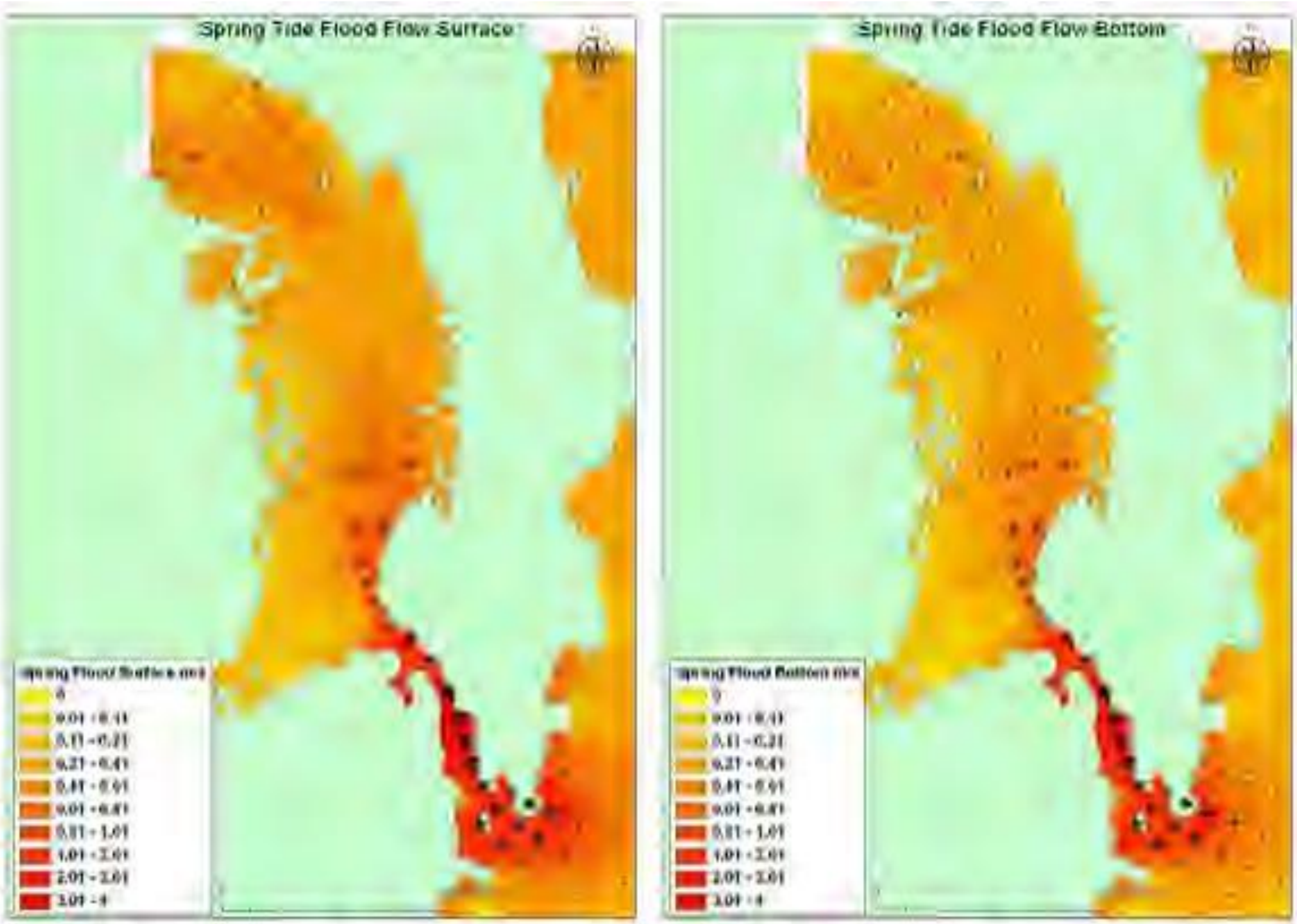


Figure 7.1: Surface and bottom current velocities and direction during a spring tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

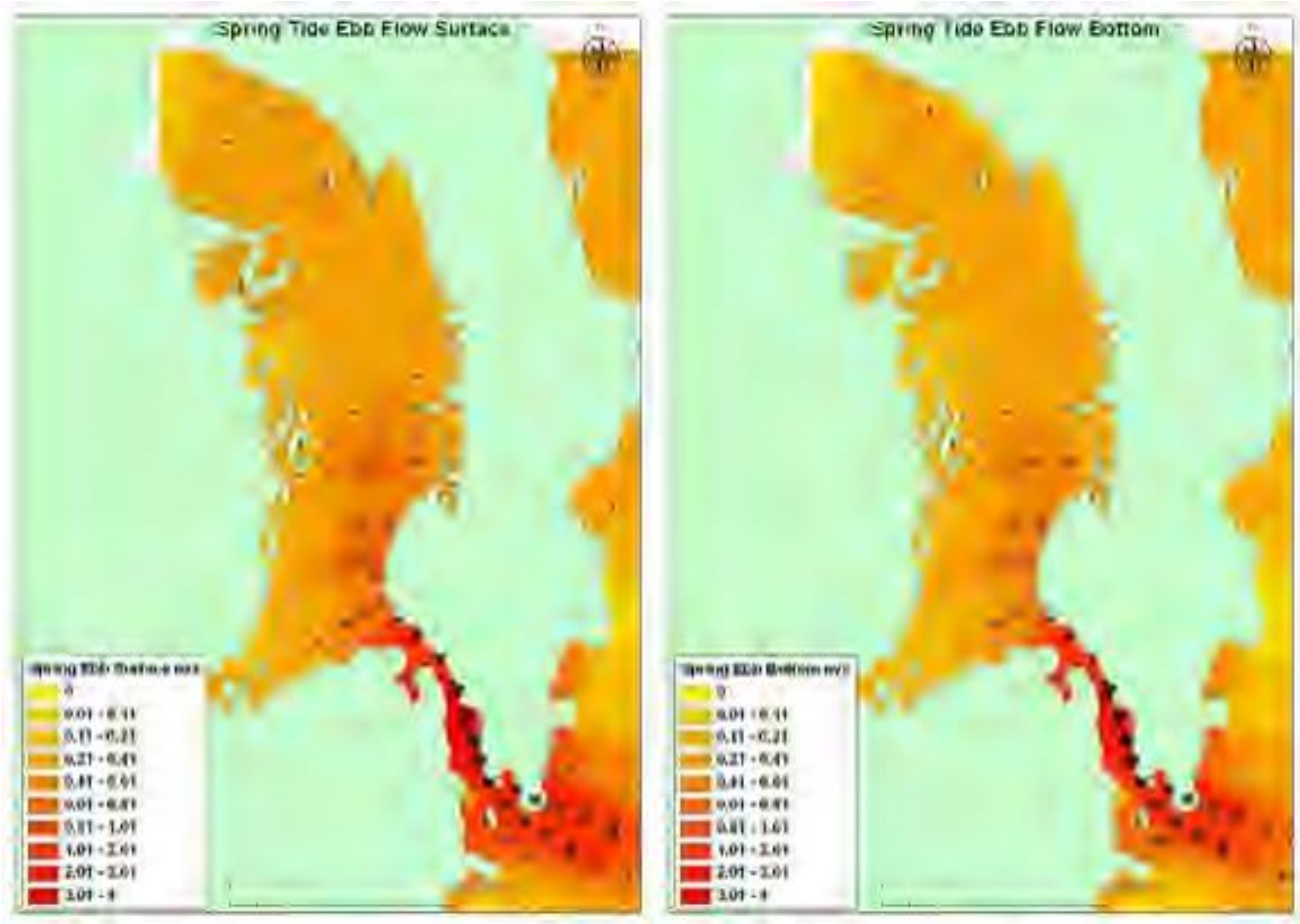


Figure 7.2: Surface and bottom current velocities and direction during a spring tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

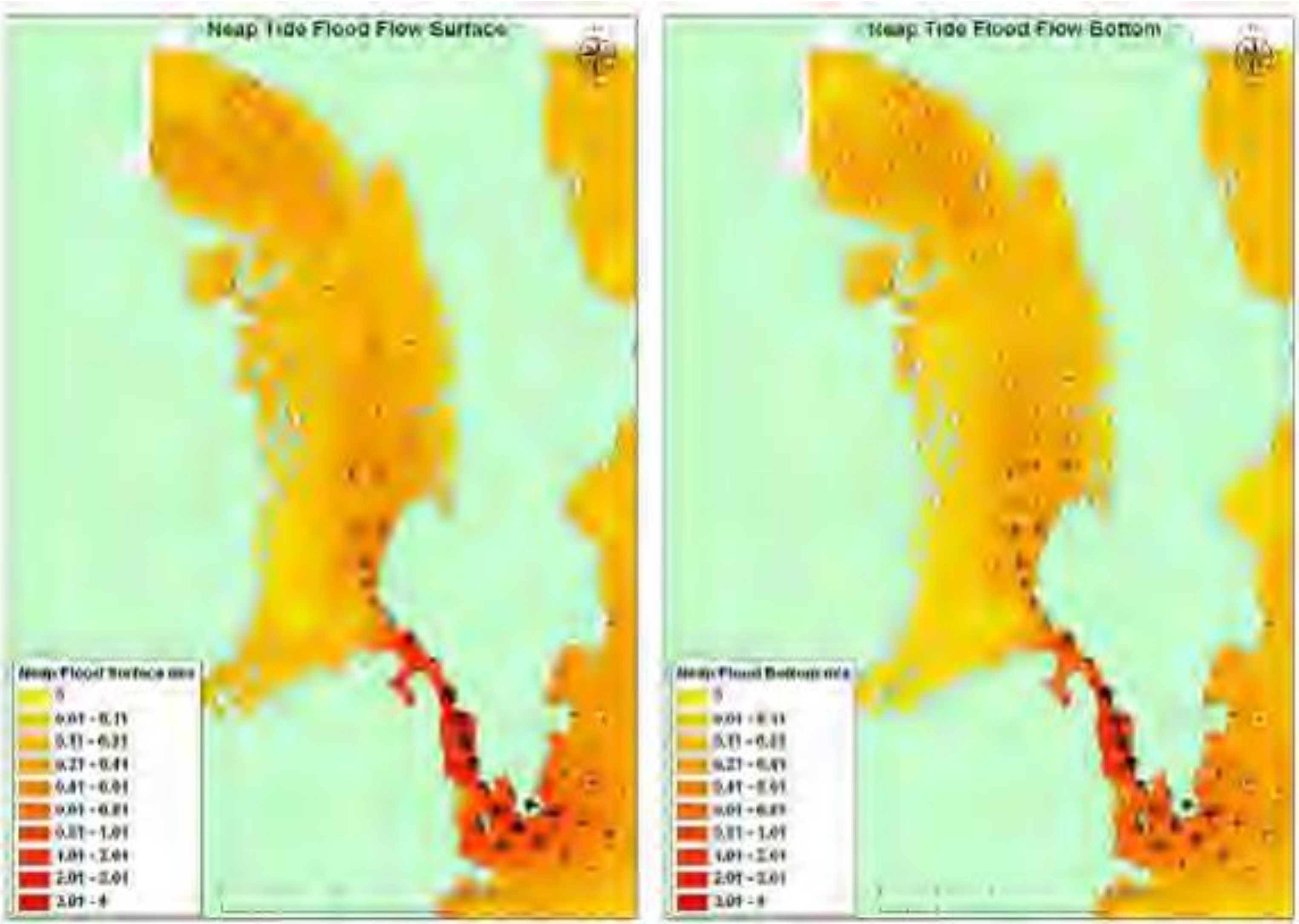


Figure 7.3: Surface and bottom current velocities and direction during a neap tide, flood flow (Source: AFBI SMILE Deflt3D-Flow Model Data).

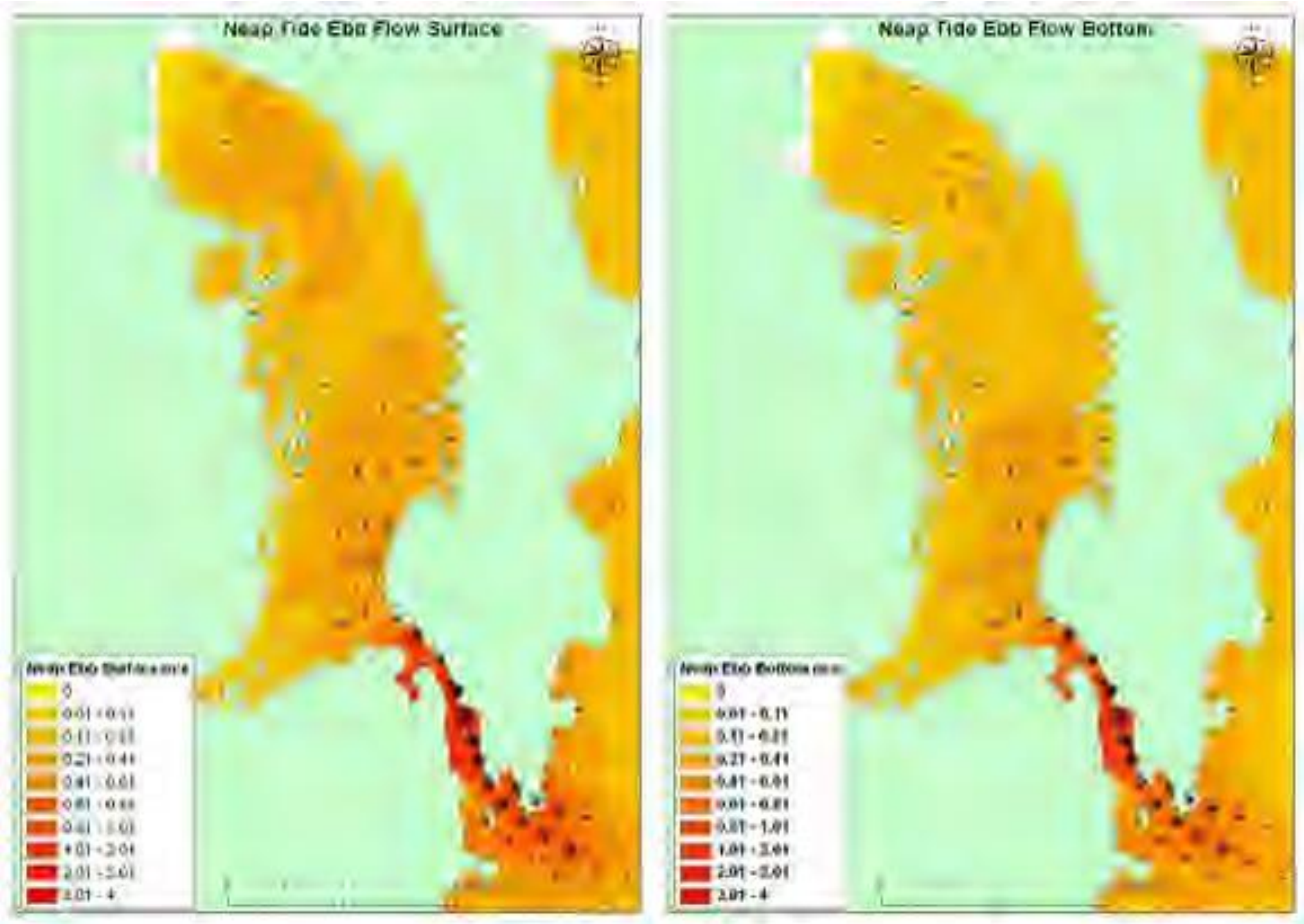
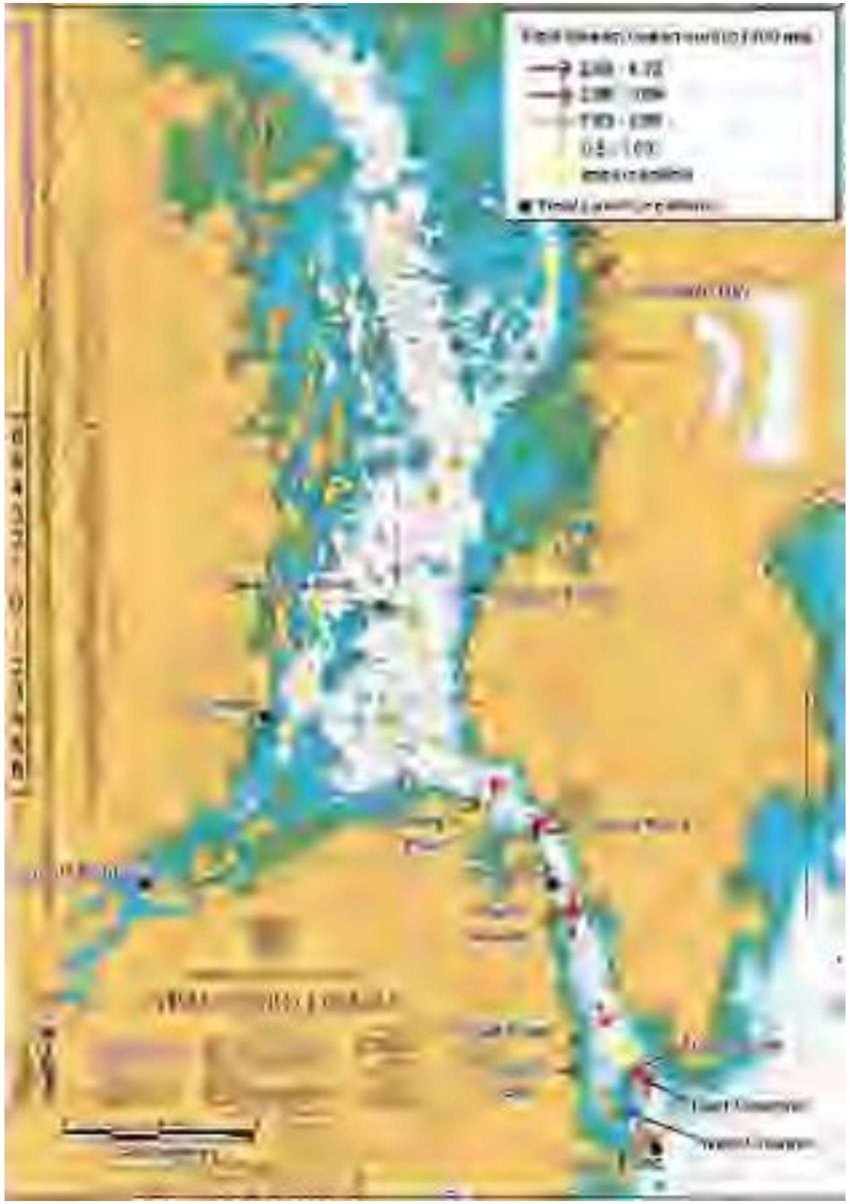


