Sanitary Survey Report
and
Sampling Plan
for Dundrum Bay

Produced by

AQUAFACT International Services Ltd

On behalf of

The Food Standards Agency in Northern Ireland

March 2012

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Glossary

ANOVA	Analysis Of Variance
ASP	Amnesic Shellfish Poisoning
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
CAAN	Countryside Access and Activities Network
CD	Chart Datum; the level of water that charted depths displayed on a nautical chart are measured from
CEFAS	Centre for Environmental, Fisheries & Aquaculture Science
CFU	Colony Forming Units
CSO	Combined Sewer Overflow
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*
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
FSA	Food Standards Agency
FSA in NI	Food Standards Agency of Northern Ireland
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
GPS	Global Positioning System
Hydrodynamic	Forces in or motions of liquids

Hydrography	The description and analysis of the physical conditions, boundaries, flows and related characteristics of water bodies
IBA	Important Bird Area
LAT	Lowest Astronomical Tide
Marpol 73/78	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978. Marpol is short for Marine Pollution, 73 for 1973 and 78 for 1978.
MPN	Most Probable Number
MSD	Marine Sanitation Device
NAP	Nitrates Action Programme
ND	Not Detectable
NIEA	Northern Ireland Environment Agency
NISRA	Northern Ireland Statistics and Research Agency
NITB	Northern Ireland Tourist Board
NI Water	Northern Ireland Water
NRL	National Reference Laboratory
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
Pediveligers	In mussels, the third and final free swimming larval stage, prior to settlement or attachment to a substrate
Phytoplankton	Plankton which are primary producers
Plankton/Planktonic	Pertaining to small, free-floating organisms of aquatic systems
PSP	Paralytic Shellfish Poisoning
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
SIN	Site identification number
SOA	Super Output Areas or ward
SPA	Special Protection Area
SPS	Sewage Pumping Station
SSAFO	Silage, Slurry and Agricultural Fuel Oil
Suspension feeders	Animals that feed on small particles suspended in water
TBTO	Tributyl Tin Oxide
UKAS	United Kingdom Accreditation Service
UKHO	United Kingdom Hydrographic Office
WeBS	Wetland Bird Survey
WWPS	Waste Water Pumping Station
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.

Dundrum Bay is located on the southeast coast of County Down between St. John's Point to the east and the Slieve Donard mountains to the east (south of Newcastle). Inner Dundrum Bay is a small sheltered bay connected to the more exposed south facing Outer Dundum Bay by a channel. The Inner Bay is approximately 6km in length and is 1.4km at its widest point. The Inner Bay is intertidal except for the entrance channel. Three main rivers flow in the Inner Bay, the Blackstaff River flows into the northeastern part of the bay and the Carrigs and Moneycarragh Rivers flow into the southwestern part of the Inner bay, west of the Downshire Bridge. Oysters and mussels are currently cultivated in Inner Dundrum Bay.

This report attempts to document and quantify all known sources of pollution to the bay. It was concluded that the main sources of pollution in Inner Dundrum Bay come from direct sewage discharges directly into the bay, inputs from the three main rivers and from non-point sources related to agricultural land-use in the wider area. Wildfowl, boats and tourism have a negligible effect on seasonal variations in the contribution of microbiological sources of contamination; meteorological conditions such as increased rainfall play a much larger role in seasonal variations.

As the Inner Bay is intertidal, there is a complete exchange of water twice a day and this prevents the long-term build up of contaminants in the area. However, there is still a contaminant loading in the Inner Bay which comes from the constant freshwater input and point sources and this is reflected by the long term B classification of the area. The tidal flows redistribute these contaminants around the entire Inner Bay and as a result only one Production Area is required for the Inner Bay. Within this Production Area, there is a RMP for oysters and a RMP for mussels. Shellfish sampling is to occur monthly.

2. Overview of the Fishery/Production Area

2.1. Location/Extent of Growing/Harvesting Area

The shellfish designated waters in Dundrum cover an area of approximately 2.12km^2 and are located in the Inner bay (see Figure 2.1) (DOENI, 2009a). Pacific oysters, native oyster and mussels are all licenced in this area.

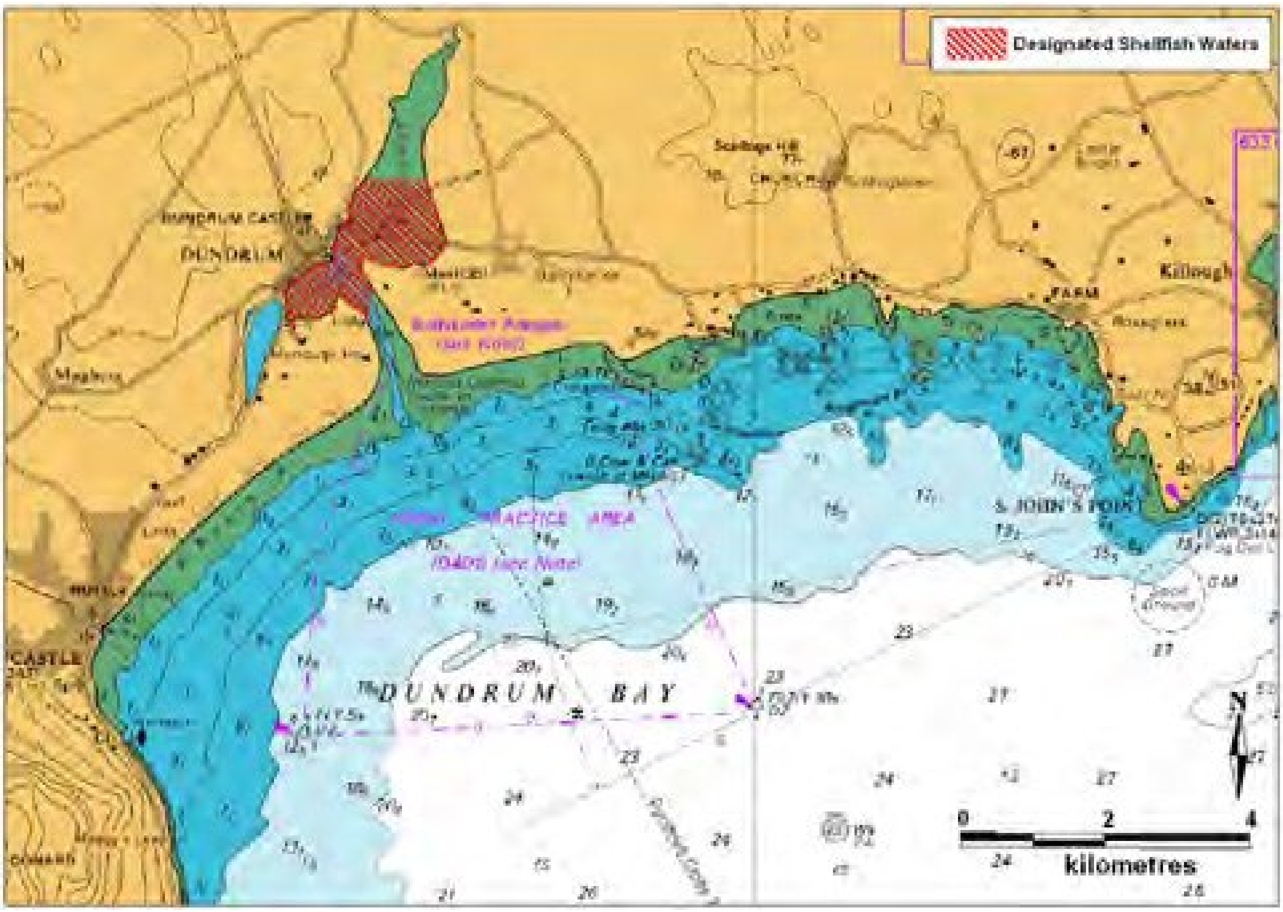


Figure 2.1: Shellfish designated waters within Dundrum Bay (Source: DOENI, 2009a).

Figure 2.2 shows the locations of the licenced sites issued as guidance by DARDNI Fisheries in 2010 and provided by FSA in NI. Inner North is licenced for both Pacific and native oysters and Inner south for mussels. The mussel licenced site covers an area of 0.04km^2 and the oyster licenced site covers an area of 0.18km^2. Pacific oysters and mussels are the only species cultivated at present and both species are cultivated by Dundrum Bay's sole producer.

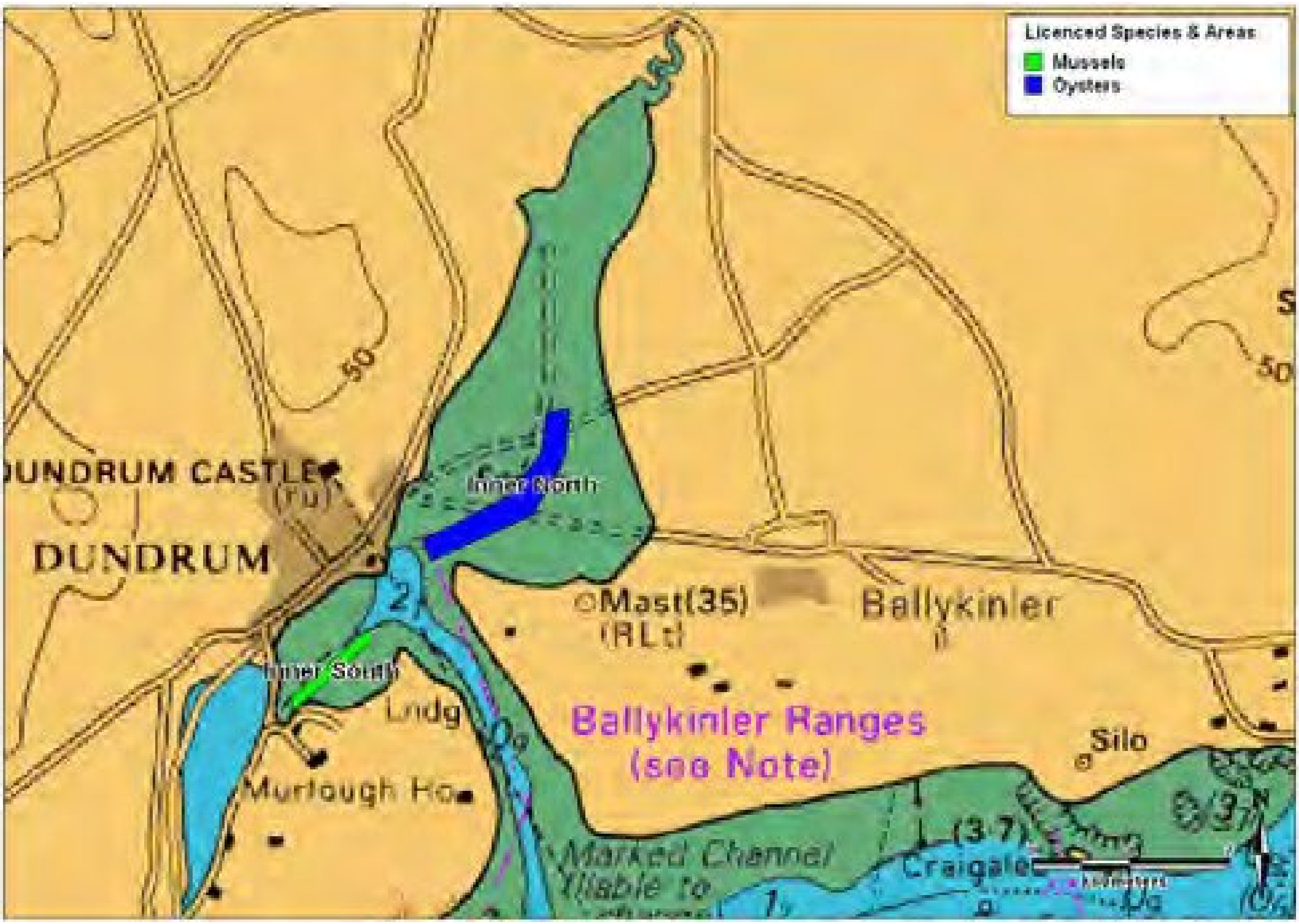


Figure 2.2: Licenced harvesting areas located within Dundrum Bay (Source: FSA in NI).

2.2. Description of the Area

Dundrum Bay is located on the southeast coast of County Down between St. John's Point to the east and the Slieve Donard mountains to the east (south of Newcastle) (see Figure 2.3). Inner Dundrum Bay is a small sheltered bay connected to the more exposed south facing Outer Dundum Bay by a channel. The Inner Bay is approximately 6km in length (from the southwest to the northeast) and is 1.4km at its widest point. The entrance channel is approximately 2km in length and approximately 550m at its widest point. The Inner Bay is intertidal except for the entrance channel. Three main rivers flow into the Inner Bay, the Blackstaff River flows into the northeastern part of the bay and the Carrigs and Moneycarragh Rivers flow into the southwestern part of the Inner bay, west of the Downshire Bridge.

Outer Dundrum Bay is approximately 14.5km wide (from St. John's Point to Newcastle) and extends approximately 6km from the coast. The outer bay is relatively shallow, and is framed by sandy beaches, interrupted by only a few reefs and rocky foreshore. There is a military firing practice area occupying part of the Outer Bay and entrance channel (see Figure 2.3).

Dundrum Bay (both Inner and Outer) is designated as a Special Area of Conservation (SAC) – Murlough SAC (Site Code: UK0016612) and a small part is a Nature Reserve (see Figure 2.4). It is designated due to the presence of a variety of dune systems, sandbanks, mud and sand flats and salt meadows and due to the presence of the common seal (*Phoca vitulina.*). Many species of wader, duck and geese visit the estuary particularly during the spring and autumn migration periods.