Figure 7.4: Surface and bottom current velocities and direction during a neap tide, ebb flow (Source: AFBI SMILE Deflt3D-Flow Model Data).



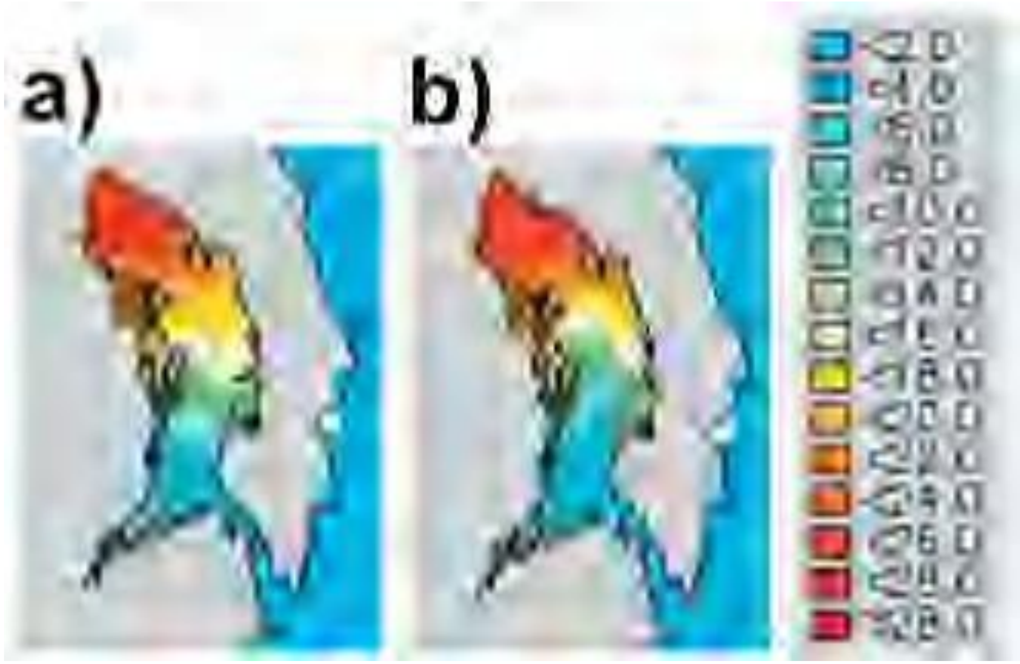


Figure 7.5: Tidal stream and residence time data for Strangford Lough.

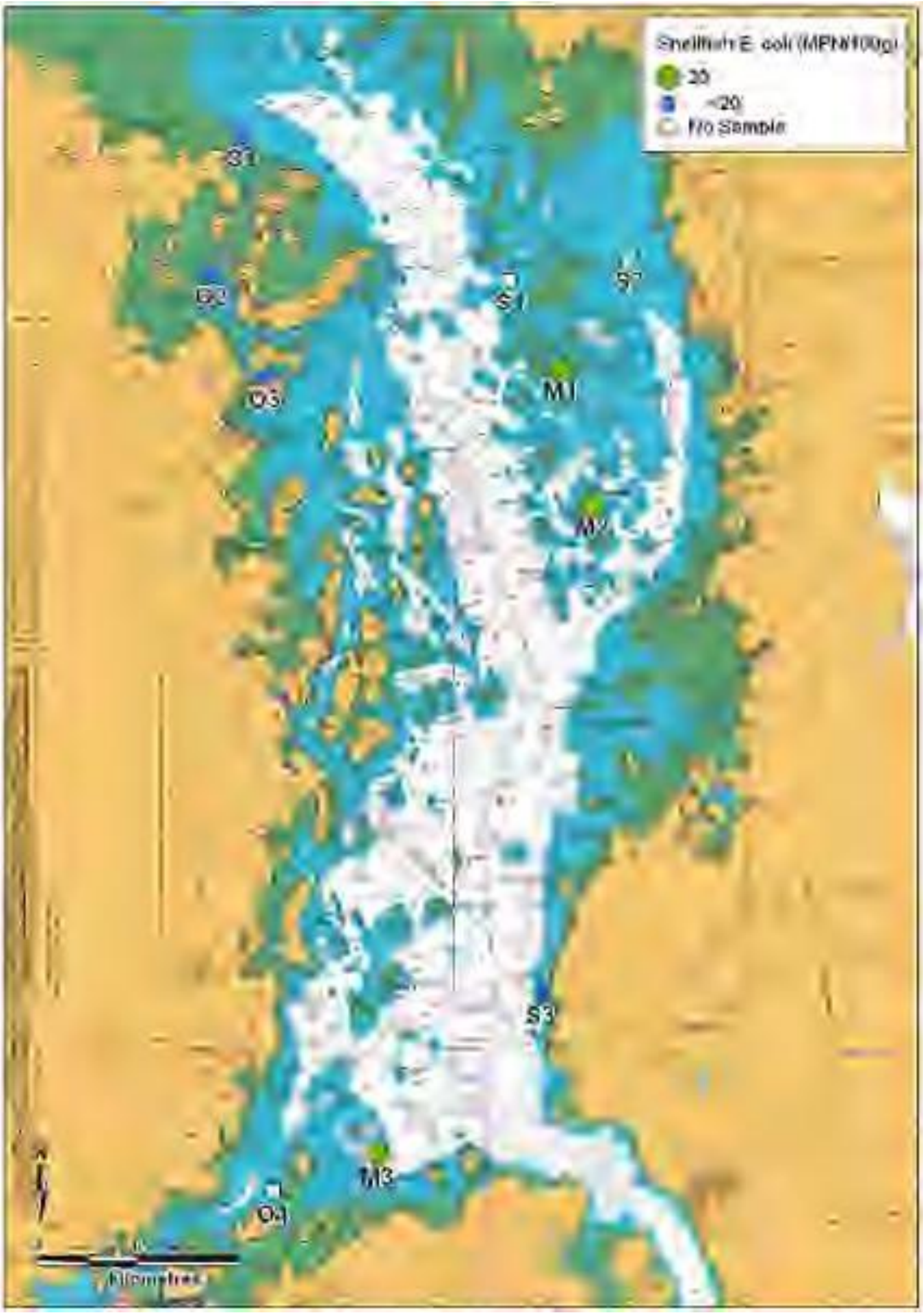


Figure 7.6: ***E. coli*** **results from shellfish samples in Strangford Lough.**

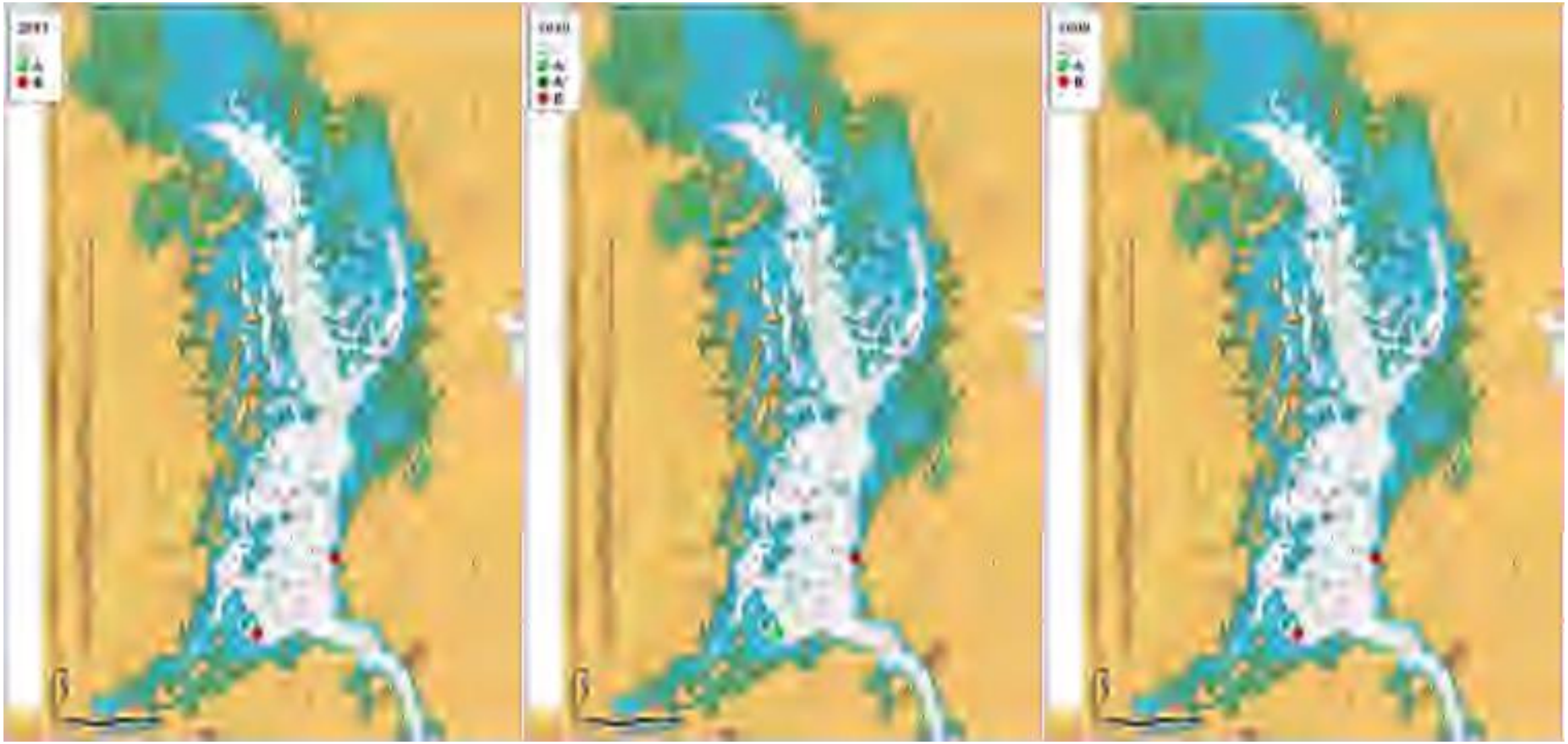


Figure 7.7: Historical classifications for Strangford Lough in 2011, 2010 and 2009.

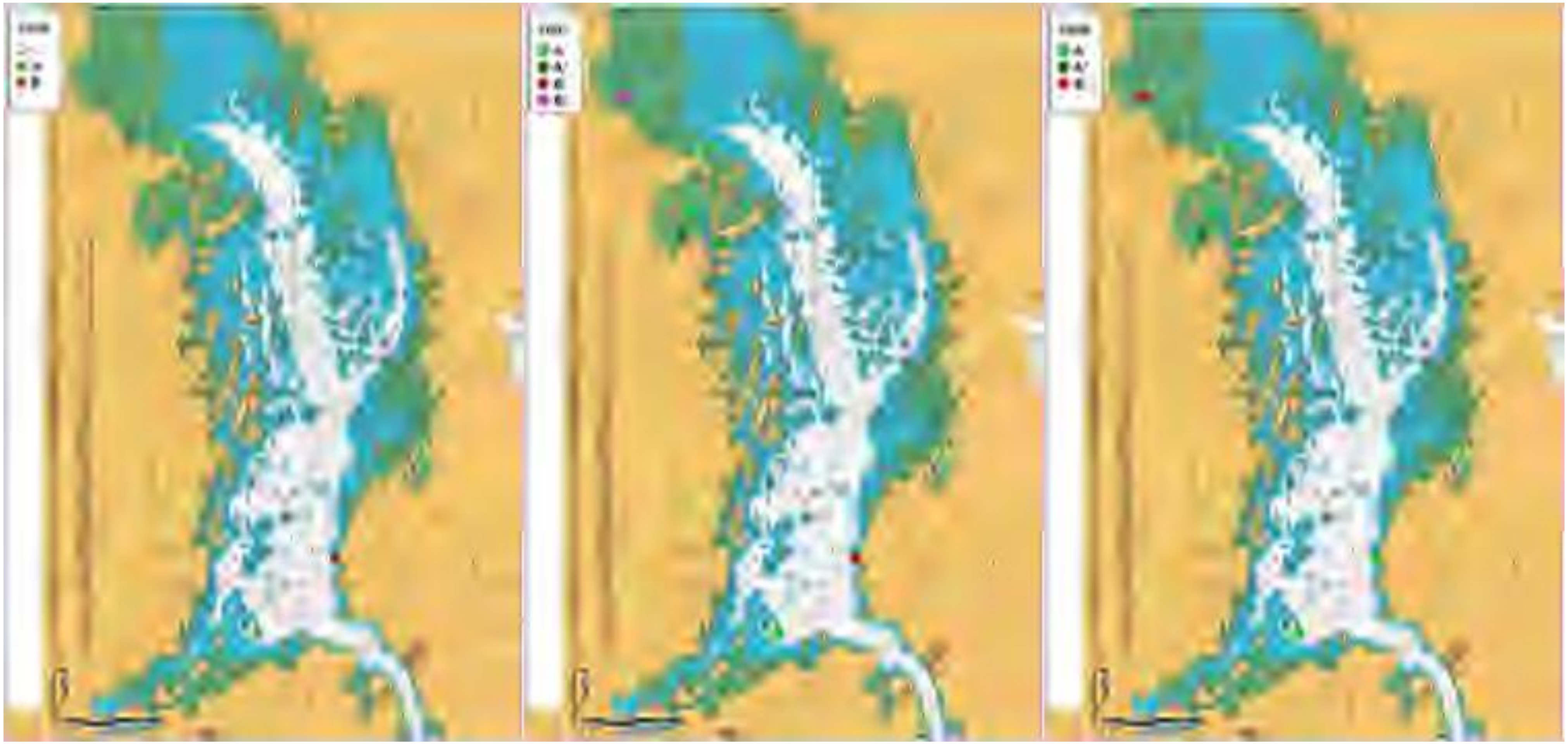


Figure 7.8: Historical classifications for Strangford Lough in 2008, 2007 and 2006.