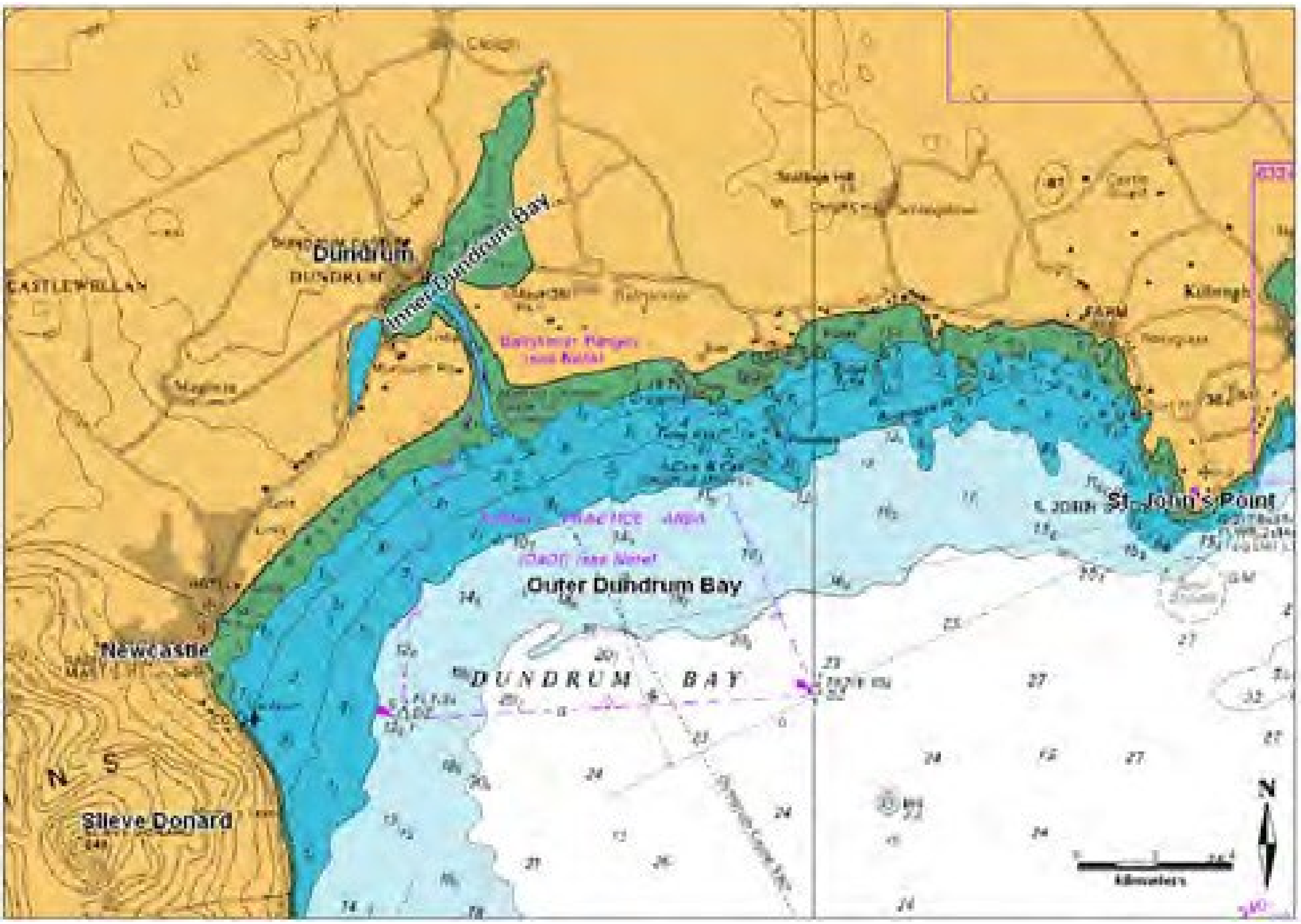


Figure 2.3: Location of Dundrum Bay.

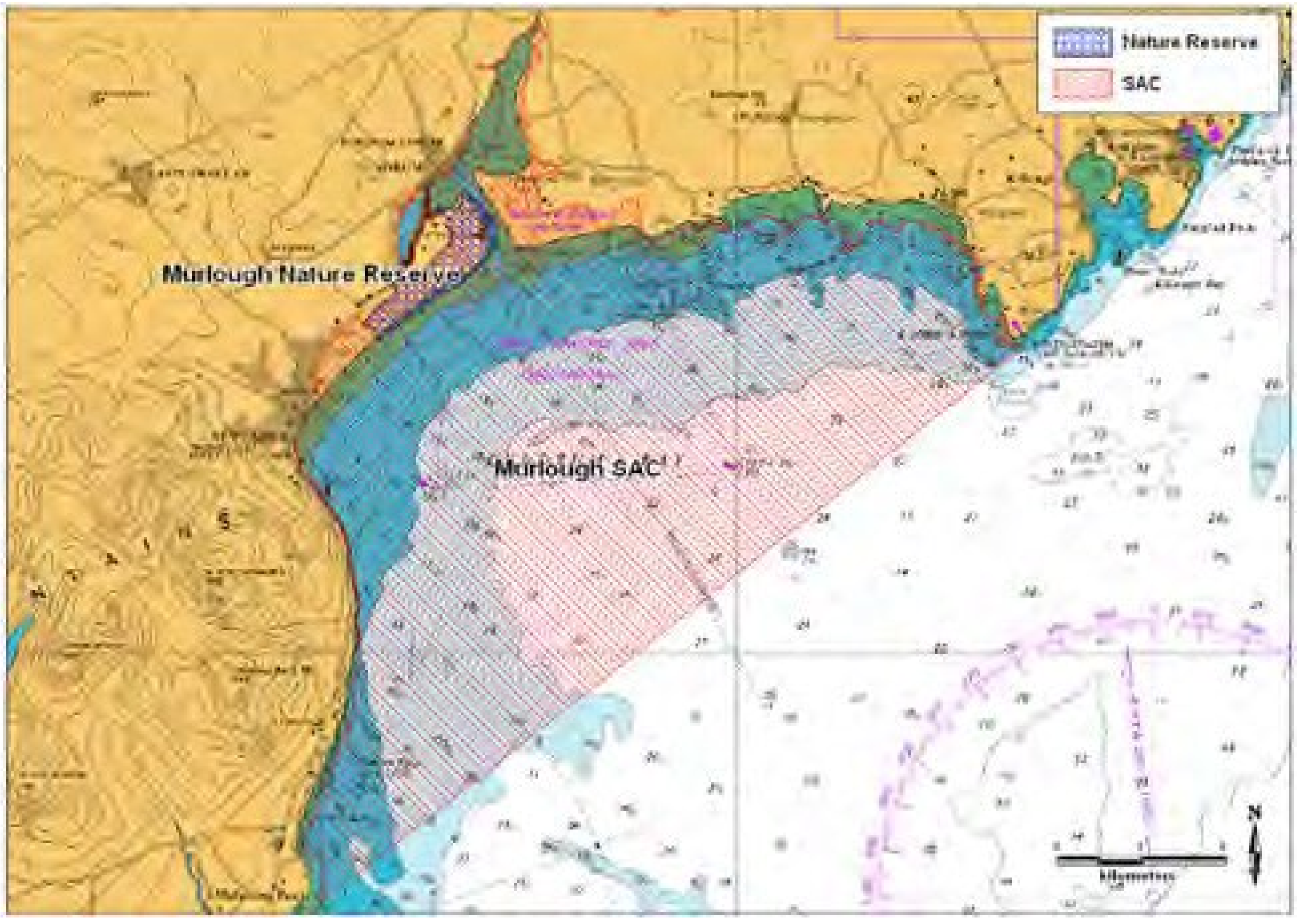


Figure 2.4: Location of the SAC and Nature Reserve in Dundrum Bay.

Land use within the catchment area is dominated by pastures, followed by natural grassland, moors and heathland and complex cultivation patterns. Along the coastal zone, land use varies between pastures, discontinuous urban fabric, agricultural activities and recreational areas such as sport and leisure facilities and beaches. As mentioned above, three main rivers flow into the Inner Bay resulting in estuarine waters connecting the inner and outer bays.

The population of the catchment is approximated 21,000[1]. The population in the two coastal towns is 7,723 in Newcastle and 1,522 in Dundrum (NISRA, 2011b).

The designated shellfish area within the Inner Bay is 2.12km^2 and the licenced shellfish sites cover an area of 0.29km^2. Pacific oysters and mussels are currently cultivated in Dundrum Bay.

[1] 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.

Dundrum Bay 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;
- 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).

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. The carrying capacity of Dundrum Bay is unknown.

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 mytilids, 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 & Fishery

Figure 2.2 shows the currently licenced mussel harvesting area within Dundrum Bay. This covers an area

0.04km^2. Mussels are cultivated by bottom culture in Dundrum Bay. Seed is transferred from wild mussel beds annually and cultured on licenced plots. The seed is laid at careful densities and managed through observation and turning to allow an even shell growth and optimum meat conditions. After approximately 1.5 – 2.5 years the mussels are ready for harvest. No data is available on production values.

2.3.2. Pacific Oysters (*Crassostrea gigas*)

2.3.2.1. 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.

2.3.2.2. Distribution & Fishery

Figure 2.2 shows the locations of the licenced oyster sites in Dundrum bay. This farmed site covers an area of 0.18km^2. 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.

No production data is available for Pacific oysters in Dundrum Bay.

3. Hydrography/Hydrodynamics

3.1. *Simple/Complex Models*

Unfortunately no models exist for Dundrum Bay. However, the information that follows will allow for an understanding of the hydrographic conditions in the Bay.

3.2. *Depth*

The waters in Inner Dundrum Bay reach a maximum depth of 2m along the entrance channel into the bay. The remainder of the inner bay is intertidal, including the area to the west of the Downshire Bridge. Outer Dundrum Bay is relatively shallow with depths descending gradually from the intertidal zone out to 20 to 30m. Figure 3.1 shows a bathymetric map of Dundrum Bay.

Figure 3.1: Depths in Dundrum Bay (modified from The Loughs Agency data).

3.3. Tides & Currents

The characteristic tidal levels in Newcastle (located approximately 7km southwest of Dundrum Bay) and Ardglass (located approximately 15km east of Dundrum Bay) can be seen in Table 3.1. These are taken from the Admiralty Chart 44-0 (UKHO, 2001). Levels are presented in metres Chart Datum, which is approximately equal to Lowest Astronomical Tide (LAT).

Table 3.1: **Newcastle and Ardglass tidal characteristics (Source: UKHO, 2001).**

Admiralty Chart 44-0- Levels (m CD)	**MHWS**	**MHWN**	**MLWN**	**MLWS**	**Datum & Remarks**
Newcastle	5.1	4.1	1.5	0.5	
Ardglass	5.2	4.2	1.7	0.7	3.14m below Ordnance Datum (Belfast)

With the exception of the entrance channel, Inner Dundrum Bay is intertidal and as a result there is a complete exchange of water twice a day. As expected, water floods in from the south through the entrance channel, where tidal flows can reach approximately 1.5m/s on both the flood and ebb tide (CAAN, 2011). The tide flows beneath the Downshire Bridge at rates of up to 3m/s between its stanchions (CAAN, 2011). With the exception of the entrance to Dundrum Inner Bay, tides are weak.

3.4. Wind and Waves

Average wind speed data for Northern Ireland from 1971-2000 can be seen in Figure 3.2 (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 3.3 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 Dundrum Bay ranges from a southerly all the way around to a northwesterly.

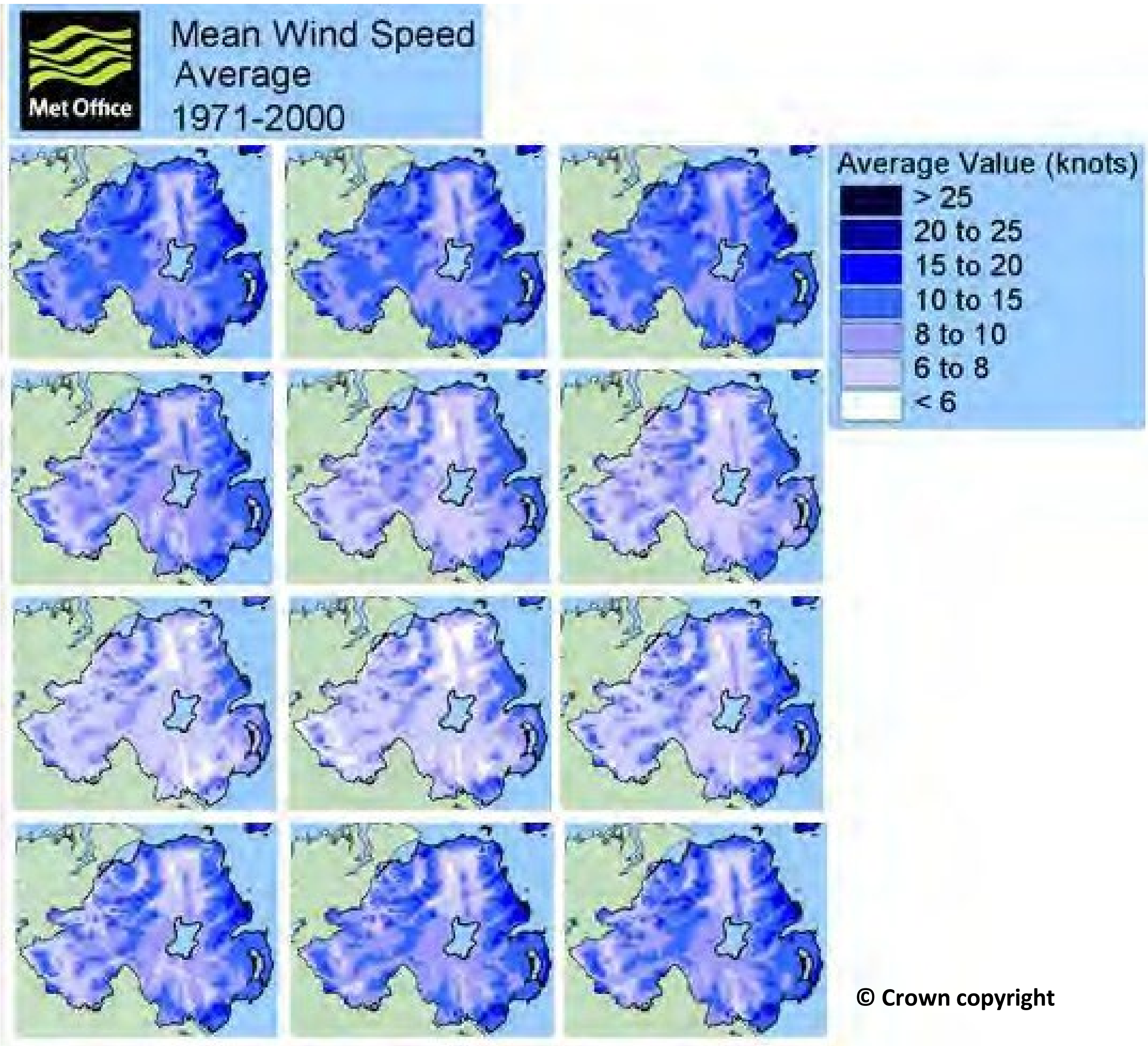


Figure 3.2: Average wind speed data for Northern Ireland from 1971 to 2000 (Source: Met Office, 2011a).