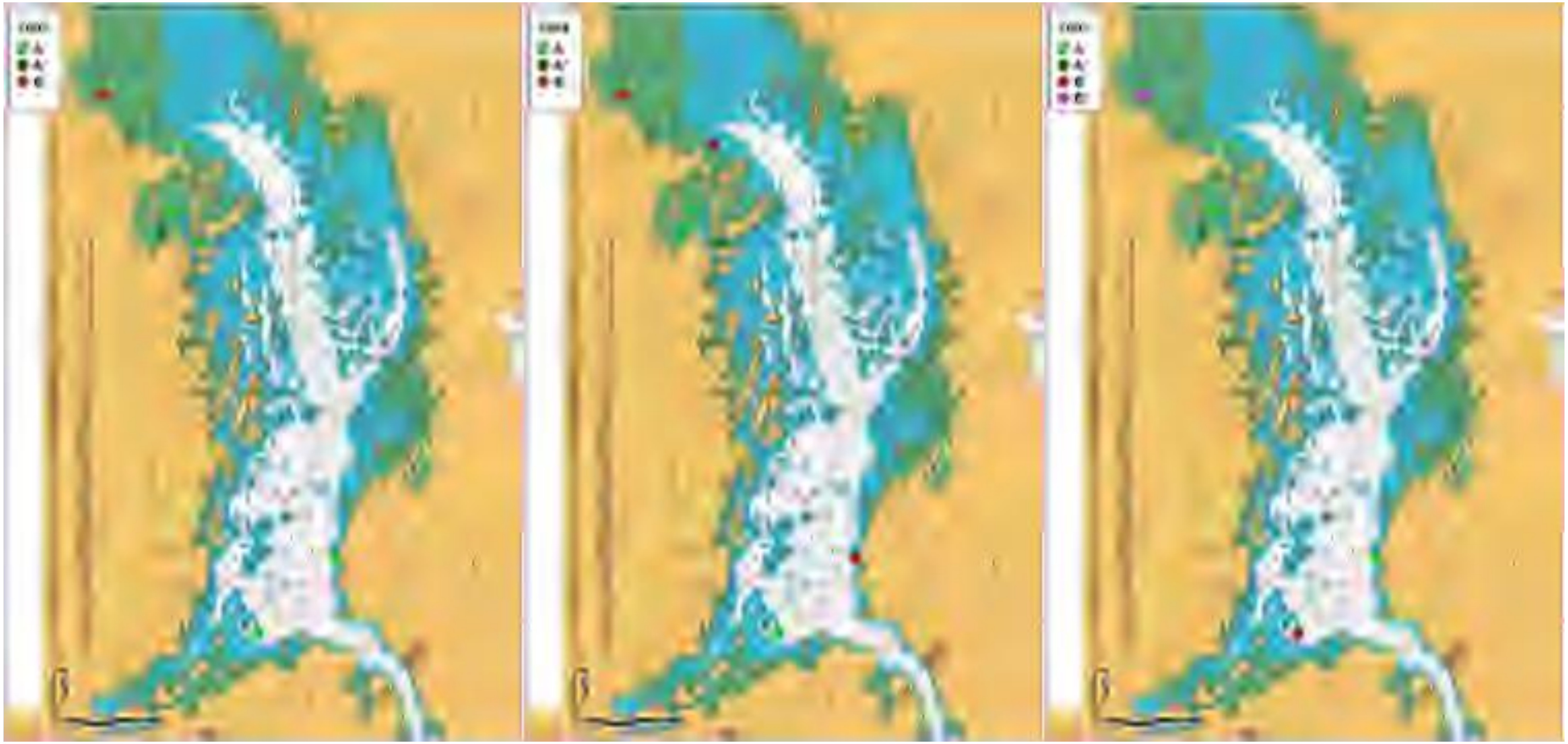


Figure 7.9: Historical classifications for Strangford Lough in 2005, 2004 and 2003.

Within Strangford Lough, the Narrows, due to having the strongest currents and deepest depths, clearly set itself apart from the remainder of the Lough and represents a Production Area (PA) in its own right (i.e. PA5). Within the Lough itself then, there was an initial clear divide between strong current flows and deeper depths in the eastern half with shallower depths and weaker current speeds in the western half. This initially split the main body of the Lough in two (roughly down the middle) (i.e. PA2 and PA3).

A review of past historical classifications data and the Lough's hydrodynamics revealed that the inner reaches of the Lough and the southwestern region of the Lough (Skate Rock and the Quoile River area) differed from the main body of the Lough enough to warrant individual Production Areas in these areas, i.e. PA1 and PA4 respectively.

Figure 7.10 shows the locations of all 5 Production Areas. Figure 7.10 also shows the Representative Monitoring Points (RMPs), which should be monitored monthly by FSA for microbiological contamination, and the licenced aquaculture production sites within the Lough. The RMPs were selected to best represent the productive licenced shellfish sites within each Production Area (PA). It should be noted that a number of Production Areas (i.e. PA1 and PA5) do not currently contain any licenced/classified fisheries and therefore RMPs are not required. If any sites do become licenced/classified in the future, RMPs will then be assigned. For the remaining Production Areas, all attempts were made to retain as many of the existing monitoring sites as possible in order to maintain the long-term data sets. In PA2, the Reagh Bay monitoring site was retained, in PA4, the Skate Rock monitoring site was retained and in PA3, the Marlfield Bay monitoring site was retained.

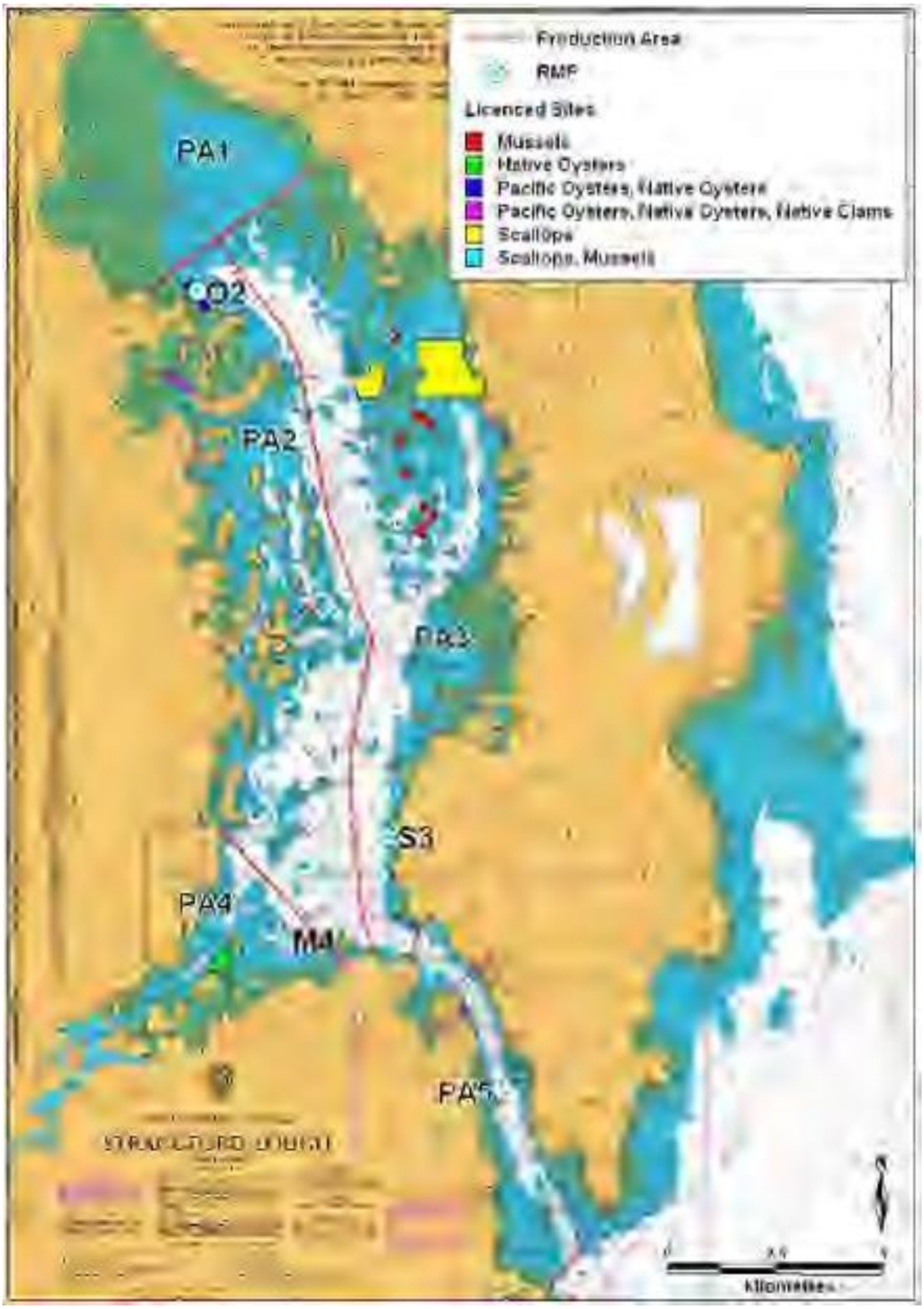


Figure 7.10: Production Areas and RMPs.

7.1.1. Production Area 1 & RMP

Production Area (PA) 1 is located in the inner reaches of the Lough and is currently not licenced for any aquaculture activity. A review of past historical classifications data and the Lough's hydrodynamics revealed that this area is is shallower, residence times are longer and currents flows are weaker than elsewhere in the Lough. This area receives the outflow from the Comber River and consists mostly of intertidal flats. As a result, this has been designated as a separate PA in case further fisheries become licenced and/or classified in the future. As there are currently no licenced aquaculture or classified sites at present, there is no requirement for a RMP in this area, however if a site was to become classified in the future a RMP would be identified. Figure 7.11 shows the PA boundary line and the bounding coordinates. Table 7.1 shows the bounding coordinates.

Figure 7.11: Location of PA1 and its bounding coordinates.

Table 7.1: Bounding coordinates for PA1.

Bounding Coordinate	Longitude	Latitude	Easting	Northing
1	-5.60576	54.5493	354972.2	369415.2
2	-5.66904	54.5219	350979.7	366229.4

7.1.2. Production Area 2 & RMP

Production Area (PA) 2 spans the western half of the Lough from PA1 down to PA4. Current speeds are weaker here compared to the eastern site and depths are shallower and the area is broken up by many small islands. The Reagh Bay monitoring site was retained as the RMP for this Production Area. Figure 7.12 shows the location of the PA, the RMP, the bounding coordinates and currently licenced sites. Table 7.2 lists the bounding coordinates and Table 7.3 gives the coordinates of the RMP.

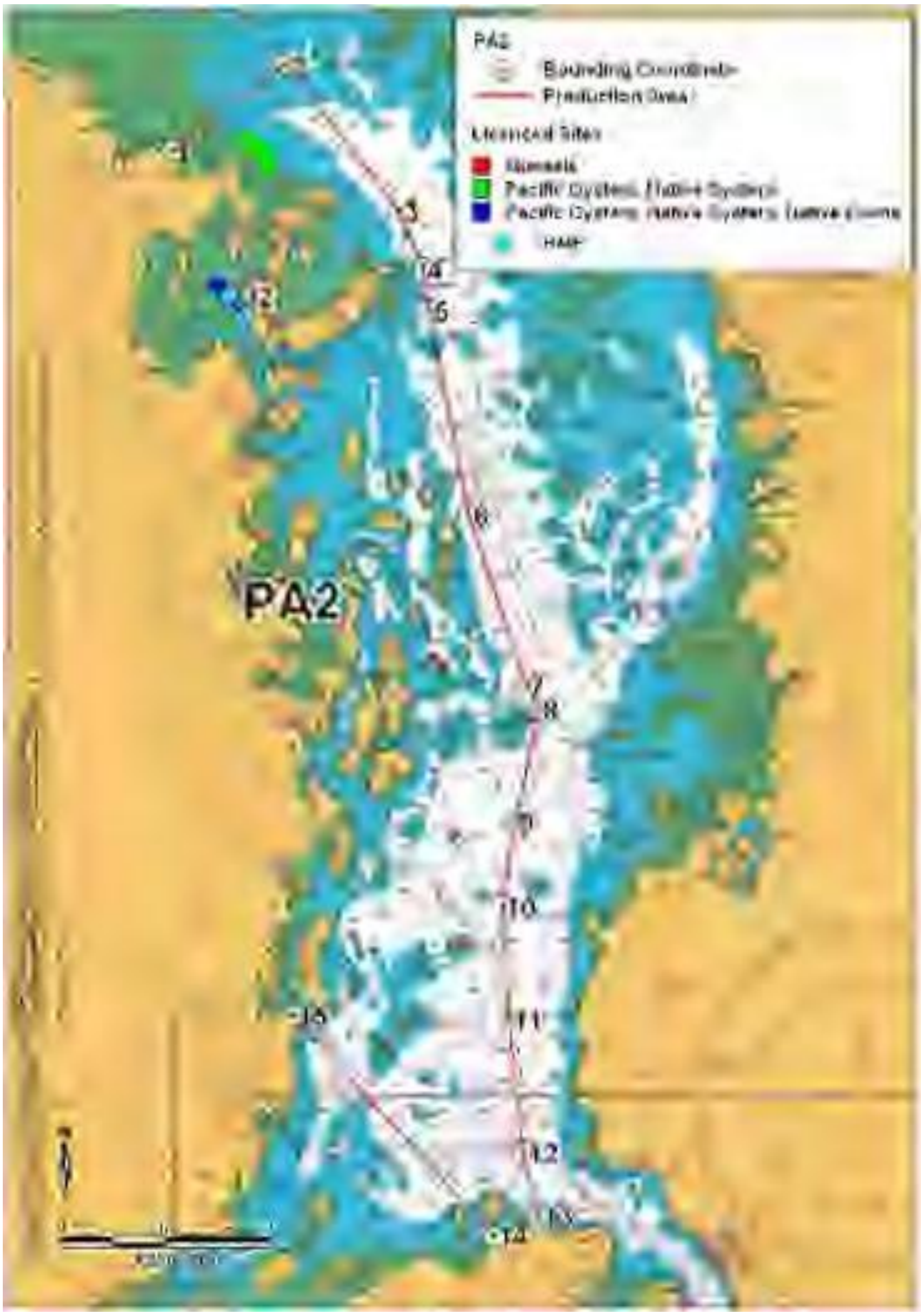


Figure 7.12: PA2 location, bounding coordinates, RMP and currently licenced sites.

Table 7.2: Bounding coordinates of PA2.

Bounding Coordinate	Longitude	Latitude	Easting	Northing
1	-5.66904	54.5219	350979.7	366229.4
2	-5.64365	54.5332	352580.9	367538.4
3	-5.61828	54.5142	354294.7	365481.6
4	-5.61302	54.507	354662.8	364684.4
5	-5.61167	54.5015	354770.3	364083.4
6	-5.60289	54.4753	355439.1	361179.8
7	-5.58971	54.4531	356377.8	358739.3
8	-5.58704	54.45	356562.5	358400.2
9	-5.59234	54.4354	356274	356770
10	-5.59532	54.4246	356122.1	355555
11	-5.59397	54.41	356265.1	353939.8
12	-5.59087	54.393	356531.1	352048.2
13	-5.58754	54.3846	356779.5	351122.7
14	-5.59725	54.3821	356158.3	350820.1
15	-5.6418	54.4104	353159.1	353877.8

Table 7.3: Coordinates of PA2 RMP.

RMP	Longitude	Latitude	Easting	Northing
O2	-5.6567	54.5035	351846.6	364203.8

7.1.3. Production Area 3 & RMP

Production Area (PA) 3 spans the eastern half of the Lough from the top of the Narrows to PA1. This area contains stronger currents and deeper depths compared with PA2 on the western side of the Lough. The existing Marlfield Bay monitoring site was retained as the RMP. Figure 7.13 shows the location of PA3, the bounding coordinates, currently licenced sites and the RMP. Table 7.4 gives the bounding coordinates and Table 7.5 gives the coordinates of the RMP.

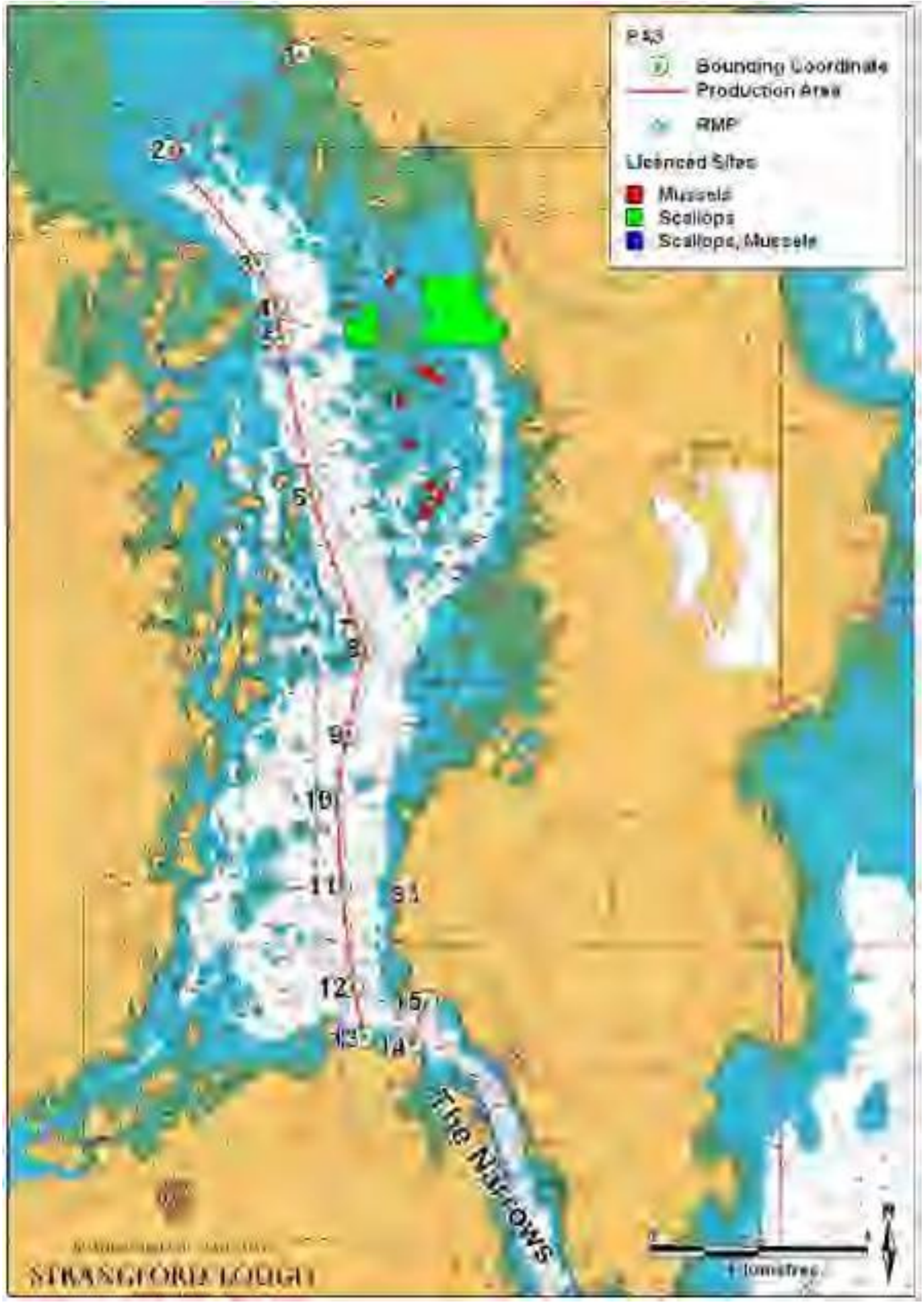


Figure 7.13: PA3 location, bounding coordinates, RMP and currently licenced sites.

Table 7.4: Bounding coordinates of PA3.

Bounding Coordinate	Longitude	Latitude	Easting	Northing
1	-5.60576	54.5493	354972.2	369415.2
2	-5.64365	54.5332	352580.9	367538.4
3	-5.61828	54.5142	354294.7	365481.6
4	-5.61302	54.507	354662.8	364684.4
5	-5.61167	54.5015	354770.3	364083.4
6	-5.60289	54.4753	355439.1	361179.8
7	-5.58971	54.4531	356377.8	358739.3
8	-5.58704	54.45	356562.5	358400.2
9	-5.59234	54.4354	356274	356770
10	-5.59532	54.4246	356122.1	355555
11	-5.59397	54.41	356265.1	353939.8
12	-5.59087	54.393	356531.1	352048.2
13	-5.58754	54.3846	356779.5	351122.7
14	-5.57384	54.3833	357674.4	351013.6
15	-5.56952	54.3908	357925.8	351854

Table 7.5: Coordinates of PA3 RMP.

RMP	Longitude	Latitude	Easting	Northing
S3	-5.58144	54.4083	357085.1	353777.9

7.1.4. Production Area 4 & RMP

Production Area (PA) 4 is located in the southwestern region of the Lough in the area of the Quoile River. This area has weaker current speeds than PA3, shallower depths and a larger freshwater input. The existing monitoring site (Skate Rock) has been retained as the RMP for PA4. This monitoring site has consistently returned microbiological results of different levels to those returned from Marlfield Bay (the RMP in PA3) and therefore the area was designated as a Production Area of its own. Figure 7.14 shows PA4, the RMP, bounding coordinates and the currently licenced sites. Table 7.6 gives the bounding coordinates and Table 7.7 gives the coordinates of the RMP.

Figure 7.14: PA4 location, bounding coordinates, RMP and currently licenced sites.

Table 7.6: Bounding coordinates of PA4.

Bounding Coordinates	Longitude	Latitude	Easting	Northing
1	-5.64183	54.4106	353155.8	353901.2
2	-5.59725	54.3821	356158.3	350820.1

Table 7.7: Coordinates of PA4 RMP.

RMP	Longitude	Latitude	Easting	Northing
M4	-5.61827	54.3869	354774.6	351313.6

7.1.5. Production Area 5 & RMPs

Production Area (PA) 5 is located in the Narrows. This area of the Lough contains the strongest current speeds, over 3.6m/s and the water depths reach up to 60m in places. The Narrows are well flushed and there is a constant exchange of water with the Irish Sea. This area of the Lough is expected to have the lowest contamination levels. As with PA 1 there are currently no licenced or classified aquaculture sites in PA5 and therefore there is no requirement for a RMP. This area has only been designated as a PA should fisheries become licenced and/or classified in the future

Figure 7.15 shows the location of PA5 and its bounding coordinates. Table 7.8 gives the bounding coordinates.

Figure 7.15: Location of PA5 and its bounding coordinates.

Table 7.8: Bounding coordinates of PA5.

Bounding Coordinates	Longitude	Latitude	Easting	Northing
1	-5.56952	54.3908	357925.8	351854
2	-5.57384	54.3833	357674.4	351013.6
3	-5.50035	54.3322	362649.7	345493.9
4	-5.52321	54.3147	361231.7	343485

7.2. Frequency of RMP Monitoring

All RMPs should be monitored monthly using the sampling methodology described in Section 7.3 below.

7.3. Sampling Methodology

All sampling should follow FSA's official control shellfish sampling and transport protocol. This protocol follows the UK NRL's (National Reference Laboratory) Recommendations for the collection and transport of bivalve molluscs for Microbiological monitoring, which outlines the following:

7.3.1. Time of Sampling

Sampling should 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. so as to avoid introducing any bias to the results.

7.3.2. Sampling Method

Wherever possible, shellfish should be sampled by the method normally used for commercial harvesting as this can influence the degree of contamination. The temperature of the surrounding seawater at the time of sampling should be recorded. Where intertidal shellfish are sampled dry, the temperature of the shellfish sample should be recorded immediately after collection. To do this the temperature probe should be placed in the centre of the bagged shellfish sample.

7.3.3. Equipment

Food grade polythene bags
Cable ties
Self adhesive labels
Absorbent paper towel
Cool box/Biotherm Box/Coleman Box
Ice packs
Insulating foam
Spray water bottle/bucket
Pocket wallet/ grip seal bag (for paperwork)

Strong adhesive tape

Return address labels

Gloves/antibacterial wipes

7.3.4. Size of Individual Animals

Samples should only consist of animals that are within the normal commercial size range. Immature/juvenile animals may provide *E.coli* results that are unrepresentative of mature stock that will be harvested for commercial sale/human consumption. In circumstances where less mature stock is being commercially harvested for human consumption then samples of these smaller bivalves may be collected for analysis.

7.3.5. Sample Composition

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

Oysters (*Crassostrea gigas* and *Ostrea edulis*)	12-18
Mussels (*Mytilus* spp.)	15-30
King scallops (*Pecten maximus*.)	10-12

There is an absolute lower number of shellfish (10) and a minimum requirement of 50 g of flesh and intravalvular fluid for the test undertaken by the laboratory. The number of animals given above is intended to satisfy these requirements and to include a small additional allowance in case animals become moribund during transit.

7.3.6. Preparation and Packaging of Samples

Any mud and sediment adhering to the shellfish should be removed. This is best achieved by rinsing/scrubbing with fresh water of potable quality or seawater from the immediate area of sampling. Do not totally re-immerse the shellfish in water as this may cause them to open. Allow to drain. Shellfish must be placed inside a strong food grade plastic bag, sealed and labelled with a waterproof label bearing the relevant sample collection information – e.g. site name, location, site identification number (SIN), date and time of sampling, species. The labelled bag should be placed in a second bag and sealed. The bagged sample should be placed in a cool box between 2 layers of ice packs and foam packaging.

7.3.7. Sample Transport

Samples should be transported in cool boxes at a temperature between 1°C and 8°C. Samples should not be frozen and freezer packs should not come into direct contact with the samples or sample bags. The cool boxes used for transport should be validated using temperature probes to ensure that the recommended temperature is achieved and maintained. To aid in the regulation of temperature, cool boxes specified by the NRL must be used where time from sampling to receipt at the laboratory exceeds 12 hours. Samples should be delivered to the relevant laboratory for analysis as soon practicable.

7.3.8. Sample Submission Form

An individual sample submission form must accompany each sample to the labopratory. The information which must be recorded on the form includes; sample site name, location, sample identification number (SIN), OS Grid reference, time and date of collection, species sampled, method of collection and seawater/shellfish temperature. Any other information deemed relevant (e.g. adverse weather) should also be recorded.

7.3.9. 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.

7.3.10. Receiving Laboratory

The laboratory to which the samples are sent must be part of the network identified by the competent authority. It must be UKAS-accredited for the testing of shellfish for *E. coli* by ISO 16649-3 and must take part in both the HPA/CEFAS Shellfish EQA scheme and appropriate NRL ring trials.

8. References

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Appendix 1

Discharge Analysis Data 2010

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Annacloy WWTW Effluent	S36AI	28/1/10	3.57	14		7.6	2.23	0.13	1.4		10.0			2.37
Annacloy WWTW Effluent	S36AI	8/2/10	3.73	6		7.5	1.15	0.13	0.6		12.0			1.28
Annacloy WWTW Effluent	S36AI	23/3/10	14.76	12		7.3	0.41	0.04	2.0		11.0			0.45
Annacloy WWTW Effluent	S36AI	13/5/10	11.79	5		6.5	4.19	0.35	1.5		7.0			4.54
Annacloy WWTW Effluent	S36AI	21/5/10	13.53	4		7.4	0.83	0.13	1.8		6.0			0.96
Annacloy WWTW Effluent	S36AI	28/6/10	0.63	2		6.8	19.74	0.79	1.7		7.0			20.53
Annacloy WWTW Effluent	S36AI	15/7/10	0.42	3		7.2	4.45	0.31	0.6		6.0			4.76
Annacloy WWTW Effluent	S36AI	22/9/10	2.30	6		7.0	2.83	0.29	0.8		28.0			3.12
Annacloy WWTW Effluent	S36AI	8/10/10	2.49	2		7.1	8.58	0.43	1.2		6.0			9.01
Annacloy WWTW Effluent	S36AI	4/11/10	2.89	5		7.3	2.45	0.04	0.6		18.0			2.49
Annacloy WWTW Effluent	S36AI	1/12/10	4.01	4		7.5	4.75	0.10	1.0		10.0			4.84
Annacloy WWTW Effluent	S36AI	16/12/10	3.88	5		7.4	5.54	0.16	1.2		9.0			5.70
Annahilt WWTW Effluent	S37AG	6/1/10	<0.094	2		6.8	6.65	0.02	2.9	3.18	6.0		7.19	6.68
Annahilt WWTW Effluent	S37AG	2/2/10	<0.094	2		6.7	8.86	<0.003	2.5	2.41	3.0		9.62	8.86
Annahilt WWTW Effluent	S37AG	1/3/10	<0.094	2		6.7	6.00	<0.003	1.6	1.82	4.0		7.02	6.00
Annahilt WWTW Effluent	S37AG	2/4/10	<0.094	2		6.6	7.65	0.01	1.0	1.18	3.0		7.85	7.66
Annahilt WWTW Effluent	S37AG	26/5/10	<0.094	1		6.8	8.83	0.02	6.6	7.19	2.0		10.81	8.85
Annahilt WWTW Effluent	S37AG	22/6/10	0.14	11		6.8	8.99	0.04	7.4	7.76	5.0		11.02	9.03
Annahilt WWTW Effluent	S37AG	16/7/10	0.18	6		6.9	3.28	0.03	1.4	1.56	11.0		3.86	3.32
Annahilt WWTW Effluent	S37AG	20/8/10	<0.094	1		7.0	3.89	0.03	3.0	3.21	2.0		4.60	3.92
Annahilt WWTW Effluent	S37AG	16/9/10	<0.094	3		6.8	3.23	0.03	1.5	1.74	1.0		4.00	3.25
Annahilt WWTW Effluent	S37AG	13/10/10	<0.094	2		6.8	3.51	0.02	3.1	3.23	5.0		4.32	3.53
Annahilt WWTW Effluent	S37AG	9/11/10	<0.094	1		6.8	3.19	<0.003	1.0	1.14	1.0		3.51	3.18
Annahilt WWTW Effluent	S37AG	6/12/10	<0.094	2		6.8	9.52	<0.003	3.5	4.17	3.0		12.30	9.51
Ballycranbeg WWTW Effluent	S35AL	15/1/10	0.62	3		7.4	4.73	0.07	<0.153		11.0			4.80
Ballycranbeg WWTW Effluent	S35AL	11/2/10	0.31	2		7.1	10.55	0.09	0.9		1.0			10.64
Ballycranbeg WWTW Effluent	S35AL	10/3/10	14.75	12		7.0	4.28	0.21	1.8		18.0			4.48
Ballycranbeg WWTW Effluent	S35AL	7/4/10	1.29	3		7.2	3.26	0.17	0.3		7.0			3.43