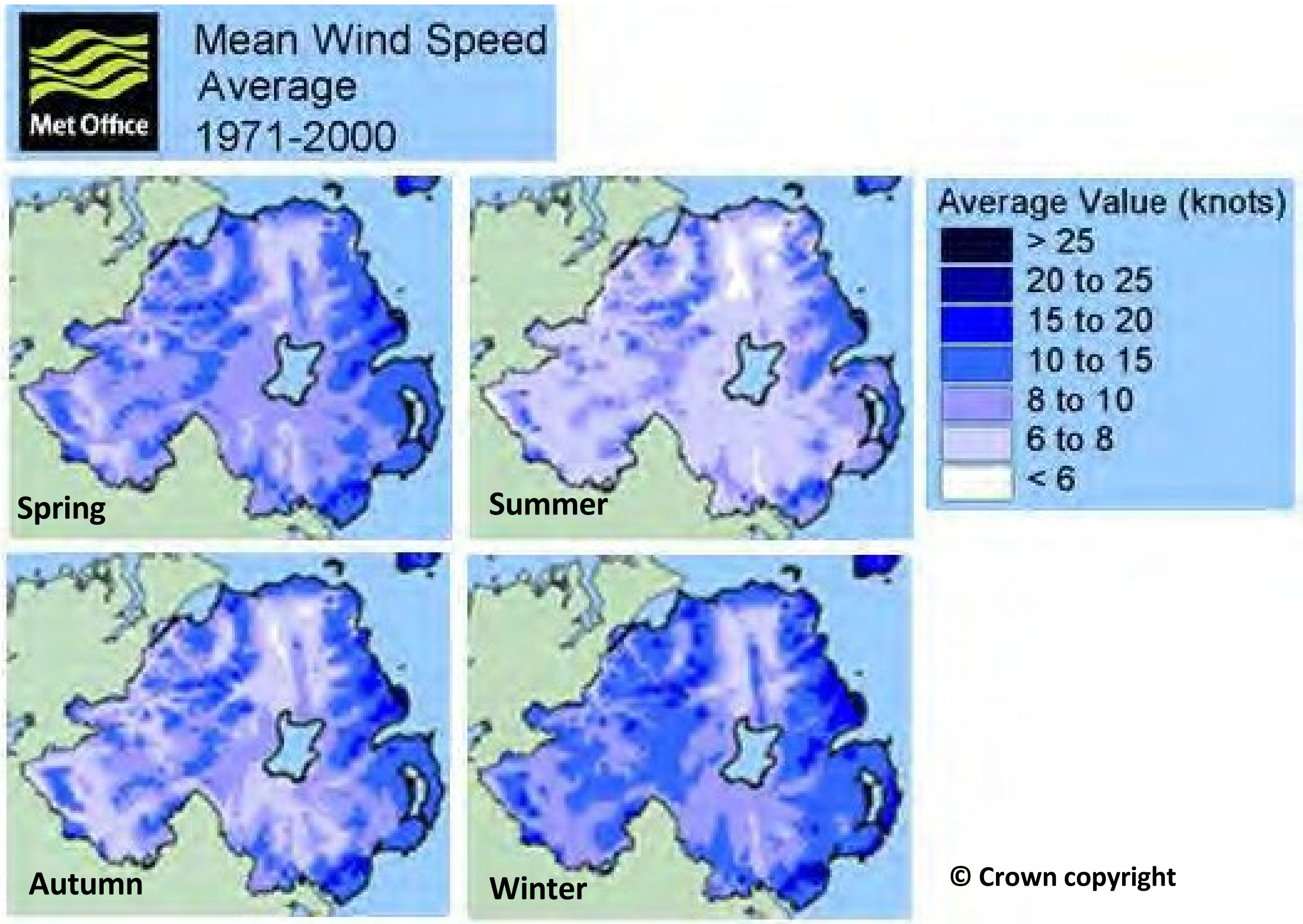


Figure 3.3: Average seasonal wind speed data for Northern Ireland from 1971-2000 (Source: Met Office, 2011a).

Wind conditions can affect the hydrodynamic conditions 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 a direction approximately 45° to the right of the direction of the prevailing wind (in the northern hemisphere), i.e. a westerly prevailing wind will produce southeasterly moving surface waves in Dundrum Bay. The height of wind waves depends on:

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

However, given the fact that Inner Dundrum Bay is sheltered and mostly intertidal, the influence of wind on water movement patterns (and subsequently on the distribution of contaminants) is negligible.

3.5. River Discharges

Figure 3.4 shows the locations of all rivers in the Dundrum Bay catchment area. Three rivers flow into Inner Dundrum Bay, the Blackstaff River flows into the northeastern part of the bay and the Carrigs and Moneycarragh Rivers flow into the southwestern part of the Inner bay, west of the Downshire Bridge. Two other un-named streams flow into the Inner Bay, one in the northern section close to the Blackstaff and one in the southern section close to the Moneycarragh. Figure 3.5 shows a close up of the freshwater sources flowing into the Inner Bay (Source: www.nimap.net). There are approximately 14 other rivers/streams that flow into Outer Dundrum Bay. There is no flow or volume data available for the rivers in the Dundrum Bay catchment area, however given the small area and shallow nature of the Inner Bay the freshwater input is significant.

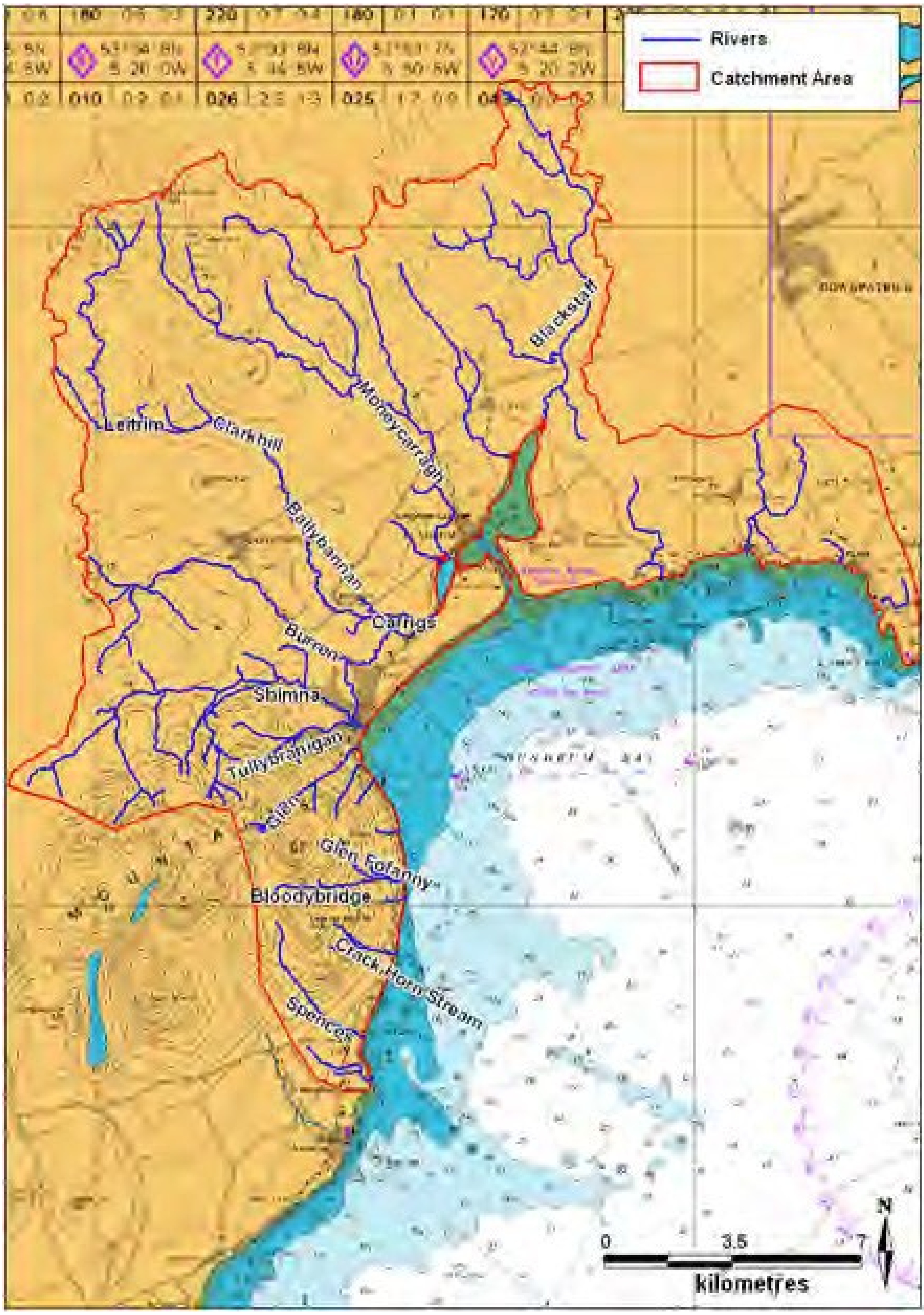


Figure 3.4: Rivers in the Dundrum Bay catchment area (Source: NIEA, 2011).

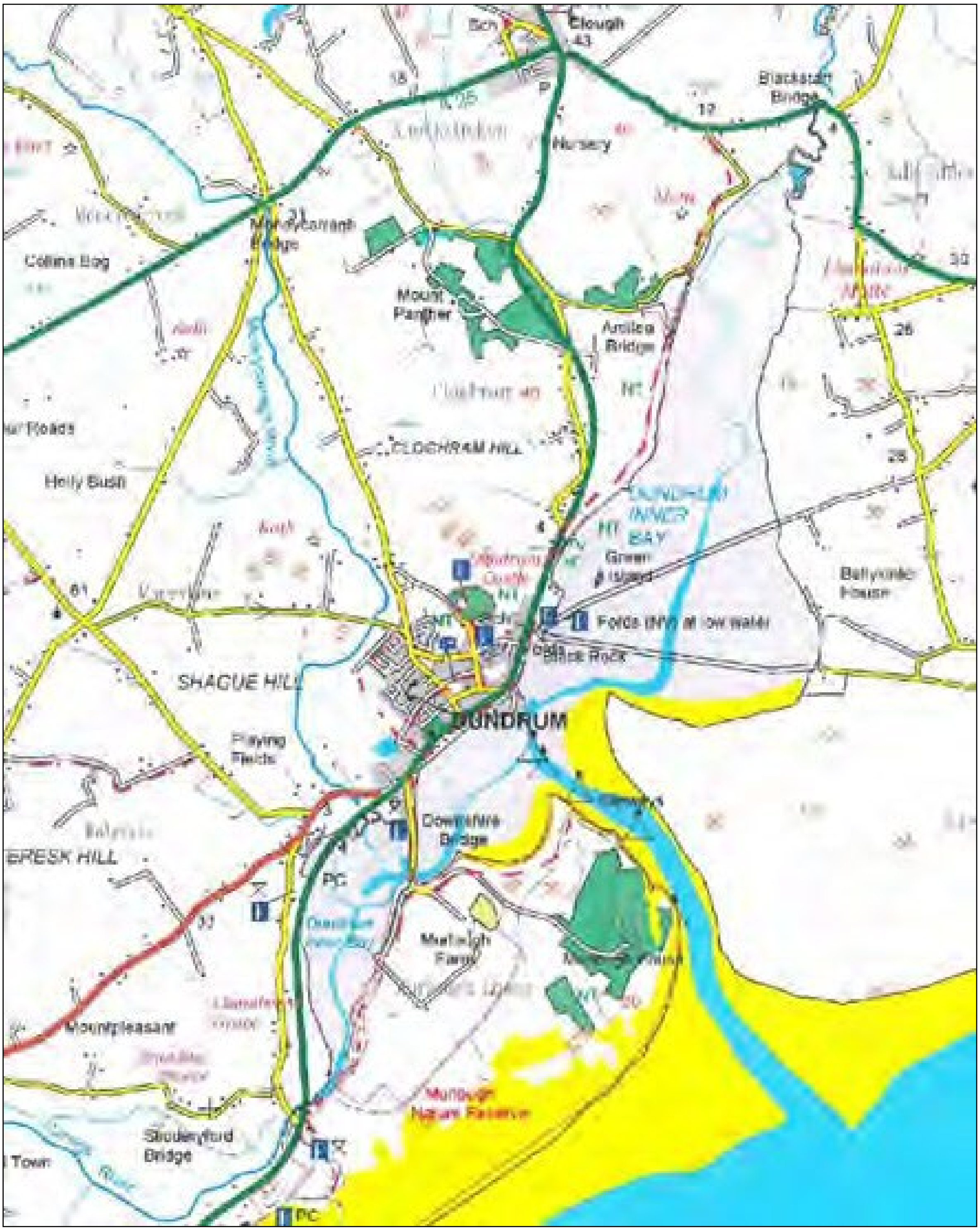


Figure 3.5: Freshwater sources flowing into Inner Dundrum Bay (Source: www.nimap.net). Land & Property Services. Crown Copyright & Database Right 2009.

3.6. Rainfall Data

3.6.1. Amount & Time of Year

Figures 3.6 and 3.7 show the average monthly rainfall data for Northern Ireland (Met Office, 2011a) from 1971 to 2000. The rainfall in the Dundrum Bay area is influenced by the nearby Mourne mountains and therefore this area is wetter than the area to the east of Dundrum Bay, which is one of the driest parts of Northern Ireland. Table 3.2 shows the average rainfall range and median values along the Inner Dundrum Bay coastline. During the period 1971 to 2000, the average rainfall around the coastline of Inner Dundrum Bay ranged from 40-140mm, with the lowest levels occurring in July (40-60mm) and the highest levels occurring in January (100-140mm). The lowest median value was 50mm in July and the highest was 120mm in January. Figure 3.8 shows the seasonal averages from 1971 to 2000 for Northern Ireland. Table 3.3 shows the seasonal rainfall ranges and median values. Seasonally, spring was the driest season (180mm) and winter was the wettest season (350mm).