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Ballycranbeg WWTW Effluent	S35AL	4/5/10	13.49	9		7.3	1.09	0.17	1.6		10.0			1.26
Ballycranbeg WWTW Effluent	S35AL	4/6/10	17.31	2		7.6	0.16	0.04	1.5		3.0			0.20
Ballycranbeg WWTW Effluent	S35AL	28/7/10	0.20	2		7.1	21.51	0.22	1.9		<0.100			21.73
Ballycranbeg WWTW Effluent	S35AL	24/8/10	4.63	5		7.5	4.21	0.73	1.0		22.0			4.94
Ballycranbeg WWTW Effluent	S35AL	20/9/10	<0.094	1		7.3	9.08	0.09	1.2		6.0			9.17
Ballycranbeg WWTW Effluent	S35AL	25/10/10	9.63	4		7.2	1.31	0.56	2.0		9.0			1.87
Ballycranbeg WWTW Effluent	S35AL	18/11/10	0.10	2		7.1	10.36	0.24	0.7		6.0			10.60
Ballycranbeg WWTW Effluent	S35AL	29/11/10	1.35	1		7.2	14.14	0.41	1.3		2.0			14.55
Ballygowan WWTW Effluent	S35AC	20/1/10	0.58	2		6.9	9.49	0.30	0.8	0.87	3.0		10.34	9.79
Ballygowan WWTW Effluent	S35AC	16/2/10	0.46	5		6.9	8.51	0.26	2.6	3.07	11.0		11.60	8.76
Ballygowan WWTW Effluent	S35AC	15/3/10	1.63	8		6.8	9.82	0.50	2.9	3.53	18.0		14.03	10.32
Ballygowan WWTW Effluent	S35AC	13/5/10	0.35	4		6.8	4.61	0.17	3.6	3.89	15.0		6.69	4.78
Ballygowan WWTW Effluent	S35AC	9/6/10	4.07	3		7.1	0.97	0.25	0.7	0.83	2.0		5.97	1.22
Ballygowan WWTW Effluent	S35AC	25/6/10	15.27	3		7.3	<0.100	0.07	1.3	1.35	8.0		16.15	<0.196
Ballygowan WWTW Effluent	S35AC	6/7/10	4.47	3		7.1	<0.100	0.07	0.9	1.08	11.0		5.76	<0.196
Ballygowan WWTW Effluent	S35AC	2/8/10	1.32	2		7.3	0.55	0.26	0.2	<0.489	10.0		3.43	0.81
Ballygowan WWTW Effluent	S35AC	3/9/10	5.77	2		7.2	<0.100	0.06	2.5	2.97	9.0		6.26	<0.196
Ballygowan WWTW Effluent	S35AC	27/10/10	0.14	5		7.0	3.95	0.04	1.4	1.48	2.0		4.63	3.99
Ballygowan WWTW Effluent	S35AC	9/12/10	0.18	21		6.8	9.93	0.72	2.7	3.26	28.0		13.48	10.65
Ballygowan WWTW Effluent	S35AC	16/12/10	0.13	6		6.8	5.28	0.29	2.3	2.95	12.0		7.69	5.57
Ballygowan WWTW UWWTR Effluent	U35AC	20/1/10	0.28	6		7.2	8.29	0.16	0.4		12.0			8.44
Ballygowan WWTW UWWTR Effluent	U35AC	16/4/10	14.45	32		7.2	0.30	0.16	2.6		15.0			0.46
Ballygowan WWTW UWWTR Effluent	U35AC	2/8/10	1.24	2		7.2	0.38	0.17	0.4		4.0			0.55
Ballygowan WWTW UWWTR Effluent	U35AC	27/10/10	<0.094	4		7.1	3.07	0.01	1.8		101.0			3.08
Ballynahinch WWTW Effluent	S36AC	4/1/10	<0.094	2		6.5	15.98	0.02	1.5	2.12	<0.100		17.62	16.00
Ballynahinch WWTW Effluent	S36AC	20/1/10	<0.094	1		6.8	7.04	<0.003	0.5	0.62	2.0		7.88	7.04

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Ballynahinch WWTW Effluent	S36AC	5/2/10	<0.094	2		6.8	2.65	0.01	0.9	0.81	4.0		3.51	2.66
Ballynahinch WWTW Effluent	S36AC	16/2/10	<0.094	2		6.8	3.80	0.01	0.3	<0.489	4.0		4.81	3.82
Ballynahinch WWTW Effluent	S36AC	4/3/10	0.20	1		6.8	6.64	<0.003	0.2	<0.489	4.0		8.02	6.64
Ballynahinch WWTW Effluent	S36AC	15/3/10	<0.094	2		6.7	7.77	0.01	1.7	1.90	4.0		8.95	7.78
Ballynahinch WWTW Effluent	S36AC	16/4/10	0.18	2		6.6	17.36	<0.003	1.9	2.10	3.0		17.76	17.36
Ballynahinch WWTW Effluent	S36AC	27/4/10	0.20	1		6.7	9.83	0.01	2.3	2.37	3.0		10.39	9.84
Ballynahinch WWTW Effluent	S36AC	5/5/10	<0.094	4		6.3	18.47	0.02	3.2	3.14	7.0		19.63	18.49
Ballynahinch WWTW Effluent	S36AC	13/5/10	<0.094	3		6.7	15.50	0.01	2.9	3.00	4.0		17.12	15.51
Ballynahinch WWTW Effluent	S36AC	9/6/10	0.40	2		6.7	10.34	0.03	2.6	2.66	2.0		11.10	10.37
Ballynahinch WWTW Effluent	S36AC	6/7/10	<0.094	2		5.9	27.71	0.02	3.5	3.71	5.0		30.01	27.73
Ballynahinch WWTW Effluent	S36AC	15/7/10	<0.094	2		6.8	4.79	0.05	1.1	1.36	4.0		5.63	4.84
Ballynahinch WWTW Effluent	S36AC	22/7/10	0.20	2		6.8	10.98	0.05	1.9	2.04	3.0		11.95	11.03
Ballynahinch WWTW Effluent	S36AC	2/8/10	<0.094	2		6.5	18.95	0.05	3.9	4.06	4.0		20.55	19.00
Ballynahinch WWTW Effluent	S36AC	18/8/10	0.17	1		6.2	25.43	0.03	3.7	4.31	2.0		27.20	25.46
Ballynahinch WWTW Effluent	S36AC	3/9/10	0.96	3		5.1	29.49	0.04	6.0	6.36	12.0		33.08	29.53
Ballynahinch WWTW Effluent	S36AC	30/9/10	<0.094	1		6.4	21.47	<0.003	2.9	2.83	1.0		22.56	21.47
Ballynahinch WWTW Effluent	S36AC	11/10/10	<0.094	2		6.9	23.27	0.04	3.2	3.33	2.0		24.97	23.31
Ballynahinch WWTW Effluent	S36AC	27/10/10	<0.094	1		6.4	16.15	<0.003	2.1	2.25	3.0		16.88	16.14
Ballynahinch WWTW Effluent	S36AC	12/11/10	<0.094	3		6.4	6.11	<0.003	0.6	0.78	6.0		6.59	6.11
Ballynahinch WWTW Effluent	S36AC	23/11/10	<0.094	2		6.9	14.36	<0.003	1.4	1.44	2.0		14.96	14.36
Ballynahinch WWTW Effluent	S36AC	9/12/10	<0.094	3		5.7	23.66	0.01	3.4	3.51	4.0		27.22	23.67
Ballynahinch WWTW Effluent	S36AC	16/12/10	<0.09	2		6.5	16.53	<0.00	1.9	2.25	3.0		18.12	16.52
Ballynahinch WWTW UWWTR Effluent	U36AC	5/2/10	<0.094	7		6.9	4.32	0.02	1.0		10.0			4.34
Ballynahinch WWTW UWWTR Effluent	U36AC	27/4/10	0.19	1		6.7	8.99	0.02	2.1		4.0			9.01
Ballynahinch WWTW UWWTR Effluent	U36AC	2/8/10	0.13	3		7.0	18.93	0.06	3.7		4.0			18.99
Ballynahinch WWTW UWWTR Effluent	U36AC	23/11/10	<0.094	1		6.6	14.59	0.01	1.4		<0.100			14.59

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	7/1/10	5.71	7	210.98	7.4	7.38	0.14	0.3		6.0	41	14.78	7.52
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	15/1/10	1.91	5	133.40	7.3	5.35	0.04	0.2		6.0	18	8.27	5.39
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	18/1/10	2.29	5	120.40	7.3	4.34	0.06	<0.153		3.0	57	8.79	4.40
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	26/1/10	2.65	4	91.33	7.2	6.65	0.09	0.3		4.0	32	10.45	6.73
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	3/2/10	0.36	6	258.67	7.9	7.43	0.08	0.4		9.0	9	8.98	7.52
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	11/2/10	0.98	8	108.03	7.3	5.50	0.10	0.6		8.0	3	7.76	5.60
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	19/2/10	2.81	2	129.23	7.2	5.11	0.18	2.1		9.0	236	9.06	5.30
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	22/2/10	5.05	3	129.72	7.1	1.20	0.18	2.5		7.0	72	7.68	1.38
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	2/3/10	2.80	7	231.46	7.1	8.15	0.41	1.7		8.0	1	13.58	8.56
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	10/3/10	5.05	4	121.73	7.2	5.90	0.27	2.2		4.0	141	12.78	6.17
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	18/3/10	7.47	7	148.82	7.3	4.92	0.39	2.1		13.0	19	14.59	5.31
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	21/3/10	6.99	7	171.02	7.2	3.94	0.33	1.7	2.19	6.0	1	12.90	4.27
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	29/3/10	0.57	1	104.30	7.2	2.68	0.12	1.2	1.48	<0.100	24	4.45	2.80
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	7/4/10	<0.094	2	82.59	6.8	4.35	0.02	1.0		5.0	4	4.83	4.37
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	14/4/10	0.29	1	112.37	7.3	2.00	0.16	1.0		1.0	<1	3.53	2.17
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	22/4/10	1.10	3	102.79	7.1	3.17	0.23	2.4		3.0	<1	6.04	3.40
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	30/4/10	<0.094	3	171.46	6.8	0.85	0.09	0.2		6.0	<1	2.49	0.94
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	4/5/10	0.13	4	126.46	6.7	1.23	0.13	0.4		6.0	77	2.51	1.36
Ballyrickard PPP WWTW	S35AU	11/5/10	<0.094	2	124.49	7.0	2.83	0.10	<0.153		4.0	5	4.24	2.93

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Effluent COMPLIANCE														
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	19/5/10	4.11	6	135.19	6.9	0.12	0.04	0.7		8.0	141	5.53	<0.196
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	27/5/10	1.68	7	150.66	7.0	3.89	0.27	<0.153		6.0	50	8.56	4.16
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	4/6/10	<0.094	2	133.42	7.3	4.09	0.02	<0.153		2.0	<1	4.78	4.10
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	7/6/10	<0.094	2	114.97	6.8	3.88	0.11	<0.153		5.0	1	5.19	4.00
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	15/6/10	0.17	2	139.56	7.3	2.76	0.06	<0.153		3.0	<1	3.95	2.82
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	23/6/10	0.16	2	159.21	7.3	2.95	0.17	<0.153		3.0	60	4.31	3.12
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	1/7/10	<0.094	2	157.94	7.2	2.02	0.09	0.2		5.0	12	3.72	2.11
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	9/7/10	<0.094	1	160.34	7.4	3.64	0.04	<0.153		3.0	<1	4.77	3.68
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	14/7/10	<0.094	2	88.51	7.2	2.96	0.02	0.2	<0.489	4.0	30	3.71	2.98
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	20/7/10	0.16	4	106.00	7.2	5.52	0.08	2.0		5.0	2	6.58	5.60
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	28/7/10	0.11	2	144.86	7.5	5.86	<0.003	2.6		3.0	13	6.87	5.87
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	5/8/10	5.80	3	123.77	7.5	2.81	0.22	5.0		6.0	340	10.44	3.03
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	13/8/10	0.11	2	231.44	7.5	4.47	0.03	0.7		6.0	4	4.93	4.50
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	16/8/10	<0.094	1	220.20	7.5	5.18	0.02	0.8		2.0	<1	5.78	5.20
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	24/8/10	<0.094	1	106.60	7.3	5.10	0.06	1.0		1.0	<1	5.95	5.16
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	1/9/10	<0.094	2	147.65	7.5	3.34	0.02	0.4		5.0	387	4.45	3.36
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	9/9/10	<0.094	1	135.60	7.4	3.90	0.01	0.2		5.0	5	4.64	3.91
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	17/9/10	0.12	3	148.70	7.0	4.76	0.03	0.3		10.0	14	6.13	4.79