Table 3.2: **Rainfall range and median monthly rainfall (mm) data along the Inner Dundrum Bay coastline (Source: Met Office, 2011a).**

Month	Rainfall Range (mm)	Median (mm)
Jan	100-140	120
Feb	70-100	85
Mar	50-90	70
Apr	60-70	65
May	40-70	55
Jun	40-65	52.5
Jul	40-60	50
Aug	50-80	65
Sept	50-90	70
Oct	100-110	105
Nov	90-110	100
Dec	100-120	80

Table 3.3: Seasonal rainfall range and median values (mm) from 1971-2000 (Source: Met Office, 2011a).

Season	Rainfall Range (mm)	Median
Spring	140-220	180
Summer	140-240	190
Autumn	200-320	260
Winter	300-400	350

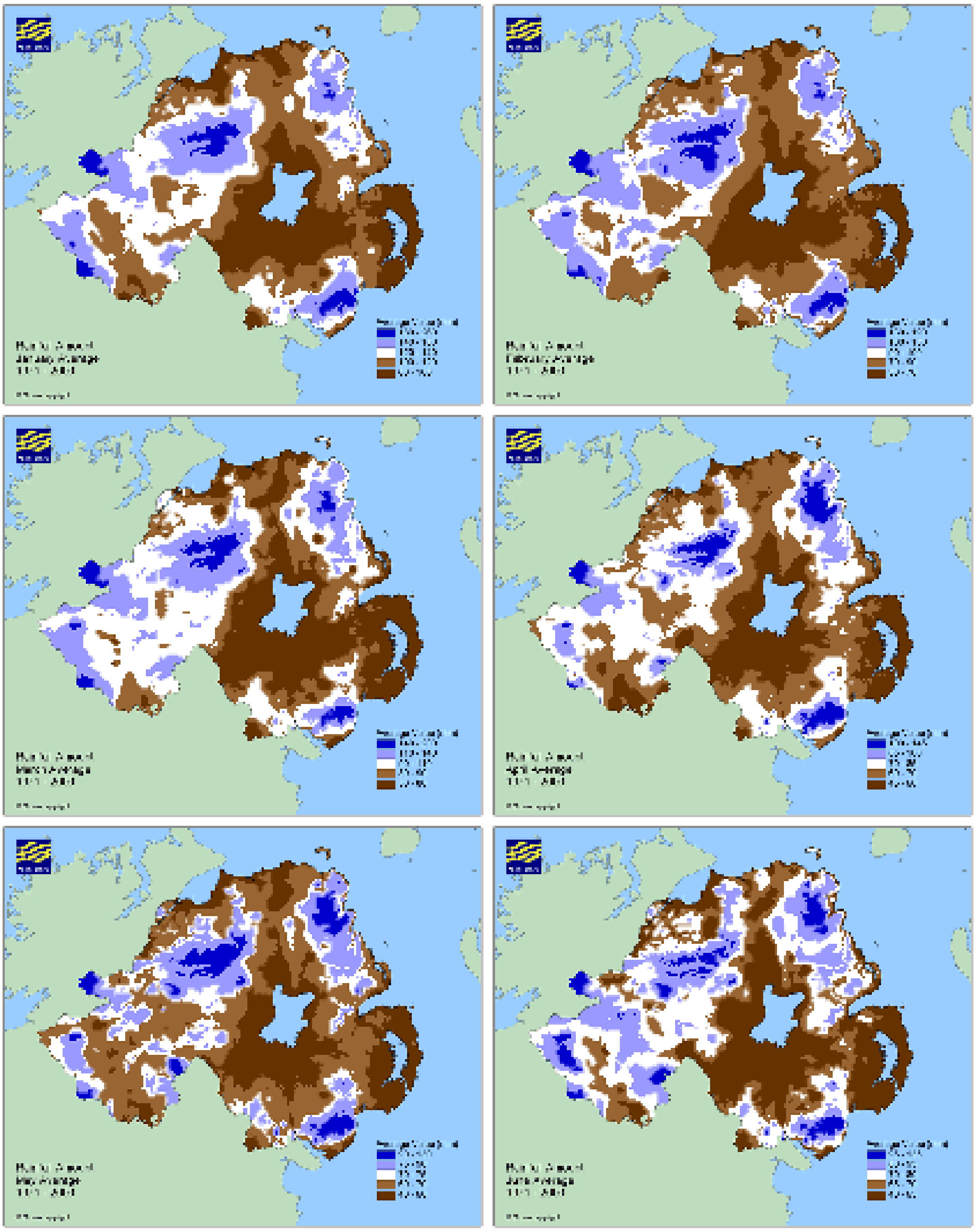


Figure 3.6: Average monthly rainfall (mm) data for January to June from 1971 to 2000 for Northern Ireland (Source: Met Office, 2011a).

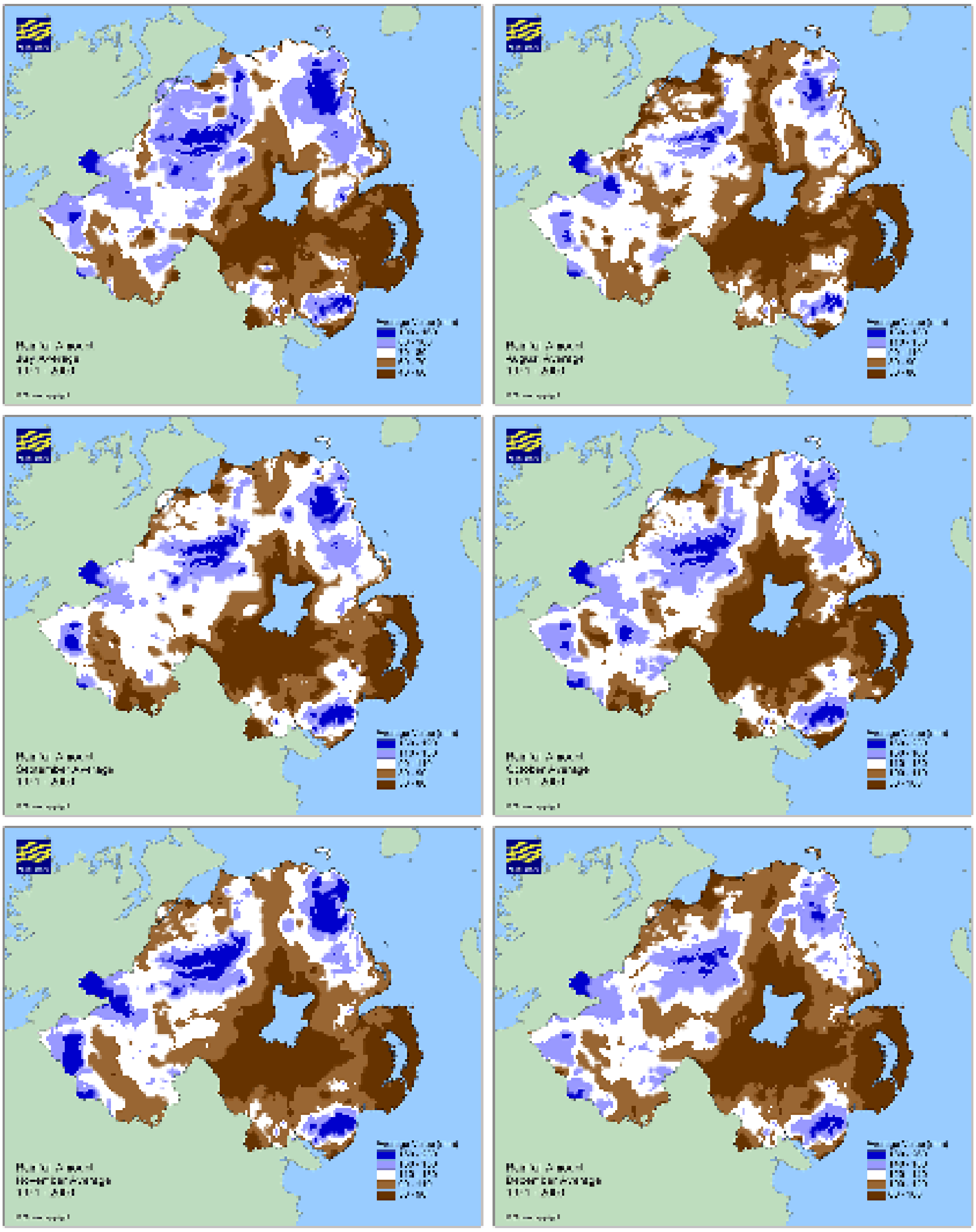


Figure 3.7: Average monthly rainfall (mm) data for July to December from 1971 to 2000 for Northern Ireland (Source: Met Office, 2011a).

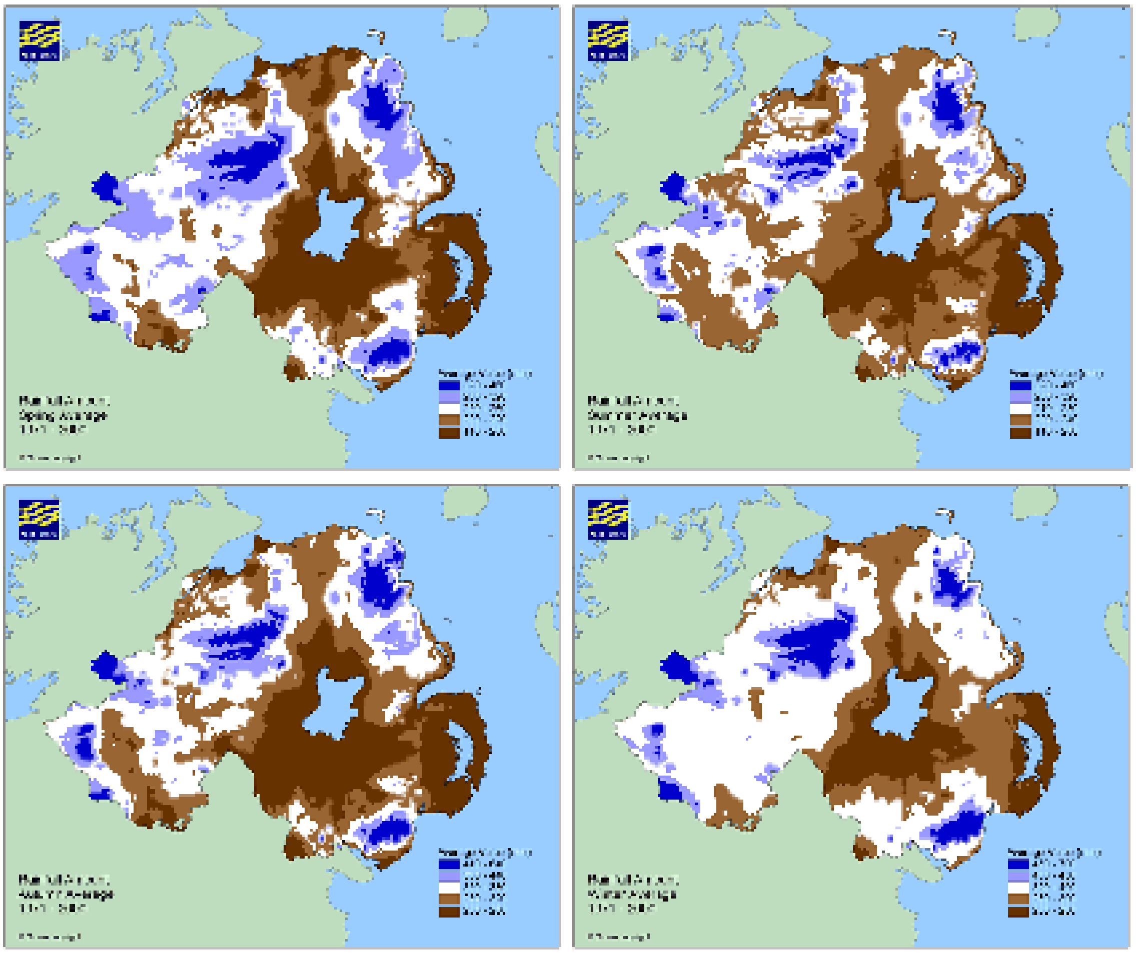


Figure 3.8: Seasonal rainfall averages (mm) from 1971 to 2000 for Northern Ireland (Source: Met Office, 2011a).

Tables 3.4 and 3.5 show the rainfall range and median values for the past 5 years for the Inner Dundrum Bay area (Met Office, 2011d). Lowest rainfall levels of 0-25mm were seen in May 2008 with the highest occurring in June 2007 and August 2008 (200-300mm). Table 3.6 shows the total seasonal rainfall figures for the Inner Dundrum Bay area based on median rainfall values from 2007-2011 (Met Office, 2011d). The following seasonal fluctuations were observed from 2007-2011: In 2007, autumn was the driest season and summer was the wettest, in 2008 spring was driest and summer was the wettest, in 2009 spring was the driest and autumn was the wettest, in 2010 spring and summer were the driest and winter was the wettest and in 2011 spring was the driest and autumn was the wettest.

Table 3.4: Averaged monthly rainfall (mm) data summarised for the Inner Dundrum Bay area from 2007-2011 (Source: Met Office, 2011d).

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2011	50-75	100-200	25-50	0-50	50-100	75-150	50-75	25-75	100-150	150-300	100-200	50-100
2010	100-300	50-150	100-200	50-100	25-50	50-100	100-150	50-75	75-150	50-75	100-200	50-100
2009	100-300	25-50	25-75	100-150	75-150	25-75	100-200	100-200	25-50	100-150	150-300	75-150
2008	150-300	75-150	75-150	25-50	0-25	50-100	100-200	200-300	100-150	75-150	50-100	75-150
2007	75-150	75-150	75-150	0-50	75-100	200-300	75-100	100-150	0-50	25-50	75-100	100-150

Table 3.5: Median monthly rainfall (mm) data summarised for the Inner Dundrum Bay area from 2007-2011 (Source: Met Office, 2011d).

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2011	62.5	150	37.5	25	75	87.5	62.5	50	125	225	150	75
2010	200	100	150	75	37.5	75	125	62.5	112.5	87.5	150	75
2009	200	37.5	50	125	112.5	50	150	150	37.5	125	225	112.5
2008	225	112.5	112.5	37.5	12.5	75	150	250	125	112.5	75	112.5
2007	112.5	112.5	112.5	25	87.5	250	87.5	125	25	37.5	87.5	125

Table 3.6: Total seasonal rainfall (mm) values from 2007-2011 based on median rainfall values (Source: Met Office, 2011d).