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	20/9/10	<0.094	5	80.75	6.8	4.29	0.03	1.7		16.0	50	5.44	4.32
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	28/9/10	0.50	4	141.90	7.0	2.84	0.25	0.7		5.0	27600	4.57	3.09
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	6/10/10	0.11	2	169.23	7.3	5.98	0.01	1.3		5.0	600	6.47	5.99
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	14/10/10	<0.094	2	216.95	7.2	9.42	0.02	2.8		5.0	<1	10.38	9.44
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	22/10/10	<0.094	2	159.55	7.0	10.84	0.03	2.9		6.0	2	11.94	10.87
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	25/10/10	<0.094	2	139.82	7.1	10.86	0.07	2.8		6.0	<1	11.75	10.93
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	2/11/10	0.32	2	95.55	7.2	5.57	0.11	1.3		3.0	9	6.99	5.68
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	10/11/10	0.11	1	63.39	6.6	4.68	0.03	0.8		5.0	96	5.23	4.72
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	18/11/10	1.67	2	95.39	7.2	2.53	0.23	1.1		5.0	50	5.44	2.76
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	26/11/10	<0.094	2	117.52	7.3	7.36	0.02	1.6		4.0	138	7.01	7.38
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	29/11/10			122.54							5		
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	7/12/10	0.38	1	206.30	7.1	8.07	0.09	2.4		3.0	4	9.27	8.16
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	15/12/10	<0.094	1	143.03	7.2	4.85	0.01	2.2		3.0	7	5.84	4.86
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	20/12/10	0.35	2	251.78	7.0	6.09	0.15	2.0		6.0	1	8.82	6.24
Ballyrickard PPP WWTW Effluent COMPLIANCE	S35AU	28/12/10	0.57	1	147.38	7.0	3.02	0.28	1.1		2.0	91	5.61	3.30
Downpatrick Aeration WWTW Effluent	S36AA	12/1/10	<0.094	1		7.1	7.27	<0.003	<0.153	<0.489	3.0		8.01	7.28
Downpatrick Aeration WWTW Effluent	S36AA	28/1/10	<0.094	2		7.5	7.13	0.01	<0.153	<0.489	<0.100		7.59	7.14
Downpatrick Aeration WWTW Effluent	S36AA	8/2/10	<0.094	1		7.4	3.89	0.03	<0.153	<0.489	1.0		4.60	3.93
Downpatrick Aeration WWTW	S36AA	24/2/10	<0.094	2		7.0	5.42	0.12	<0.153	<0.489	11.0		6.38	5.54

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Effluent														
Downpatrick Aeration WWTW Effluent	S36AA	12/3/10	<0.094	2		7.0	9.11	<0.003	<0.153	<0.489	6.0		9.15	9.11
Downpatrick Aeration WWTW Effluent	S36AA	23/3/10	<0.094	3		6.9	7.74	<0.003	0.3	<0.489	4.0		7.78	7.75
Downpatrick Aeration WWTW Effluent	S36AA	8/4/10	<0.094	1		7.5	6.98	<0.003	<0.153	<0.489	5.0		7.11	6.98
Downpatrick Aeration WWTW Effluent	S36AA	19/4/10	<0.094	1		6.7	6.58	0.01	0.2	<0.489	3.0		7.01	6.58
Downpatrick Aeration WWTW Effluent	S36AA	5/5/10	<0.094	1		7.1	8.05	<0.003	0.7	0.51	2.0		9.00	8.06
Downpatrick Aeration WWTW Effluent	S36AA	21/5/10	0.12	<0.186		7.2	8.13	0.01	1.3	1.28	3.0		8.64	8.14
Downpatrick Aeration WWTW Effluent	S36AA	17/6/10	<0.094	1		7.3	6.34	0.02	2.4	2.50	3.0		7.44	6.36
Downpatrick Aeration WWTW Effluent	S36AA	28/6/10	<0.094	2		7.5	5.50	0.01	0.7	0.99	11.0		6.32	5.51
Downpatrick Aeration WWTW Effluent	S36AA	15/7/10	<0.094	1		7.4	2.82	0.01	0.4	0.50	4.0		3.39	2.83
Downpatrick Aeration WWTW Effluent	S36AA	30/7/10	0.11	1		7.6	5.35	0.01	1.2	1.22	4.0		5.62	5.36
Downpatrick Aeration WWTW Effluent	S36AA	10/8/10	<0.094	1		7.4	6.91	<0.003	1.7	1.70	4.0		7.17	6.91
Downpatrick Aeration WWTW Effluent	S36AA	26/8/10	0.11	2		7.5	5.35	0.01	0.5	0.70	9.0		6.34	5.36
Downpatrick Aeration WWTW Effluent	S36AA	6/9/10	0.27	1		7.4	5.28	0.05	0.5	0.53	1.0		5.94	5.33
Downpatrick Aeration WWTW Effluent	S36AA	22/9/10	0.12	1		7.2	6.79	0.23	1.7	1.76	1.0		7.36	7.02
Downpatrick Aeration WWTW Effluent	S36AA	8/10/10	0.10	2		7.4	6.08	0.02	0.4	0.56	13.0		6.65	6.10
Downpatrick Aeration WWTW Effluent	S36AA	19/10/10	<0.094	1		7.4	7.11	0.02	0.5	0.82	9.0		8.33	7.12
Downpatrick Aeration WWTW Effluent	S36AA	4/11/10	<0.094	2		7.2	4.96	0.01	0.3	0.69	5.0		5.80	4.97
Downpatrick Aeration WWTW Effluent	S36AA	15/11/10	<0.094	2		7.4	3.53	<0.003	0.2	<0.489	7.0		3.99	3.53

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Downpatrick Aeration WWTW Effluent	S36AA	1/12/10	<0.094	6		7.5	6.17	<0.003	0.4	0.92	27.0		7.90	6.17
Downpatrick Aeration WWTW Effluent	S36AA	17/12/10	<0.094	1		7.8	6.23	<0.003	0.3	<0.489	1.0		6.57	6.22
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	12/1/10	<0.094	2		7.0	8.20	<0.003	<0.153	<0.489	3.0		9.05	8.20
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	8/2/10	<0.094	2		7.4	4.72	<0.003	<0.153	<0.489	4.0		5.36	4.72
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	12/3/10	<0.094	1		6.8	8.95	<0.003	<0.153	<0.489	3.0		9.47	8.96
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	18/4/10	0.11	3		7.5	8.83	0.03	0.2	<0.489	4.0		9.37	8.85
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	5/5/10	<0.094	2		7.3	7.53	0.01	0.5	<0.489	6.0		8.22	7.54
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	15/7/10	<0.094	2		7.5	4.03	0.01	0.4	0.62	4.0		4.76	4.05
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	10/8/10	<0.094	2		7.4	6.61	<0.003	1.6	1.62	4.0		7.26	6.60
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	6/9/10	0.26	1		7.5	5.66	0.05	0.5	1.01	2.0		6.40	5.72
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	8/10/10	0.15	3		7.5	5.52	0.02	0.2	0.84	21.0		7.06	5.54
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	15/11/10	<0.094	2		7.4	3.23	0.02	<0.153	0.58	10.0		3.85	3.25
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	1/12/10	0.21	11		7.6	4.85	0.01	0.2	1.01	29.0		6.92	4.86
Downpatrick Aeration WWTW UWWTR Effluent	U36AA	17/12/10	<0.094	2		7.8	7.24	<0.003	0.3	0.54	4.0		8.68	7.24
Drumaness MBR WWTW Effluent	S36BD	19/1/10	<0.094	1		7.1	11.61	0.03	1.3	1.30	0.6		11.77	11.64
Drumaness MBR WWTW Effluent	S36BD	15/2/10	<0.094	1		6.7	21.26	<0.003	2.6	2.55	0.1		21.81	21.26
Drumaness MBR WWTW Effluent	S36BD	19/3/10	0.52	2		6.7	14.83	0.18	1.7	1.80	0.7		15.75	15.01
Drumaness MBR WWTW Effluent	S36BD	15/4/10	<0.094	1		6.8	24.65	<0.003	3.0	3.34	0.4		26.26	24.65
Drumaness MBR WWTW	S36BD	12/5/10	0.32	1		6.1	32.00	0.04	4.6	4.63	1.1		35.90	32.08

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Effluent														
Drumaness MBR WWTW Effluent	S36BD	8/6/10	0.61	2		5.3	28.44	0.01	4.0	4.32	0.3		30.73	28.45
Drumaness MBR WWTW Effluent	S36BD	5/7/10	6.92	3		6.8	11.84	0.02	3.7	3.72	0.8		19.23	11.86
Drumaness MBR WWTW Effluent	S36BD	6/8/10	0.10	1		6.4	22.06	0.04	3.8	3.87	0.3		22.48	22.10
Drumaness MBR WWTW Effluent	S36BD	2/9/10	1.05	2		6.4	23.94	0.14	4.2	4.30	1.5		26.45	24.08
Drumaness MBR WWTW Effluent	S36BD	26/10/10	<0.094	3		6.5	14.80	0.01	2.2	2.29	3.8		14.51	14.80
Drumaness MBR WWTW Effluent	S36BD	22/11/10	1.22	1		7.1	12.29	0.07	<0.153	1.35	1.7		13.60	12.36
Drumaness MBR WWTW Effluent	S36BD	8/12/10	0.11	2		6.4	28.20	0.07	3.4	3.54	0.6		31.97	28.27
Drumaness WWTW UWWTR Effluent	U36BD	19/1/10	<0.094	2		7.3	10.25	0.01	1.0		1.0			10.25
Drumaness WWTW UWWTR Effluent	U36BD	15/2/10	<0.094	1		7.1	20.86	0.01	2.6		<0.100			20.87
Drumaness WWTW UWWTR Effluent	U36BD	19/3/10	1.63	2		7.0	15.06	0.09	2.5		2.0			15.15
Drumaness WWTW UWWTR Effluent	U36BD	15/4/10	0.12	2		6.5	26.98	0.03	3.5		1.0			27.00
Drumaness WWTW UWWTR Effluent	U36BD	12/5/10	0.45	2		6.3	28.80	0.14	4.4		3.0			28.94
Drumaness WWTW UWWTR Effluent	U36BD	8/6/10	2.98	4		5.5	35.90	0.02	4.8		3.0			35.90
Drumaness WWTW UWWTR Effluent	U36BD	5/7/10	5.31	5		6.8	7.41	0.02	5.0		3.0			7.43
Drumaness WWTW UWWTR Effluent	U36BD	6/8/10	0.14	2		6.6	21.83	0.06	3.6		1.0			21.89
Drumaness WWTW UWWTR Effluent	U36BD	2/9/10	0.29	2		6.4	23.94	0.09	3.8		39.0			24.04
Drumaness WWTW UWWTR Effluent	U36BD	16/10/10	<0.094	2		6.6	20.34	0.02	3.0		4.0			20.36
Drumaness WWTW UWWTR Effluent	U36BD	13/12/10	<0.094	<0.186		7.0	15.69	0.03	1.7		<0.100			15.71

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Drumaness WWTW UWWTR Effluent	U36BD	16/12/10	<0.09	1		6.8	22.91	0.01	3.0		3.0			22.92
Greyabbey MBR WWTW Effluent	S35AG	15/1/10	<0.094	2	104.82	7.4	8.76	<0.003	0.9		8.5			8.76
Greyabbey MBR WWTW Effluent	S35AG	10/3/10	0.59	<0.186	74.56	6.8	14.23	0.19	1.3		0.9			14.42
Greyabbey MBR WWTW Effluent	S35AG	7/4/10	<0.094	1	57.69	7.1	8.70	<0.003	0.8		0.1			8.70
Greyabbey MBR WWTW Effluent	S35AG	4/5/10	0.22	1	57.14	6.7	21.04	0.11	1.9		0.2			21.16
Greyabbey MBR WWTW Effluent	S35AG	14/5/10	<0.094	1	51.39	6.7	19.08	0.03	2.0		<0.100			19.12
Greyabbey MBR WWTW Effluent	S35AG	4/6/10	0.27	1	58.37	6.0	31.70	0.05	3.9		0.8			31.75
Greyabbey MBR WWTW Effluent	S35AG	28/7/10	<0.094	2	66.10	6.4	27.38	<0.003	5.0		0.1			27.38
Greyabbey MBR WWTW Effluent	S35AG	24/8/10	0.62	1	51.51	7.0	10.64	0.03	1.1		0.1			10.67
Greyabbey MBR WWTW Effluent	S35AG	20/9/10	0.15	1	92.69	6.8	17.49	0.04	1.7		0.4			17.53
Greyabbey MBR WWTW Effluent	S35AG	25/10/10	<0.094	1	98.72	6.7	15.44	0.07	1.8		0.7			15.52
Greyabbey MBR WWTW Effluent	S35AG	18/11/10	<0.094	1	74.18	6.9	8.72	<0.003	1.1		0.2			8.71
Greyabbey MBR WWTW Effluent	S35AG	29/11/10	<0.094	<0.186	327.33	7.0	12.83	0.01	1.6		0.8			12.83
Killinchy WWTW Effluent	S35AI	18/1/10	0.16	6		7.0	17.71	0.08	2.8		9.0			17.79
Killinchy WWTW Effluent	S35AI	3/2/10	<0.094	11		7.7	8.70	0.06	2.6		38.0			8.76
Killinchy WWTW Effluent	S35AI	29/3/10	0.41	7		7.3	13.36	0.16	4.3		8.0			13.52
Killinchy WWTW Effluent	S35AI	30/4/10	0.10	7		6.9	12.32	0.09	3.6		24.0			12.41
Killinchy WWTW Effluent	S35AI	27/5/10	0.40	13		7.0	16.33	0.21	5.0		10.0			16.54
Killinchy WWTW Effluent	S35AI	23/6/10	0.62	7		6.8	19.52	0.35	6.0		17.0			19.87
Killinchy WWTW Effluent	S35AI	20/7/10	0.30	7		7.2	7.10	0.12	1.8		14.0			7.22
Killinchy WWTW Effluent	S35AI	16/8/10	1.04	6		6.4	10.38	0.13	2.5		23.0			10.50
Killinchy WWTW Effluent	S35AI	17/9/10	0.29	5		7.2	10.72	0.18	3.2		13.0			10.91

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Killinchy WWTW Effluent	S35AI	27/10/10	0.15	8		7.2	6.44	0.06	2.0		21.0			6.50
Killinchy WWTW Effluent	S35AI	10/11/10	<0.094	3		7.1	6.85	0.04	1.3		12.0			6.89
Killinchy WWTW Effluent	S35AI	7/12/10	0.71	7		7.2	12.10	0.06	3.6		29.0			12.16
Killinchy WWTW UWWTR Effluent	U35AI	3/2/10	0.16	8		7.2	18.62	0.12	3.5		23.0			18.74
Killinchy WWTW UWWTR Effluent	U35AI	22/2/10	2.02	11		7.3	8.84	0.15	3.0		5.0			8.98
Killinchy WWTW UWWTR Effluent	U35AI	29/3/10	0.10	2		6.9	1.20	0.02	1.0		2.0			1.22
Killinchy WWTW UWWTR Effluent	U35AI	30/4/10	0.11	8		6.7	8.03	0.07	2.4		14.0			8.10
Killinchy WWTW UWWTR Effluent	U35AI	27/5/10	0.24	10		6.9	7.69	0.12	2.7		11.0			7.81
Killinchy WWTW UWWTR Effluent	U35AI	6/6/10	0.40	11		7.2	17.40	0.29	4.8		14.0			17.69
Killinchy WWTW UWWTR Effluent	U35AI	20/7/10	<0.094	17		6.9	2.26	0.05	1.1		9.0			2.31
Killinchy WWTW UWWTR Effluent	U35AI	16/8/10	1.80	6		6.4	14.83	0.22	4.5		10.0			15.04
Killinchy WWTW UWWTR Effluent	U35AI	17/9/10	0.17	6		7.0	5.93	0.09	2.3		5.0			6.03
Killinchy WWTW UWWTR Effluent	U35AI	14/10/10	0.25	7		7.0	14.79	0.17	3.9		17.0			14.96
Killinchy WWTW UWWTR Effluent	U35AI	10/11/10	<0.094	3		6.5	5.97	0.02	1.2		9.0			5.99
Killinchy WWTW UWWTR Effluent	U35AI	7/12/10	0.47	5		7.0	7.40	0.03	2.5		15.0			7.43
Killyleagh WWTW Effluent	S36AD	12/1/10	<0.094	9	248.08	7.1	9.47	0.03	0.8		6.0			9.50
Killyleagh WWTW Effluent	S36AD	28/1/10	<0.094	3	62.30	7.2	10.02	0.01	1.0		3.0			10.02
Killyleagh WWTW Effluent	S36AD	8/2/10	<0.094	3	118.55	7.3	7.24	<0.003	1.0		7.0			7.24
Killyleagh WWTW Effluent	S36AD	24/2/10	<0.094	4	261.58	7.0	15.58	0.06	1.7		12.0			15.63
Killyleagh WWTW Effluent	S36AD	12/3/10	<0.094	2	113.43	6.9	17.49	0.07	1.7		8.0			17.57
Killyleagh WWTW Effluent	S36AD	23/3/10	<0.094	2	598.47	6.7	14.83	0.37	1.8		14.0			15.20
Killyleagh WWTW Effluent	S36AD	8/4/10	<0.094	2	48.04	7.3	6.96	<0.003	0.5		9.0			6.96