Season/Year	2011	2010	2009	2008	2007
Spring	137.5	262.5	287.5	162.5	225
Summer	200	262.5	350	475	462.5
Autumn	500	350	387.5	312.5	150
Winter	287.5	375	350	450	350

3.6.2. Frequency of Significant Rainfalls

Figure 3.9 shows the average monthly median rainfall for the Inner Dundrum Bay area from 1971-2000 (Met Office, 2011a). 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, 2011c). Figure 3.10 shows the average monthly median rainfall for the Inner Dundrum Bay area from 2007 – 2011 (Met Office, 2011d). In these more recent years, January, November, August and July were the wettest 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.

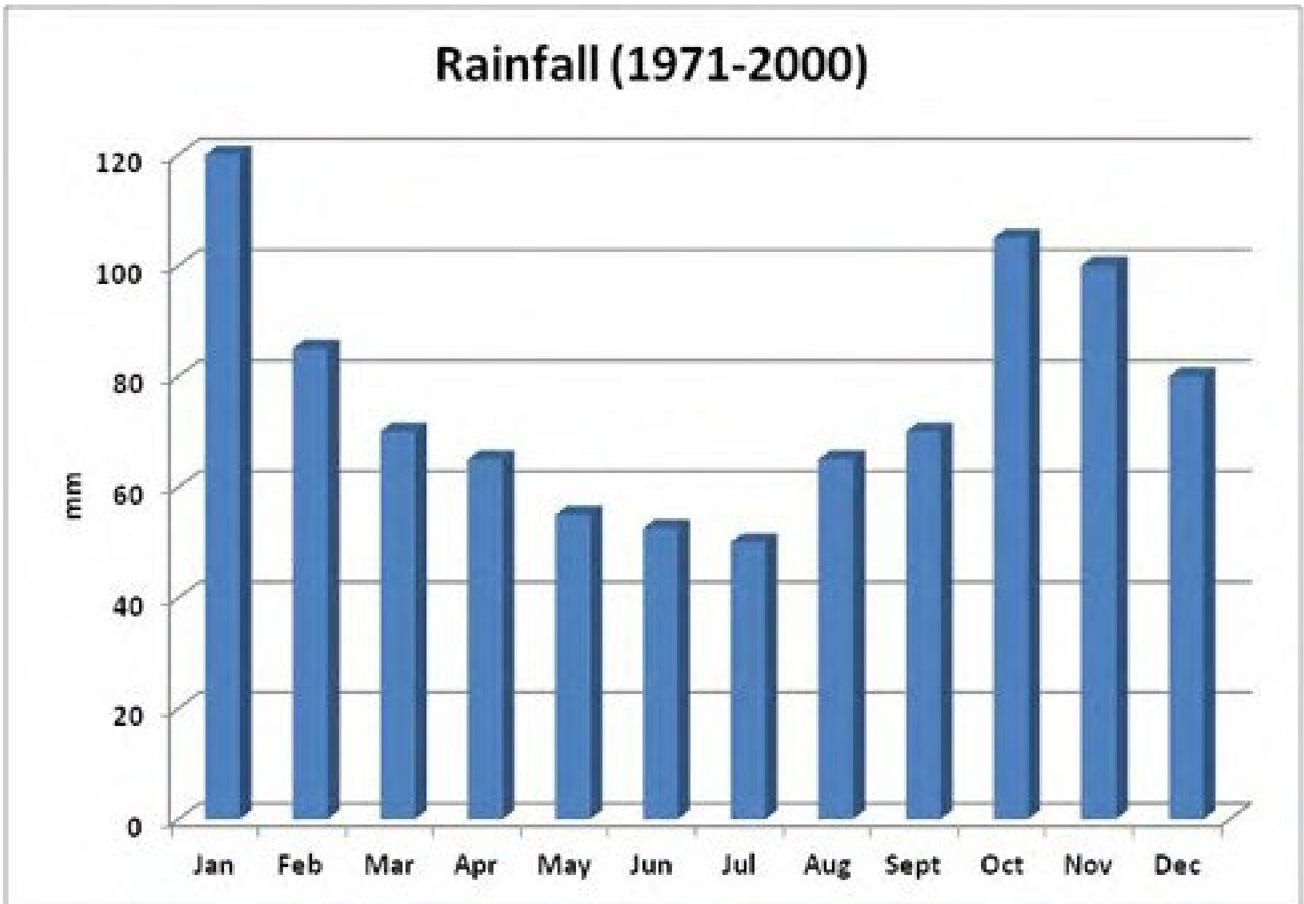


Figure 3.9: Average monthly median rainfall (mm) data along the Inner Dundrum Bay coast from 1971-2000 (Source: Met Office, 2011a).

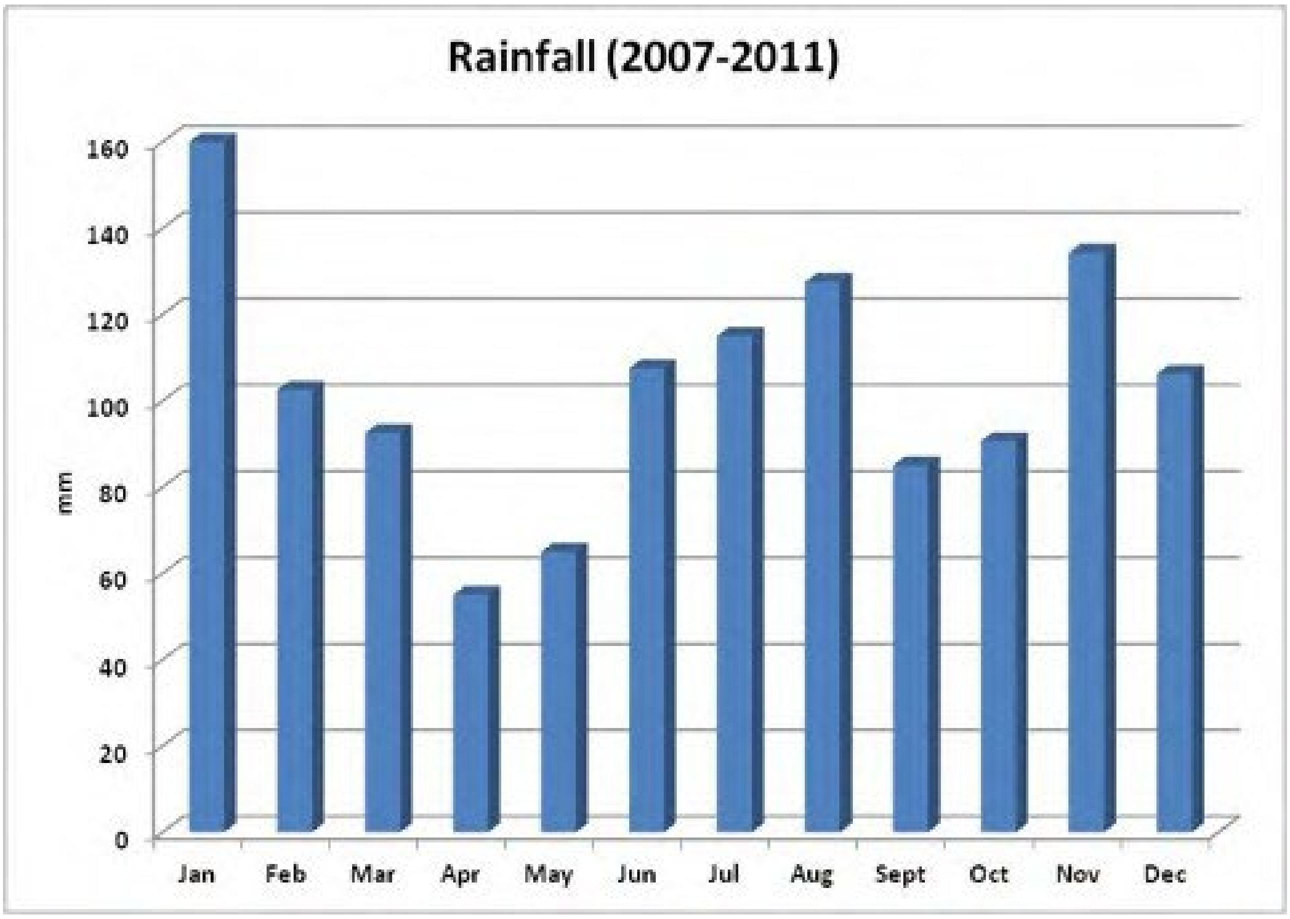


Figure 3.10: Average monthly rainfall (mm) data along the Inner Dundrum Bay coast from 2007-2011 (Source: Met Office, 2011d).

3.7. Salinity

Three sites in Inner Dundrum Bay (See Figure 3.11) are regularly monitored by the Northern Ireland Environment Agency (NIEA) Water Management Unit under the Water Framework Directive and the Shellfish Waters Directive. Salinity analysis is one of many parameters measured (see Section 5.1.1). Table 3.7 shows the salinity measurements recorded from 2005 to 2009 at the three Inner Dundrum Bay sites. Values ranged from 28.44 to 35.4 psu at Site 1, from 29.16 to 35.3 psu at Site 2 and from 23.94 to 35.4 psu at Site 3. The waters in Inner Dundrum Bay are a mixture of brackish and fully marine water. As the state of the tide during sampling is unknown the value of these results are somewhat limited. The typical scenario expected in a bay like Inner Dundrum Bay is for salinity level to be highest on the flooding tide and lowest on the ebbing tide.

Figure 3.11: Location of the salinity monitoring sites in Inner Dundrum Bay.

Table 3.7: Salinity results from 2005-2009, Inner Dundrum Bay (Source: NIEA).

Date	Inner Dundrum Bay 1	Inner Dundrum Bay 2	Inner Dundrum Bay 3
09/02/2005	33.92	34.07	34.21
22/06/2005	33.80	33.81	33.68
07/09/2005	33.73	33.78	33.90
14/12/2005	30.12	32.84	32.70
15/02/2006	33.18	33.56	33.42
22/06/2006	33.21	32.80	33.20
26/09/2006	33.81	33.48	33.33
12/02/2007	28.44	29.16	23.94
15/05/2007	33.72	33.71	33.71
11/09/2007	35.40	35.30	35.40
05/12/2007	33.30	33.80	33.80
20/02/2008	32.80	34.00	34.10
24/11/2008	30.70	33.70	33.50
15/12/2008	33.10	33.40	33.10
23/04/2009	34.00	34.00	33.80
03/06/2009	33.30	34.20	34.00
14/09/2009	32.50	32.50	32.40

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. Suspended solid concentrations and Secchi depth (light penetration depth) values are available from the 3 stations seen in Figure 3.11 above. Table 3.8 shows the Secchi depths results and Table 3.9 shows the suspended solid concentrations. Secchi depth ranged from 0.5 to 2.5m and suspended solids ranged from <2 to 37 mg/l. These values are not indicative of very turbid waters, however the use of this data is limited as the state of the tide during sampling is not known. The typical scenario expected in a bay like Inner Dundrum Bay is for turbidity levels to be highest on the ebbing tide and lower on the flooding tide.

Table 3.8: Secchi depth (m) values from three monitoring site in Inner Dundrum Bay (Source: NIEA).

Date	Inner Dundrum Bay 1 (m)	Inner Dundrum Bay 2 (m)	Inner Dundrum Bay 3 (m)
09/02/2005	1.00	1.00	1.00
22/06/2005	1.00	2.00	2.00
07/09/2005	2.00	2.00	2.00
14/12/2005	1.00	1.00	1.00
15/02/2006	0.50	0.50	0.50
22/06/2006	1.30	>1.5	>1.5
26/09/2006	2.00	2.00	2.00
12/02/2007	<1	<1	<1
15/05/2007	1.50	2.00	2.00
11/09/2007	>1.5	>1.5	>2
05/12/2007	2.00	2.00	2.00
20/02/2008	>2	>2	>1.5
24/11/2008	>0.5	>1	>1
15/12/2008	0.75	0.75	0.75
23/04/2009	<2	<2	<2
03/06/2009	>1	>2	>2
14/09/2009	>1.5	2.50	>2.5

Table 3.9: Suspended solid concentrations (mg/l) from three monitoring sites in Inner Dundrum Bay (Source: NIEA).

Date	Inner Dundrum Bay 1 (mg/l)	Inner Dundrum Bay 2 (mg/l)	Inner Dundrum Bay 3 (mg/l)
09/02/2005	15	8	5
22/06/2005	3	<2	3
07/09/2005	<2	<2	<2
14/12/2005	3.00	<2	<2
15/02/2006	23	18	16
22/06/2006	<2	<2	<2
26/09/2006	5	14	7
12/02/2007	12	37	20
15/05/2007	3	<2	<2

Date	Inner Dundrum Bay 1 (mg/l)	Inner Dundrum Bay 2 (mg/l)	Inner Dundrum Bay 3 (mg/l)
11/09/2007	3	<2	<2
05/12/2007	3.00	8	6
20/02/2008	9	4	4
15/12/2008	8.00	8	6
23/04/2009	3	3	5
03/06/2009	3	<2	<2
14/09/2009	<2	2	<2

4. Identification of Pollution Sources

4.1. Desktop Survey

Pollution sources were considered within the catchment area of Dundrum Bay (see Figure 4.1). The catchment area covers an area of 271.2km^2 and it is approximately 25km east west at its widest point and 25km north south at its longest point. The rivers which drain into Dundrum Bay can also be seen in Figure 4.1. Only the pollution sources associated with the water bodies which drain into the Bay were considered in this assessment.

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

4.1.1. Human Population

Dundrum Bay and its catchment area is 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 Dundrum Bay catchment area.

Figure 4.2: Super Output Areas within the Dundrum Bay catchment area.

Data on human populations for 2010 for Northern Ireland was obtained from The Northern Ireland Statistics and Research Agency (NISRA) website (NISRA, 2011a). Figure 4.3 shows the human population within the Dundrum Bay catchment area and Table 4.1 shows this data in tabular form.

Population size around the coast of Inner Dundrum Bay ranges from 2,168 people in Killough 2 SOA (located along the eastern and southeastern shore of the Bay) to 3,011 people in Seaforde SOA (located around the northeastern tip of Inner Dundrum Bay). Population size along the western shore of the Inner Bay is 2,713 (Dundrum SOA) and along the southwestern shore is 2,320 (Murlough). Population size in Dundrum village is 1,522 and in Newcastle town is 7,723 (NISRA, 2011b). The total population within the Dundrum Bay catchment is estimated at approximately 21,000 people[2].