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Killyleagh WWTW Effluent	S36AD	19/4/10	<0.094	3	83.43	6.6	15.95	0.01	1.9		3.0			15.96
Killyleagh WWTW Effluent	S36AD	5/5/10	<0.094	1	349.67	6.8	18.75	0.01	2.5		6.0			18.76
Killyleagh WWTW Effluent	S36AD	21/5/10	0.13	3	484.42	6.6	21.08	0.02	2.2		11.0			21.10
Killyleagh WWTW Effluent	S36AD	17/6/10	0.10	3	573.49	6.7	19.74	0.16	2.9		15.0			19.89
Killyleagh WWTW Effluent	S36AD	28/6/10	0.46	2	915.57	7.2	0.65	0.14	3.6		24.0			0.80
Killyleagh WWTW Effluent	S36AD	15/7/10	<0.094	2	826.53	7.1	9.12	0.01	1.6		11.0			9.13
Killyleagh WWTW Effluent	S36AD	30/7/10	<0.094	1	345.77	7.0	17.57	0.05	2.7		6.0			17.62
Killyleagh WWTW Effluent	S36AD	10/8/10	<0.094	1	452.49	6.9	14.70	0.09	2.8		10.0			14.79
Killyleagh WWTW Effluent	S36AD	26/8/10	<0.094	2	702.92	6.9	18.46	0.04	2.9		14.0			18.50
Killyleagh WWTW Effluent	S36AD	6/9/10	0.21	1	472.13	6.9	16.98	0.16	3.6		8.0			17.14
Killyleagh WWTW Effluent	S36AD	22/9/10	<0.094	2	607.00	6.9	18.83	0.02	2.6		8.0			18.85
Killyleagh WWTW Effluent	S36AD	8/10/10	0.11	2	1697.20	7.1	12.07	0.01	1.6		23.0			12.08
Killyleagh WWTW Effluent	S36AD	19/10/10	0.36	1	526.12	7.0	9.99	0.12	2.3		13.0			10.11
Killyleagh WWTW Effluent	S36AD	4/11/10	<0.094	1	161.01	7.2	6.42	<0.003	0.6		3.0			6.43
Killyleagh WWTW Effluent	S36AD	15/11/10	0.13	1	92.47	7.3	9.41	<0.003	1.1		6.0			9.41
Killyleagh WWTW Effluent	S36AD	1/12/10	<0.094	1	237.08	7.4	13.06	<0.003	0.5		6.0			13.05
Killyleagh WWTW Effluent	S36AD	17/12/10	<0.094	2	385.52	7.5	19.31	<0.003	2.0		5.0			19.30
Killyleagh WWTW UWWTR Effluent	U36AD	8/2/10	<0.094	4		7.2	6.73	<0.003	0.9		10.0			6.72
Killyleagh WWTW UWWTR Effluent	U36AD	5/5/10	<0.094	2		6.7	18.35	0.01	2.5		9.0			18.36
Killyleagh WWTW UWWTR Effluent	U36AD	10/8/10	0.14	5		7.0	15.29	0.16	3.0		12.0			15.45
Killyleagh WWTW UWWTR Effluent	U36AD	19/10/10	0.79	5		7.1	10.10	0.20	2.3		12.0			10.31
Kilmore WWTW Effluent	S36AM	5/2/10	12.67	53		7.5	2.14	0.19	1.3		83.0			2.32
Kilmore WWTW Effluent	S36AM	16/2/10	38.34	42		7.3	<0.100	<0.003	5.4		96.0			<0.196
Kilmore WWTW Effluent	S36AM	4/3/10	29.19	70		7.4	<0.100	0.14	3.5		77.0			<0.196
Kilmore WWTW Effluent	S36AM	27/4/10	39.67	57		7.2	0.12	<0.003	5.5		51.0			<0.196
Kilmore WWTW Effluent	S36AM	24/5/10	31.56	62		7.2	<0.100	1.12	5.7		42.0			1.10

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Kilmore WWTW Effluent	S36AM	25/6/10	9.01	20		6.8	10.65	5.32	7.8		72.0			15.98
Kilmore WWTW Effluent	S36AM	22/7/10	5.51	15		7.4	3.53	0.24	1.1		13.0			3.77
Kilmore WWTW Effluent	S36AM	18/8/10	21.28	21		7.4	<0.100	0.08	4.1		32.0			<0.196
Kilmore WWTW Effluent	S36AM	14/9/10	27.58	44		7.4	0.10	0.05	3.8		59.0			<0.196
Kilmore WWTW Effluent	S36AM	11/10/10	5.54	7		7.2	15.21	8.33	4.0		17.0			23.54
Kilmore WWTW Effluent	S36AM	12/11/10	2.10	7		7.2	8.29	0.27	1.0		18.0			8.56
Kilmore WWTW Effluent	S36AM	9/12/10	42.00	53		7.5	<0.100	0.02	5.5		75.0			<0.196
Loughries WWTW Effluent	S35AM	7/1/10	3.53	11		7.4	10.37	0.21	2.0		9.0			10.58
Loughries WWTW Effluent	S35AM	3/2/10	1.84	5		7.9	9.12	0.19	1.4		4.0			9.31
Loughries WWTW Effluent	S35AM	29/3/10	0.97	4		7.3	7.37	0.13	1.2		5.0			7.50
Loughries WWTW Effluent	S35AM	30/4/10	0.28	6		6.8	9.69	0.08	1.8		6.0			9.77
Loughries WWTW Effluent	S35AM	27/5/10	0.28	7		7.0	10.26	0.07	2.1		6.0			10.33
Loughries WWTW Effluent	S35AM	23/6/10	0.41	3		6.9	10.00	0.14	2.2		11.0			10.14
Loughries WWTW Effluent	S35AM	5/8/10	0.48	7		7.1	8.31	0.11	1.8		5.0			8.42
Loughries WWTW Effluent	S35AM	16/8/10	0.31	3		7.0	7.11	0.11	1.9		4.0			7.21
Loughries WWTW Effluent	S35AM	17/9/10	0.96	8		6.8	8.47	0.15	1.9		16.0			8.62
Loughries WWTW Effluent	S35AM	14/10/10	0.49	5		7.1	13.80	0.16	2.6		8.0			13.95
Loughries WWTW Effluent	S35AM	26/11/10	0.63	8		7.0	7.41	0.13	1.1		8.0			7.54
Loughries WWTW Effluent	S35AM	7/12/10	0.99	4		7.3	10.09	0.11	1.7		10.0			10.21
Moneyreagh MBR WWTW Effluent	S35AT	20/1/10	0.38	1		7.1	12.80	<0.003	1.3	1.90	0.3		13.77	12.80
Moneyreagh MBR WWTW Effluent	S35AT	16/2/10	<0.094	1		7.2	18.05	<0.003	2.5	2.58	0.2		19.71	18.05
Moneyreagh MBR WWTW Effluent	S35AT	16/4/10	0.96	1		6.8	22.24	0.08	3.7	3.69	0.4		23.63	22.32
Moneyreagh MBR WWTW Effluent	S35AT	13/5/10	15.37	30		7.1	<0.100	0.02	10.1	10.17	6.6		18.63	<0.196
Moneyreagh MBR WWTW Effluent	S35AT	24/5/10	6.41	7		7.3	4.56	0.06	2.4	2.50	0.9		11.83	4.62
Moneyreagh MBR WWTW Effluent	S35AT	25/6/10	1.49	1		6.6	19.40	0.16	4.7	4.22	0.4		19.36	19.57

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Moneyreagh MBR WWTW Effluent	S35AT	6/7/10	0.24	1		6.7	14.98	0.04	2.7	2.65	3.2		15.15	15.02
Moneyreagh MBR WWTW Effluent	S35AT	2/8/10	0.18	1		7.1	16.73	0.04	2.2	2.27	1.5		17.32	16.77
Moneyreagh MBR WWTW Effluent	S35AT	3/9/10	0.38	1		7.1	1.87	0.08	1.8	1.82	1.2		2.46	1.95
Moneyreagh MBR WWTW Effluent	S35AT	27/10/10	0.11	2		7.0	15.84	0.01	1.9	1.98	1.8		15.62	15.85
Moneyreagh MBR WWTW Effluent	S35AT	23/11/10	0.10	1		7.2	15.98	0.02	2.1	2.08	1.1		16.70	16.00
Moneyreagh MBR WWTW Effluent	S35AT	16/12/10	0.26	1		7.0	17.00	0.03	2.4	2.63	2.1		19.73	17.03
Moneyreagh WWTW UWWTR Effluent	U35AT	20/1/10	<0.094	1		7.3	13.17	0.01	1.3		1.0			13.19
Moneyreagh WWTW UWWTR Effluent	U35AT	16/4/10	0.20	2		6.9	20.58	0.02	3.3		6.0			20.61
Moneyreagh WWTW UWWTR Effluent	U35AT	2/8/10	<0.094	2		7.1	8.99	0.02	1.7		2.0			9.01
Moneyreagh WWTW UWWTR Effluent	U35AT	27/10/10	<0.094	6		7.1	13.02	<0.003	1.6		4.0			13.02
Portaferry New WWTW Effluent	S35AV	15/1/10	0.81	3		6.7	11.89	0.08	1.3		15.0	60		11.97
Portaferry New WWTW Effluent	S35AV	26/1/10	0.21	4		7.0	11.17	0.04	1.1		9.0	7		11.21
Portaferry New WWTW Effluent	S35AV	22/2/10	2.08	8		6.9	13.45	0.11	2.1		9.0	24		13.56
Portaferry New WWTW Effluent	S35AV	26/3/10	<0.094	7		6.7	9.71	0.01	1.5		21.0	560		9.72
Portaferry New WWTW Effluent	S35AV	7/4/10	<0.094	1		6.5	10.23	<0.003	1.2		18.0	219		10.23
Portaferry New WWTW Effluent	S35AV	22/4/10	0.18	4	2207.20	6.8	16.21	0.03	3.8		9.0	192		16.23
Portaferry New WWTW Effluent	S35AV	4/5/10	0.12	4	2375.60	6.6	12.55	0.04	3.6		6.0	56		12.59
Portaferry New WWTW Effluent	S35AV	14/5/10	0.12	3		6.8	13.36	0.04	3.6		10.0	308		13.40
Portaferry New WWTW	S35AV	19/5/10	0.15	4	2297.80	6.6	14.86	0.04	3.6		7.0	115		14.90

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Effluent														
Portaferry New WWTW Effluent	S35AV	4/6/10	0.16	6	2042.90	6.7	15.98	0.03	3.3		9.0	231		16.01
Portaferry New WWTW Effluent	S35AV	15/6/10	0.26	3	1995.20	6.8	13.96	0.04	2.8		4.0	21		14.01
Portaferry New WWTW Effluent	S35AV	24/6/10	0.28	5		6.9	13.41	0.11	4.1		6.0	126		13.52
Portaferry New WWTW Effluent	S35AV	1/7/10	0.30	3	2741.90	6.7	11.49	0.03	3.3		3.0	58		11.52
Portaferry New WWTW Effluent	S35AV	14/7/10	<0.094	2	1846.00	6.7	11.11	0.01	1.3		3.0	91		11.12
Portaferry New WWTW Effluent	S35AV	28/7/10	0.33	2	1975.30	7.4	10.08	0.14	0.2		1.0	57		10.22
Portaferry New WWTW Effluent	S35AV	24/8/10	<0.094	2	199.11	6.9	9.27	0.01	1.1		14.0	387		9.28
Portaferry New WWTW Effluent	S35AV	9/9/10	<0.094	3	394.75	7.0	13.89	0.03	2.9		9.0	16		13.92
Portaferry New WWTW Effluent	S35AV	20/9/10	<0.094	3	205.86	7.0	12.56	0.03	3.9		12.0	11		12.59
Portaferry New WWTW Effluent	S35AV	6/10/10	0.12	6	339.52	7.0	14.02	0.03	2.5		10.0	<1		14.05
Portaferry New WWTW Effluent	S35AV	22/10/10	<0.094	2	221.62	6.7	15.88	0.02	3.4		14.0	1020		15.90
Portaferry New WWTW Effluent	S35AV	2/11/10	<0.094	3	186.85	7.0	12.72	0.01	2.2		6.0	43		12.73
Portaferry New WWTW Effluent	S35AV	18/11/10	<0.094	1	131.26	6.8	10.87	<0.003	1.6		10.0	43		10.86
Portaferry New WWTW Effluent	S35AV	29/11/10	<0.094	1	176.41	6.9	14.51	<0.003	2.5		6.0	3		14.51
Portaferry New WWTW Effluent	S35AV	15/12/10	<0.094	3	139.21	7.0	16.01	0.01	3.2		7.0	12		16.02
Portglenone WWTW UWWTR Effluent	U13AW	26/5/10	0.17	1		7.0	21.86	0.14	4.1		2.0			22.00
Portglenone WWTW UWWTR Effluent	U13AW	30/6/10	<0.094	3		7.2	9.26	0.06	2.8		7.0			9.32
Portglenone WWTW UWWTR Effluent	U13AW	24/9/10	0.10	1		7.5	7.99	0.04	0.5		1.0			8.02