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 Dundrum Bay system.

[2] 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.

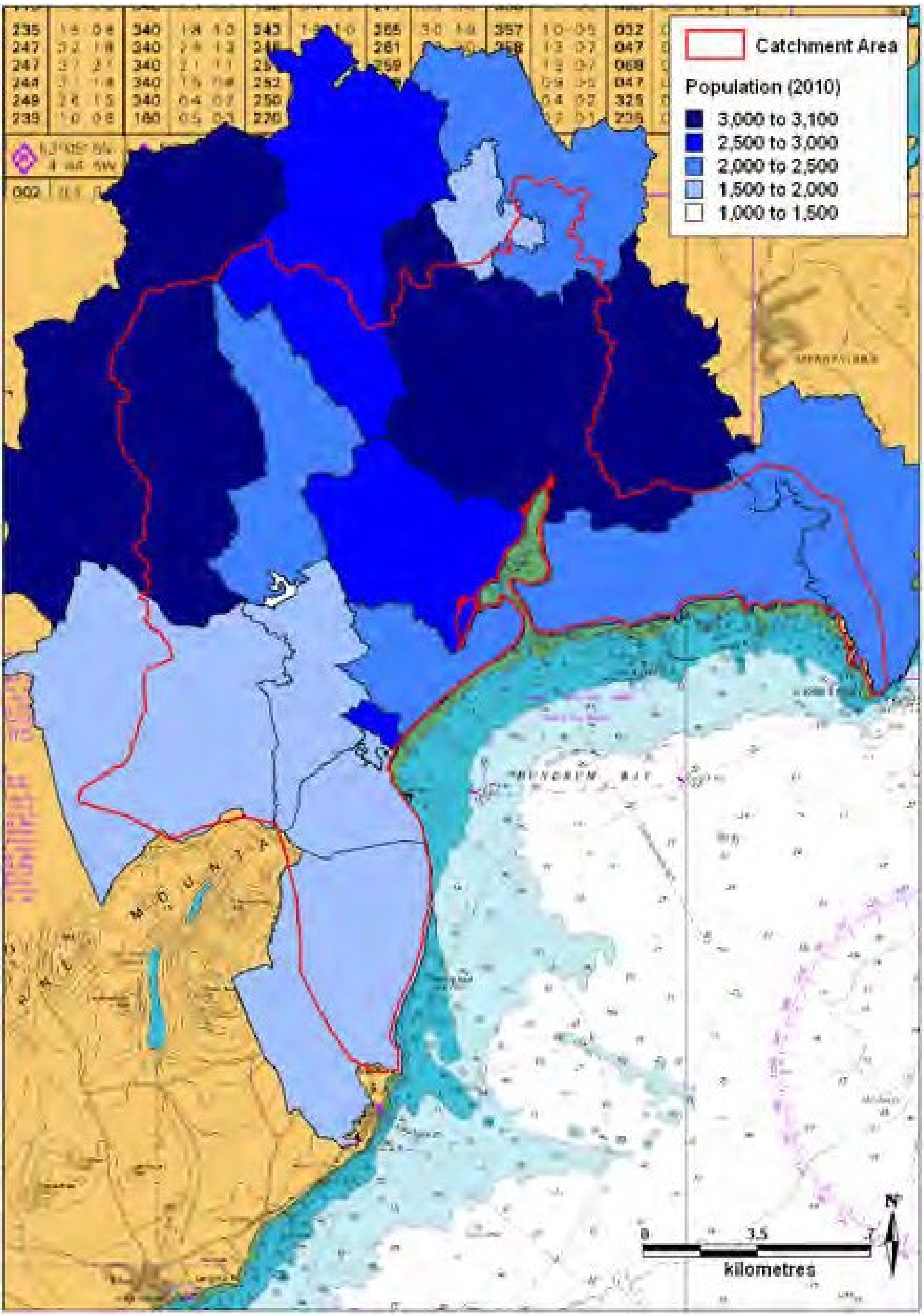


Figure 4.3: Human population within the Dundrum Bay Catchment Area (Source: NISRA, 2011a).

Table 4.1: Human population within the Dundrum Bay Catchment Area (Source: NISRA, 2011a).

SOA	Population (2010)
Annalong 1	1682
Tollymore 1	1625
Tollymore 2	1846
Shimna	2605
Seaforde	3011
Murlough	2320
Killough 1	2022
Killough 2	2168
Dunmore	2911
Dundrum	2713
Drumaness 1	1747
Drumaness 2	2095
Donard 1	1564
Donard 2	1716
Castlewellan 1	1262
Castlewellan 2	2374
Ballyward	3020

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, 265,000 trips were made to Down[3] with an estimated value of £40.2 million, 41,600 trips were made to Banbridge with an estimate value of £4.6 million and 93,600 trips were made to Newry & Mourne with an estimated value of £12.7 million (NITB, 2010). Down District Council covers the majority of the catchment area and is therefore the most relevant. The tourists to Down represent approximately 8.5% of the visitors who visited Northern Ireland in 2009.

[3] The Dundrum Bay area is broken into 3 district councils/local authority areas – 1) Down which covers Dundrum Bay and the majority of the catchment area 2) Banbridge, which covers a small section towards the western side of the catchment area and 3) Newry & Mourne, which covers a small section in the south-western part of the catchment area.

Dundrum village caters for passing tourists and day-trippers, although in recent years the tourist function has changed with the loss of local caravan sites for housing development (DOENI, 2009b). Figure 4.4 shows the tourism facilities in the Dundrum Bay catchment area. Along the coast, there are bathing waters, beaches, a yacht club, numerous access points, walkways and caravan parks. There are also golf courses, forest parks, viewpoints, and heritage sites in the wide catchment area.

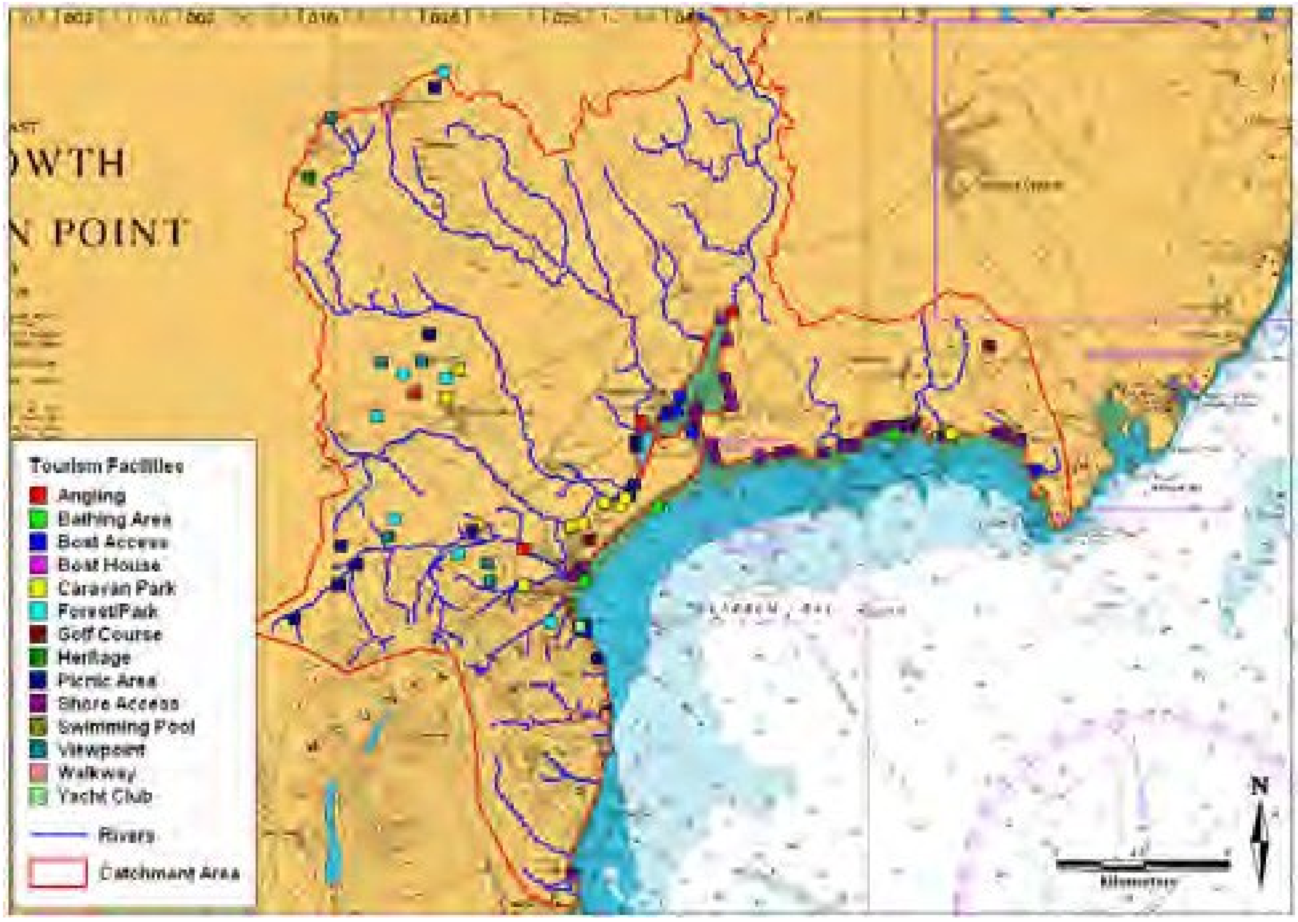


Figure 4.4: Tourism facilities in the Dundrum Bay catchment area (Source: www.nimap.net; Down District Council).

Increases in population in the local area due to tourism may result in an increase in the quantity of sewage discharged within the Dundrum Bay 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 from the oyster and mussel flesh samples from Dundrum Bay 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). Only those seasons with ≥12 results were used, therefore the cockle data from 2005 to 2007 was not used in this analysis. Box-plots are frequently used to assess and compare sample distributions of microbiological data.

Figure 4.5 shows box-plots produced for both species 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.

This analysis revealed that there were significant differences between spring and summer and spring and autumn at the Inner North oyster site and a significant difference between spring and summer at the Inner South mussel site. It can be seen in Figure 4.5 that the seasonal differences with the oysters was due to the fact that *E. coli* levels in spring were significantly lower than in summer and autumn and likewise the seasonal difference in the mussels was due to a significantly lower *E. coli* concentration in the spring months. This and the fact that rainfall in spring has been much lower than in all other seasons over the past 5 years (See Section 3.6 Rainfall) suggests that it is climatic conditions rather than increases in tourism that have more of an affect on water and therefore shellfish quality in Dundrum Bay.

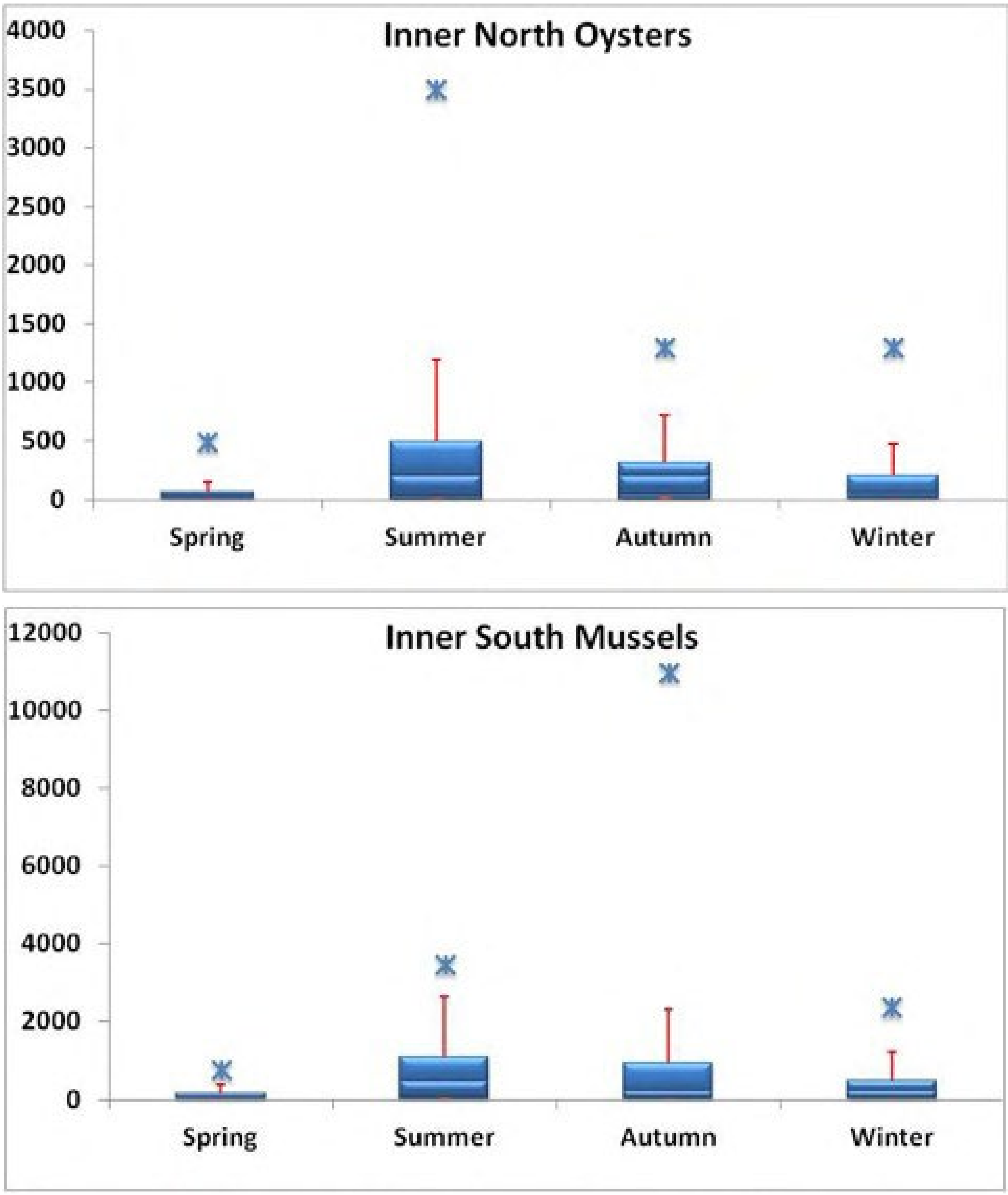


Figure 4.5: Seasonal variation of *E. coli* in shellfish flesh from Dundrum Bay.

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 (P) 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.

4.1.3.1. Continuous Sewage Discharges

There are 15 Waste Water Treatment Works (WWTWs) within the Dundrum Bay catchment area which discharge into Dundrum Bay or into a tributary of the Bay. Figure 4.6 shows the locations of these WWTWs and the locations of their continuous sewage discharge pipes. Three of these WWTWs have septic tanks not continuous discharges associated with them (Foffanybane WWTW, Burren Road WWTW and Moneyscalp WwTW and these are dealt with in Section 4.1.3.2 Rainfall Dependent Seage Discharges. One of the WWTW discharge directly into Inner Dundrum Bay (Dundrum WWTW), 2 discharge directly into Outer Dundrum Bay (Newcastle WWTW and Ballykinler) and 7 discharge into rivers/streams which ultimately discharge into Inner Dundrum Bay. The p.e. (population equivalent) of Dundrum WWTW is 2,613.

In addition, there are 30 Waste Water Pumping Stations (WWPSs) and 22 Sewage Pumping Stations (SPS) located within the catchment area. The locations of these pumping stations can be seen in Figure 4.7. These pumping stations have discharges associated with them.

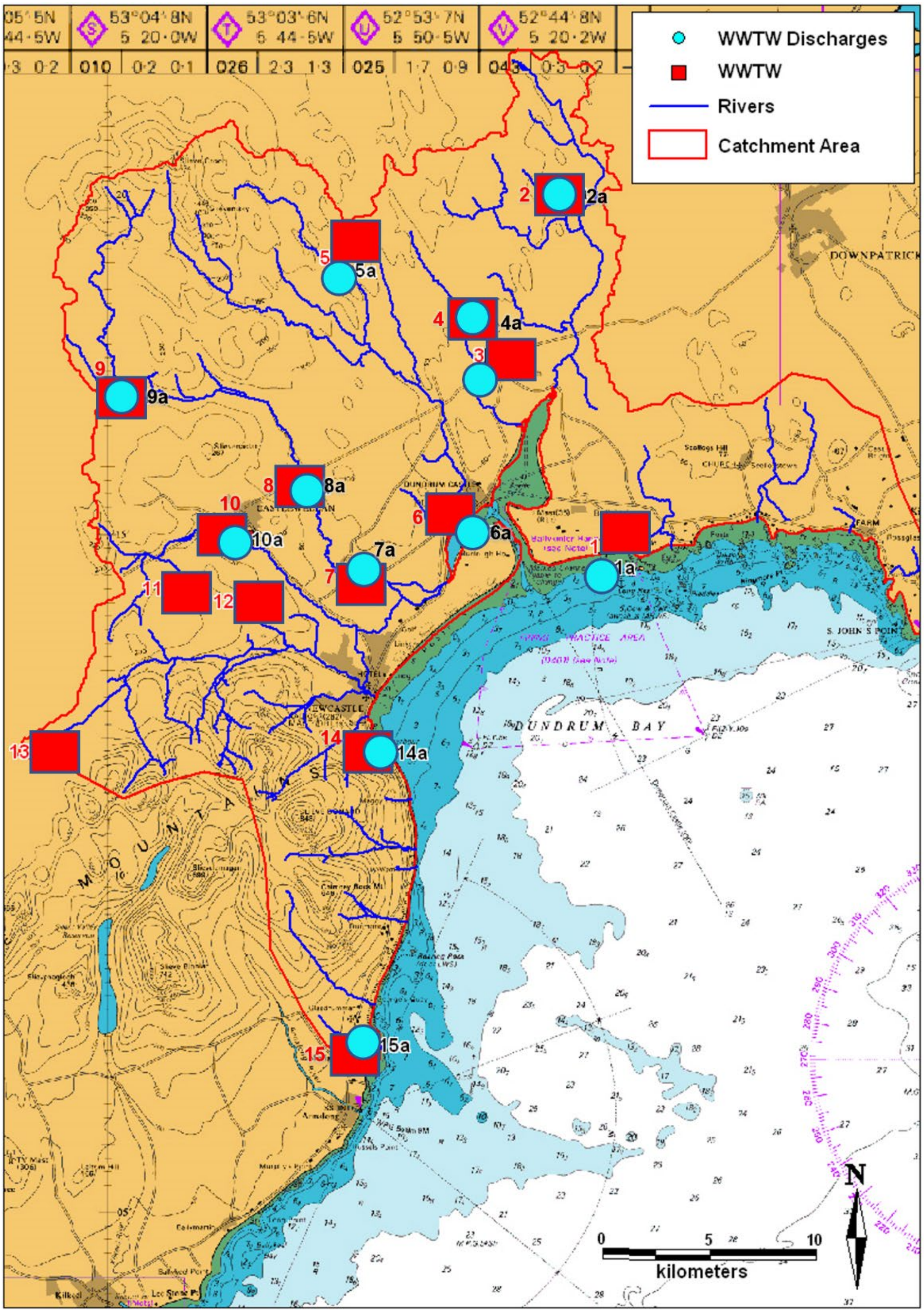


Figure 4.6: WWTWs and continuous discharges within the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Table 4.2: WWTW and continuous discharges within the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

MapID	ID	Easting	Northing	Longitude	Latitude	Receiving Water	p.e	Treatment	FFT/m³ /day	DWF/m³ /day	Discharge Data
1	Ballykinler WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
1a	Ballykinler Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
2	Loughinisland WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Loughinsiland Lake	N/A	N/A	N/A	N/A	N/A
2a	Loughinisland Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
3	Chough WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Stream leading to Dundrum Bay	N/A	N/A	N/A	N/A	N/A
3a	Clough Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
4	Seaforde WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Stream leading to Dundrum Bay	N/A	N/A	N/A	N/A	N/A
4a	Seaforde Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
5	Drumaroad WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Moneycarragh River	N/A	N/A	N/A	N/A	N/A
5a	Drumaroad Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
6	Dundrum WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Inner Dundrum Bay	2613	N/A	N/A	N/A	N/A
6a	Dundrum Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
7	Maghera WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Carrigs River	N/A	N/A	N/A	N/A	N/A
7a	Maghera Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
8	Annesborough WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Ballybannan River	N/A	N/A	N/A	N/A	N/A
8a	Annesborough Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
9	Leitrim WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Leitrim River	N/A	N/A	N/A	N/A	N/A
9a	Leitrim Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
10	Castlewellan WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Burren River	N/A	N/A	N/A	N/A	N/A
10a	Castlewellan Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
11	Moneyscalp WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
12	Burren Road WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A

MapID	ID	Easting	Northing	Longitude	Latitude	Receiving Water	p.e	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
13	Foffanybane WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
14	Newcastle WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
14a	Newcastle Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
15	Unnamed WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
15a	Unnamed Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A

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

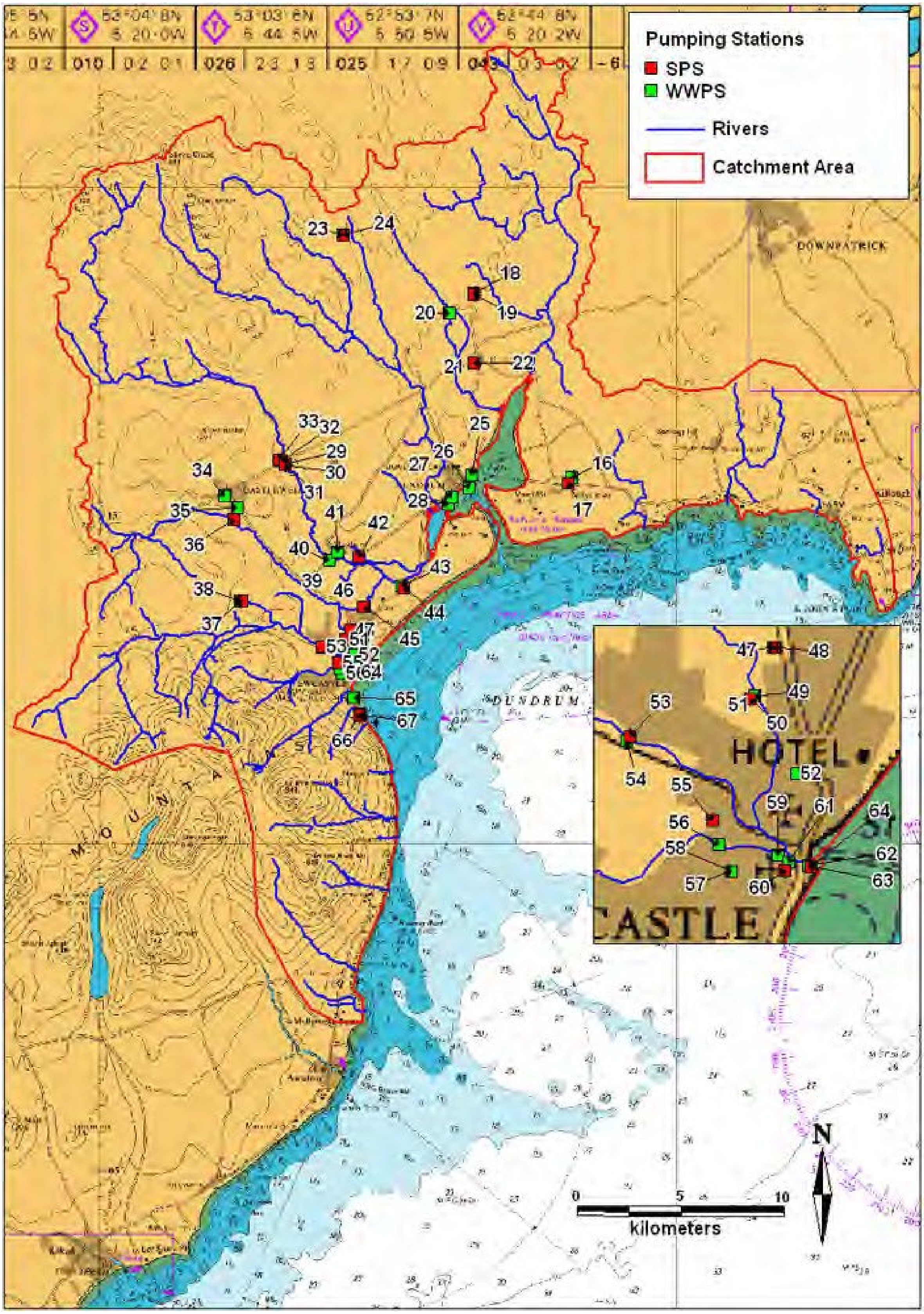


Figure 4.7: WWPS and SPS within the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Table 4.3: WWPS and SPS in the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit, NI Water, www.nimap.net).

Map ID	Name	Receiving Waterbody	Funtion	Easting	Northing	Longitude	Latitude
16	Ballykinler Village WwPS	Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
17	Ballykinler Village SPS	To adjacent storm sewer then to unnamed stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
18	Pinetrees WwPS	Unnamed Stream, Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
19	Seaforde SPS	Goes to Road Drainage Pipe then to Unknown Stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
20	Seaforde WwPS	Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
21	Castlewellan Road (SPS)	Un-named Stream, via adjacent surface water culvert. Tributary to the Irish Sea	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
22	Castlewellan Road WwPS	Trib. Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
23	Drumaroad Village SPS	Rivers Agency Watercourse, Trib. To Moneycarragh River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
24	Chapel Lane WwPS	Unnamed Stream	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
25	Kieltys School WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
26	The Quay WwPS	Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
27	Flynns WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
28	Downshire WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
29	Annsborough Park WwPS	Ballynannan River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
30	Annesborough Park SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
31	Annsborough Park SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
32	Clarkill WwPS	Ballynannan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
33	Bellfield SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
34	Castlewellan Two WwPS*	Trib. Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
35	Castlewellan One WwPS*	Trib. Burren River	Final Effluent	[Redacted]	[Redacted]	[Redacted]	[Redacted]
36	Castlewellan SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
37	Tudor Heights WwPS	Trib. Shimna River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
38	Tudor Heights SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Map ID	Name	Receiving Waterbody	Funtion	Easting	Northing	Longitude	Latitude
39	Maghera Dundrine Road WwPS	Trib. Carrigs River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
40	Maghera (Dundrine Road) SPS	Trib. To Carrigs River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
41	Maghera Housing WwPS*	Trib. Carrigs River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
42	Maghera Housing SPS	Un-Named Stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
43	Mourneview Newcastle WwPS	Trib. Carrigs River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
44	Mourneview SPS	Cargis River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
45	Murlough WwPS	Trib. Carrigs River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
46	Murlough SPS	Unknown tributary of Carrigs River.	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
47	Burrenview Court SPS	To drainage ditch leading to Burren River.	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
48	Burrenview Court WwPS	Trib. Shimna River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
49	Burren River WwPS	Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
50	Burren River SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
51	Burren SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
52	Shimna Road WwPS	Trib. Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
53	Rathicillan SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
54	Rathicillan WwPS	Shimna River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
55	Rowleys Meadow SPS	Tullybrannigan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
56	Bryansford Meadow WwPS	Tullybranigan River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
57	Bryansford Grove WwPS	Trib. Tullybranigan River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
58	Bryansford Grove SPS	Tullybrannigan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
59	Castle Park Bowling Green WwPS*	Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
60	Castle Park SPS	Dundrum Bay	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
61	Castle Park WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
62	Castlebridge WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
63	Castlebridge WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
64	Castlebridge SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
65	Black Rock WwPS*	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
66	Newcastle Harbour WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Map ID	Name	Receiving Waterbody	Funtion	Easting	Northing	Longitude	Latitude
67	Harbour SPS	Dundrum Bay	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]

* indicates that the location is estimated.

4.1.3.2. Rainfall Dependent Sewage Discharges

Figure 4.8 shows all rainfall dependent discharges i.e. Combined Sewer Overflows (CSO) and septic tanks within the catchment area. Tables 4.4 and 4.5 detail these discharges respectively. There are 28 combined sewer overflows and 3 septic tanks in the Dundrum Bay Catchment Area. Of these, 5 flow directly into Inner Dundrum Bay.