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Portglenone WWTW UWWTR Effluent	U13AW	14/12/10	<0.094	3		7.2	10.65	<0.003	1.1		4.0			10.65
Ringniell WWTW Effluent	S35AR	18/1/10	0.85	3		7.1	7.94	0.03	0.7		4.0			7.97
Ringniell WWTW Effluent	S35AR	3/2/10	<0.094	3		7.8	14.75	0.08	1.2		11.0			14.83
Ringniell WWTW Effluent	S35AR	29/3/10	<0.094	2		6.9	5.79	0.02	1.7		4.0			5.82
Ringniell WWTW Effluent	S35AR	30/4/10	<0.094	4		6.7	5.18	0.02	3.1		9.0			5.20
Ringniell WWTW Effluent	S35AR	27/5/10	0.12	14		6.9	8.07	0.03	6.1		13.0			8.10
Ringniell WWTW Effluent	S35AR	23/6/10	0.55	16		6.8	6.24	0.08	5.8		76.0			6.32
Ringniell WWTW Effluent	S35AR	20/7/10	<0.094	4		6.9	4.55	0.02	1.5		9.0			4.57
Ringniell WWTW Effluent	S35AR	16/8/10	0.15	1		6.9	6.47	0.02	7.3		6.0			6.48
Ringniell WWTW Effluent	S35AR	17/9/10	<0.094	2		6.9	6.00	0.03	4.4		6.0			6.02
Ringniell WWTW Effluent	S35AR	14/10/10	<0.094	6		6.7	8.93	0.01	5.1		8.0			8.95
Ringniell WWTW Effluent	S35AR	10/11/10	<0.094	1		6.7	7.52	<0.003	1.2		8.0			7.51
Ringniell WWTW Effluent	S35AR	15/12/10	<0.094	2		7.2	5.20	0.03	2.5		6.0			5.23
Saintfield WWTW Effluent	S36BS	4/1/10	<0.094	1		6.7	6.25	0.02	<0.153	<0.489	5.0		7.39	6.26
Saintfield WWTW Effluent	S36BS	5/2/10	<0.094	2		6.8	2.51	0.01	1.1	0.98	5.0		3.36	2.52
Saintfield WWTW Effluent	S36BS	4/3/10	<0.094	1		6.7	6.64	<0.003	1.8	1.93	1.0		7.98	6.64
Saintfield WWTW Effluent	S36BS	27/4/10	0.32	1		6.8	5.39	0.01	1.9	2.02	3.0		5.81	5.40
Saintfield WWTW Effluent	S36BS	24/5/10	<0.094	2		6.7	5.61	0.02	3.1	3.17	1.0		6.35	5.63
Saintfield WWTW Effluent	S36BS	25/6/10	0.17	1		6.8	9.74	0.05	5.0	4.83	<0.100		9.58	9.79
Saintfield WWTW Effluent	S36BS	22/7/10	0.15	2		7.4	3.26	0.02	0.6	0.74	4.0		3.80	3.29
Saintfield WWTW Effluent	S36BS	18/8/10	0.37	2		7.2	3.18	0.17	4.8	5.32	6.0		5.21	3.35
Saintfield WWTW Effluent	S36BS	14/9/10	<0.094	1		7.1	5.01	0.01	2.4	2.37	1.0		5.96	5.01
Saintfield WWTW Effluent	S36BS	11/10/10	<0.094	2		7.4	7.71	0.03	2.6	2.77	2.0		8.32	7.73
Saintfield WWTW Effluent	S36BS	12/11/10	<0.094	4		6.9	3.99	<0.003	0.6	0.66	4.0		4.69	3.98
Saintfield WWTW Effluent	S36BS	9/12/10	<0.094	2		7.0	6.71	0.01	1.9	1.90	2.0		7.32	6.71
Saintfield WWTW UWWTR Effluent	U36BS	5/2/10	<0.094	3		7.0	4.09	0.01	1.2		9.0			4.10
Saintfield WWTW UWWTR Effluent	U36BS	16/2/10	<0.094	2		6.8	4.97	<0.003	3.2		6.0			4.97

Sample Point Description	Site Code	Sampled date	NH_4 mg/l	BOD (ATU) mg/l O2	Cl mg/l	pH	NO_3 mg/l	NO_2 mg/l	P (SRP) mg/l	P (TOT) mg/l	SS mg/l	Total Coliforms MPN	Total N mg/l	Total Oxidised N mg/l as N
Saintfield WWTW UWWTR Effluent	U36BS	4/3/10	0.75	1		6.9	8.19	0.08	2.5		6.0			8.27
Saintfield WWTW UWWTR Effluent	U36BS	18/4/10	<0.094	2		6.7	9.47	0.02	2.5		2.0			9.48
Saintfield WWTW UWWTR Effluent	U36BS	24/5/10	0.13	4		6.8	5.80	0.05	2.8		11.0			5.86
Saintfield WWTW UWWTR Effluent	U36BS	6/7/10	0.11	1		7.0	10.73	0.05	2.3		13.0			10.78
Saintfield WWTW UWWTR Effluent	U36BS	22/7/10	0.16	1		7.3	3.66	0.02	0.6		<0.100			3.68
Saintfield WWTW UWWTR Effluent	U36BS	18/8/10	0.15	2		7.2	6.06	0.04	3.7		1.0			6.10
Saintfield WWTW UWWTR Effluent	U36BS	30/9/10	0.14	1		6.9	7.13	<0.003	2.0		2.0			7.14
Saintfield WWTW UWWTR Effluent	U36BS	11/10/10	<0.094	1		7.2	8.08	0.02	2.5		<0.100			8.10
Saintfield WWTW UWWTR Effluent	U36BS	9/12/10	0.10	3		7.2	7.74	0.02	2.6		2.0			7.76
Saintfield WWTW UWWTR Effluent	U36BS	16/12/10	<0.09	2		6.9	6.86	<0.00	2.5		3.0			6.85
Strangford WWTW Effluent	S36AK	28/1/10	2.12	5	719.82	7.6	12.14	0.12	2.3		13.0			12.26
Strangford WWTW Effluent	S36AK	8/2/10	0.27	5	612.51	7.5	16.48	0.08	2.6		12.0			16.55
Strangford WWTW Effluent	S36AK	23/3/10	0.72	10	2776.90	6.9	20.18	0.11	3.9		33.0			20.29
Strangford WWTW Effluent	S36AK	19/4/10	2.58	8	2159.30	6.6	22.06	0.34	4.9		19.0			22.40
Strangford WWTW Effluent	S36AK	21/5/10	0.57	8	2281.00	6.8	32.10	0.14	7.2		40.0			32.28
Strangford WWTW Effluent	S36AK	17/6/10	1.72	7	2734.80	6.9	27.28	0.27	6.8		68.0			27.56
Strangford WWTW Effluent	S36AK	15/7/10	5.25	17	2437.20	7.1	5.31	0.56	4.3		43.0			5.87
Strangford WWTW Effluent	S36AK	10/8/10	1.31	5	1957.10	6.9	23.24	0.22	5.9		28.0			23.46
Strangford WWTW Effluent	S36AK	6/9/10	0.47	3	1701.00	6.9	27.84	0.07	6.8		35.0			27.91
Strangford WWTW Effluent	S36AK	8/10/10	1.38	3	6216.10	7.2	9.00	0.42	2.8		99.0			9.42
Strangford WWTW Effluent	S36AK	4/11/10	0.17	4	1088.10	7.5	6.04	0.05	1.0		16.0			6.09
Strangford WWTW Effluent	S36AK	1/12/10	0.11	6	1761.00	7.6	15.39	0.03	3.1		32.0			15.43

NH_4 Ammonium, NO_3 Nitrate, NO_2 Nitrite, P Phosphorus, BOD Biochemical Oxygen Demand, SS Suspended Solids, Cl Chloride

Appendix 2

Shellfish Sampling *E. coli* Results

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CERTtFICATE OF ANALYSIS

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Appendix 3

Water Sampling *E. coli* Results

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Parameter and Method Reference	Rllltl	••••	p.,,,f-.11+1	Ftllllll!"M
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NIWaler AnalyOcal Services

Certifieale of Analysis

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t2:llttpi.lQ; AOlM'Fl_lW,n 14.."l!IIU

Parameter and Method Reference			Pass Fail	Fail Level
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Sample Comments

Issued by: N,.r,uishil, -ga,.iw1
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NIWater AnaJytiCql Services

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Certificate Id: 1428714 / 2011-04-21
Sample ID: AQUAFT 4W-11-1428714

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AguohPrtvau S..mpla pofn1

WIG

Parameter and Method Reference		Unit	Pass Fail	Fail Level
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f: oMPfflsl.l"Pf\'11		MPN		
Tol..lo-;fflMI•		MPN		
fotill«fl\11m& Pl 1D!IW:'	• •	MPN		

Slllfllle COfllf))l!fllt:

Issued by: ll.tti.'Ul'III MclJ011:1t1l• 1JY(>
ldiQobiolo9"1U11n 9"•
t1•AP,•:.-OU

Please note results relate only to the items tested.
Tests marked * on this report are not included in the UKAS Accreditation Schedule for Analytical Services...

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NI Water Analyfical Services

Certificate of AnaJysls

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Sample Comments:

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A.gunHP.i III&Samplit point

ei,J11•·• W11(1! l, Hil ;till1.().1.'!
!.1mplif ID: A"-L1.at1 1w,11 iE;lE

Parameter and Method Reference	Result	Unit	Pass Fail	Fail Level
t A!III		MPN		
£ l P,-,""ia,:k,•		MPN		
T!Jli,l WKOfillIJ		MPN		
TOIIlJOCitCMNPrOll\lmr:tlYl'l		MPN		

Sample Comments:

Issued by: l 111tiaMtMoR.lglilr4WI
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n..-p. 11

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NI Water An lylical Ser'/ioes
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A911nll Pr'iViile S11mple (IOinl

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51Mf)fli10: .litl'UITT <JW•Il·• lfl7

WH

Par:im1111Jr and t.lGttKNl0k0*'''-'''';;;. ;;	R0• :;;.;•:-	Unll	Pass/Fail	Fail Level
F ti0\	Q.O	IJI¥1		
f 'OO)PM=u IVfl	Q.O	IAl¥1		
fd .r.Aflo.rl	Q.O	IAl¥1		
rQ\,J.,,.ll<,fl 4'1'ot:lll!Oa!A'II	Q.O	IIIIIII		

Sample Comments:

Issued by: Kiill:i•li. lkMi:n.iuhl(iW)
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Sdn1plit IQ: AOtJ.A._CT. ,w.,1.1,11.iu7tll

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Parameter and Method Reference	Alnwl!	,, '	Pass Fail	Fail Limit
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£= 1:1111 , 1111/f'{A¥{	•,,	'' '' ''		
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folllOCl,lomwlf'fci,.,1110!/WI	•••	''''''		

Sample Comments:

Issued by: 14lilll b0011Qlt!JfWJ
IAkullM,"'QY Um11111111
'11'4•1\.11t•Mtl

Please note results relate only to the items tested.
Tests marked * in this report are not included in the UKAS accreditation schedule for this laboratory. Result method is available on request.

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•.. ••·•••,-.,11<1o-•t• !U"•*•.t.N/w-'• 111-,. '\f..;_.,;1.••••...,.. e'f-IT ,i:b
1'-·W f '--t-'..,,fl•-'- ..\l-• ._ ¥ t •• nul ..u u.u.u.u. Wut,..._•- _..._l'<',..,..• OCIMIW-
.'''-,__-__IIIH,##.. ,___,__,- ,,,-/in.lo —————=(/INo_,..M'
/;;;l,lr/•••..,<Jttf''''',111111...1\ n.,o.4,,11,LJ▪>'-•..,.... ll,♦t,11, O.:.UUIN.c.Ms;_.
Jl11-.t,1ol1

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NI Water Analy!JCal Se!Vices

CertiOoat or Analysis

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Sample Comments:

Issued by: IUua,haMd.kl, (4W)
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NI Waler AnalyOcal Services

Cenificate of Analysis

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S9n1fll11ID: AOUNl J.W-1I•I j

Parameter and Method Reference	Result	Unit	Pass/Fail	Fail Level
E """	0.0	MPN		
£ «,l! l'",lltyfl	n.n	MPN		
TolJl:,ol,lc,,,..	1!.0	MPN		
f olal:,ol,rt,tPl-NU!	,••,,	MPN		

Sample Comments:

Issued by: U.IA5-I MCUONQlll l.fWI
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"11-Api.?011

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NIWaler Analytical Services
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T,\1:1)m,,1Ao"1t' P,,..11"' ♦	;'	fJPh		

Sample Comments:

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Parameter and Method Reference	flt.Mill	••,,,	'P.tn:r:1m	FM Lern!I
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Sample Comments:

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NI Water Analytical Services
Certificate al Analysis

northern ireland water

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Parameter and Method Reference	Ilhull	u,111	Pass/Fail	Fail Level
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, 11W.,,...,,., ...,•,•,".	''	MPN		

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ASIW*Pri'iflt" SM!et-i R2fnl

Certificate Id: 1429724 - 2011-04-21
Sample ID: AQUAFT AW-11-1428724

Parameter and Method Reference	Urdt	f-'DIIFall.	Fail Level
E. coli	MPN		
E. coli Presumptive	MPN		
Total coliforms	MPN		
Total coliforms Presumptive	MPN		

Sample Comments:

Issued by: lf41lnf1J M<:MC.M<lle14\lfl
Mbnblllf Q11l.1 1'11181JI
"2"1-AP,•;!011

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NI Wat•• Analytical Services

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C!!ttUk:11tld11•:mro1201•4'CI

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TNDOllrJ,n,,:	0,0	MPf.J		
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Sample Comments:

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NIWater Analytical services

Certiffcate of,Analysis

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C.,m11litnd 0'4•; I "" Wll
AAY:tltPriYf\11§!omRJ" pn!al

Certificate Id: 1420720 / 2011-04-21
Sample ID: AQUAPT AW-11/14297/0

hmnnilirf ,11"4M(KhodRtktlf!IWI	••••••	IIIIII	P.. a,r;1111	Fdill Level
•_,••,		MPft		
E WJPlw;ulfPt',11	0.0	MPt:		
161.1oa11111m,	0.0			
"l'OUlJ Ol'lllfmt 1/v.t				

Sample Comments:

Issued by: tM:Hl'iilM.d.lOl\a.1i-let4WJ
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NI Waler Analyllcal Services
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Parameter and Method Reference	Result	U11"	P n1'fad	Fall L,w..
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E. coli Presumptive	••	• • • • , ,		
TciUa,ll!llm1,	• •	" " " "		
ro-1 1111,11, Pf•11,s11...	1h1	M rr M		

Sample Comments:

Issued by: ll:iiai.i• Mdrilun1Qk(,W()
M Hlbkll 'f MllnttMf
'ft, flt..20!1

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,-..,..._, '9'fiott''''•l.,_......., ,.... ,fo41.,.. """"ll>! -.,!Yto •••--- –
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-jo,,,-£__ - ,_ .''.''.''.'' 1''t''.'', • - - - i 1 1-i- _M •l,,, --1f'U''I :
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NI Waler Analytical Services
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t.l!rn1)111,d \'ko!" , ii AO!1(111
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A911.ill PJhrnl• Sampilt potnl

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II, F.ill,v•I

Jlihllie IIIII

Parameter and Method Reference

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Sample Comments:

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Certificate Id: 1420729 / 2011-04-21
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Parameter and Method Reference		Unit	Pass Fail	fail t.Mttl
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Sample Comments:

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Certlllcate ot Analysis

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Sample Comments:

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NIWater /Inalylieal Servioes

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Certificate Id: 1428731 / 2011-04-21
'SIlrnplt ID., AQUAFT 4W-11-1428731

Parameter and Method Reference	Result	Unit	Pass Fail	Fail Level
I:,:d.	0.0	MPN		
E,o/11 IIM"	0.0	MPN		
T'-"	2.0	MPN		
1# oot"<'l'!'fl.J [Il'ly,!	2.0	MPN		

Sample Comments:

Issued by: tfllMllfMullon,"QWI ffll
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J t-Apr-'011

[illegible]

NI Waler Analylical Servlcea
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Parameter and Method Reference		Unit	Pass/Fail	FMIAYtl
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Sample Comments:

Issued by: lf•IUIIII Mc.Monaott\4'/1)
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Please note results relate only to the items tested.
Tests marked * on this report are not included in the UKAS Accreditation Schedule NI Analytical Services. Result ...
Tests marked $ are ...
Methods ... performed ... Laboratory ... NI Water ... Belfast ... Laboratory ...

£.,Ai,

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Certilicate or Analysis

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Certificate Id: 1428733 / 2011-04-21
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Parameter and Method Reference	Result	Unit	Pass/Fail	Fail Level
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Sample Comments:

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JA•-•"""'•/J.,..-,.,.,.. .._od_ .,.. ,,.,.,r ,_.,.., ,,,-

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NI Water Analytical Sorvices
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Certificate Id: 1428734 / 2011-04-21
Sample ID: AQUAFT 4W-11-1428734

Parameter and Method Reference			
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Sample Comments:

Issued by: Halils-flaMtl,kmagliiftWI
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,.,. .eon