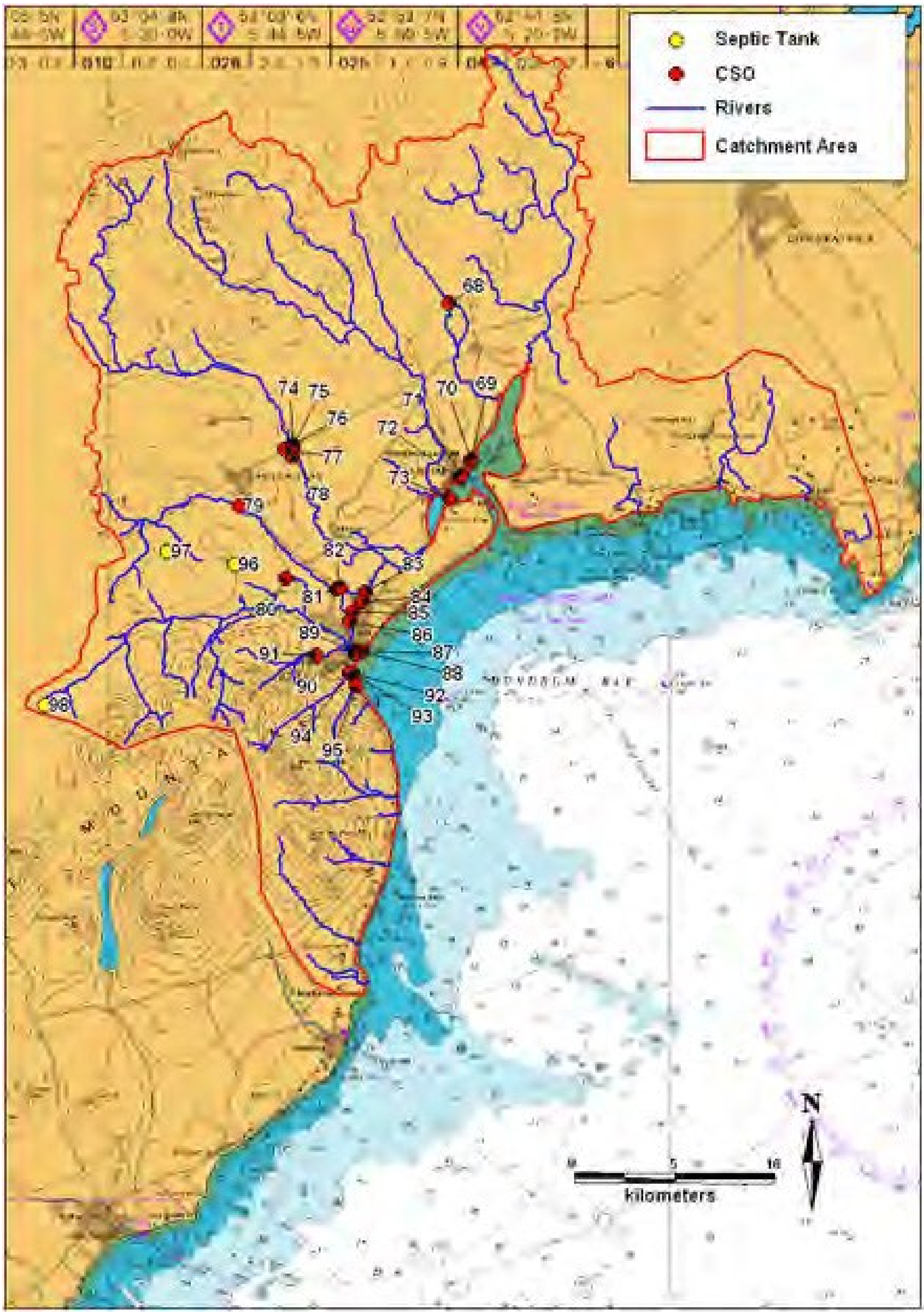


Figure 4.8: All overflow discharges and septic tanks within the Dundrum Bay Catchment Area (Source: NI Water, NIEA Water Management Unit, www.nimap.net).

Table 4.4: CSOs within the Dundrum Bay catchment Area (Source: NI Water, NIEA Water Management Unit).

MapID	Name	Receiving_Waterbody	Easting	Northing	Type	Longitude	Latitude
68	Seaforde CSO	Trib. Dundrum Bay	340012	341346	Combined	-5.85001	54.3017
69	Main Street Dundrum One CSO	Dundrum Bay	340783	336850	Combined	-5.84029	54.26113
70	Main Street Dundrum Two CSO	Dundrum Bay	340794	336780	Combined	-5.84015	54.2605
71	Murlough Inn CSO	Dundrum Bay	340527	336379	Combined	-5.84443	54.25697
72	Main Street Dundrum Three CSO	Dundrum Bay	340439	336303	Combined	-5.84582	54.25631
73	Keel Point CSO	Dundrum Bay	340188	335722	Combined	-5.84994	54.25116
74	Mill Hill CSO 3A	Tributary of Ballybannon River	335590	337078	Unknown	-5.91982	54.26458
75	Ballylough Road	Ballybannon River	335588	337085	Unknown	-5.91985	54.26464
76	Mill Hill One CSO	Ballybannon River	335580	337085	Combined	-5.91997	54.26464
77	Mill Hill Two CSO	Via Storm sewer Ballybannon River	335384	336978	Combined	-5.92302	54.26373
78	Annsborough Park CSO	Ballybannon River	335570	336789	Combined	-5.92026	54.26199
79	Castlewellan CSO	Burren River	334086	335291	Combined	-5.94368	54.24893
80	Barbican Farm Bryansford CSO	Un-named	335498	333244	Combined	-5.92296	54.23018
81	Burrendale Hotel One CSO	Burren River	336997	332981	Combined	-5.90011	54.22742
82	Burrendale Hotel Two CSO	Burren River	337125	333017	Combined	-5.89813	54.22771
83	Murlough CSO	Trib. Carrigs River	337821	332902	Combined	-5.88752	54.22649
84	Mourneview Road	Unknown	337751	332604	Unknown	-5.88873	54.22383
85	Burrenview Court North CSO	Burren River	337479	332307	Combined	-5.89303	54.22124
86	Burren CSO	Burren River	337397	332020	Combined	-5.89442	54.21869

MapID	Name	Receiving_Waterbody	Easting	Northing	Type	Longitude	Latitude
87	Downs Road CSO	Dundrum Bay	337781	331175	Combined	-5.88892	54.211
88	Valentia Place CSO	Dundrum Bay	337631	331194	Combined	-5.89121	54.21121
89	Main Street Newcastle CSO	Dundrum Bay	337608	331109	Combined	-5.8916	54.21045
90	Castlepark	Dundrum Bay	337593	331086	Unknown	-5.89184	54.21025
91	Bonnys Caravan Park	Tullybrannigan River	336456	331038	Unknown	-5.90928	54.21012
92	Tullybrannigan Road CSO	Glen River	337427	330536	Combined	-5.89464	54.20535
93	Central Promenade CSO	Dundrum Bay	337523	330536	Combined	-5.89317	54.20533
94	Shanslieve Drive CSO	Glen River	337427	330536	Combined	-5.89464	54.20535
95	South Promenade	Dundrum Bay	337631	330173	Unknown	-5.89168	54.20204

Table 4.5: Septic tanks located within the Dundrum Bay Catchment Area ((Source: NI Water, NIEA Water Management Unit).

MapID	Name	Longitude	Latitude	Easting	Northing
96	Burren Road (50-56)	-5.94546	54.23358	334020	333580
97	Moneyscalp	-5.97565	54.23715	332040	333920
98	Fofannybane	-6.03012	54.19684	328614.3	329333.3

4.1.3.3. Emergency Discharges

No details on emergency discharges within the catchment area were available; however it can be assumed that some if not all of the pumping stations and overflows shown in Figure 4.8 above have emergency flows associated with them.

4.1.4. Industrial Discharges

Figure 4.9 shows the 2 industrial discharges within the Dundrum Bay catchment area. One, Dundrum Bay Oyster Fishery has a licenced discharge into Inner Dundrum Bay and the second CES Quarry Products Ltd. has a licenced discharge into Carrigs River. Details on these discharges can be seen in Table 4.6.

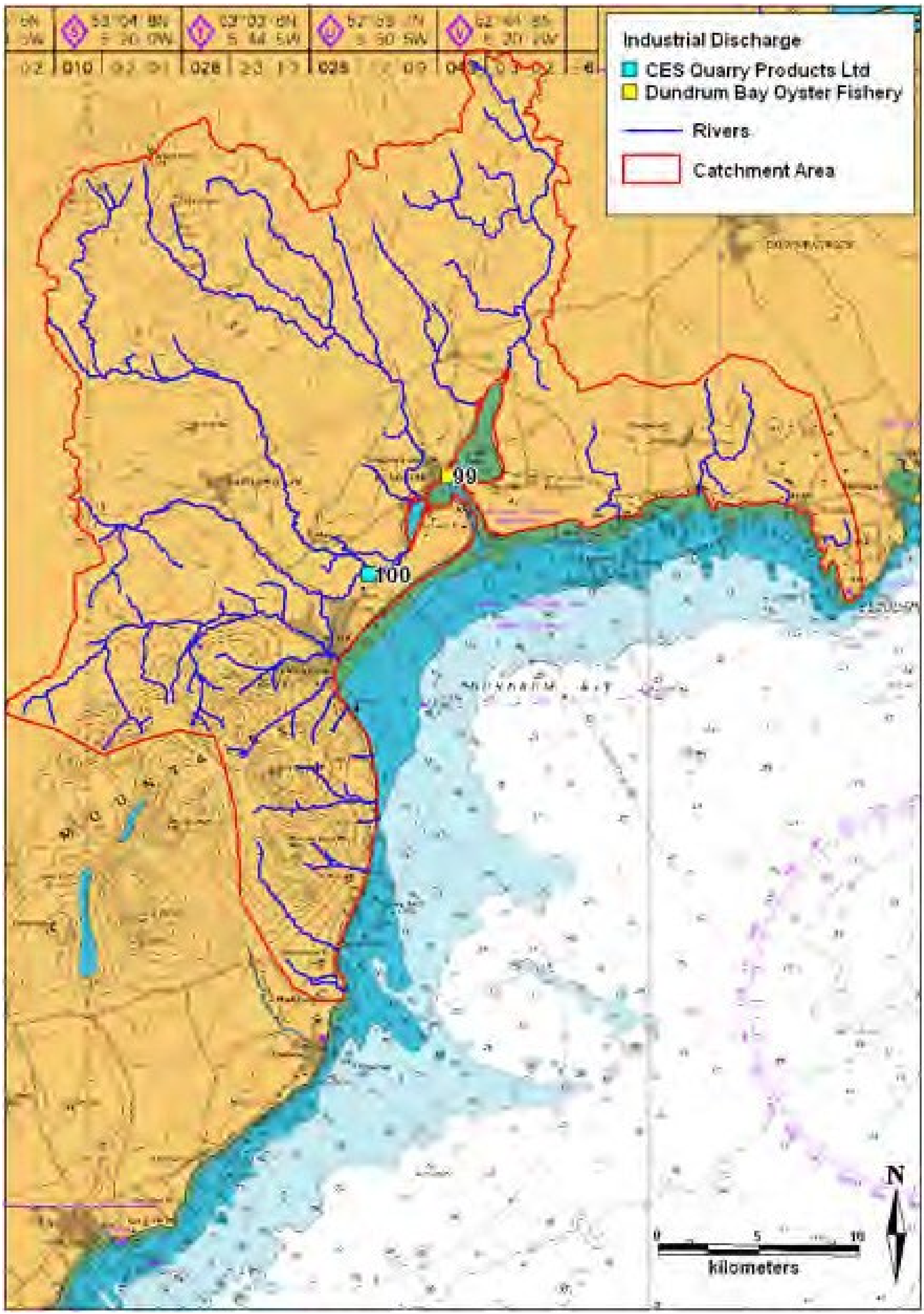


Figure 4.9: All industrial discharges within the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit).

Table 4.6: Details on industrial discharges with the Dundrum Bay Catchment Area (Source: NIEA Water Management Unit).

MapID	Station	File Ref	Company	Grid Ref	Easting	Northing	Longitude	Latitude	Industry
99	60954	TC42/92	Dundrum Bay Oyster Fishery	J4074036530	340740	336530	-5.8411	54.25827	Food Processing : Shell Fishery
100	61281	TC148/00	CES Quarry Products Ltd	J3851033590	338510	333590	-5.87665	54.23248	Minerals : Concrete Products

4.1.5. Land use Discharges

Figure 4.10 shows the Corine land use within the Dundrum Bay catchment area. Figure 3.4 (page 18) shows all rivers/streams within the catchment area.

Within the catchment area, land use is dominated by pastures (159.14km^2; 56.36%), followed by natural grassland (27.32km^2; 9.68%), moors and heathland (24.52km^2, 8.68%) and complex cultivation patterns (19.82km^2, 7.02%) (see Figure 4.11). Forestry (coniferous and broad-leafed) makes up 4.46% of the land use in the area (12.59km^2). In total, agricultural activities (non-irrigated arable land, pastures, complex cultivation patterns and agriculture/natural vegetation) comprise 67.62% (190.95km^2) of the land use in the area.

Data from the Department of Agriculture and Rural Development Farm Census 2010 (DARD, 2010) can be seen in Table 4.9 below. Figures 4.12 to 4.19 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.

Numbers of farms within the catchment area ranged from 5 in Donard (Down) to 212 in Ballyward (Banbridge). The total area farmed within the catchment area varied from 73ha in Donard (Down) to 7,153ha in Ballyward (Banbridge).The total crops farmed within the catchment area varied from 0ha in Donard (Down) to 816ha in Seaforde (Down). Total grass and rough grazing areas within the catchment area ranged from 73ha in Donard (Down) to 6,966ha in Ballyward (Banbridge).

The total number of cattle within the catchment area ranged from 38 in Donard (Down) to 10,861 in Ballyward (Banbridge). The total number of sheep within the catchment area ranged from 0 in Shimna (Down) to 23,682 in Ballyward (Banbridge).

Numbers of pigs within the catchment area ranged from 0 in Shimna (Down), Murlough (Down), Castlewellan (Down) and Donard (Down) to 3,915 in Killough (Down).

Poultry is only farmed in 5 of the SOAs: Seaforde (Down), Murlough (Down), Dunmore (Down), Ballyward (Banbridge) and Kilough (Down). Within these 5 SOAs, poultry numbers ranged from 32,000 in Ballyward (Banbridge) to 63,000 in Murlough (Down).

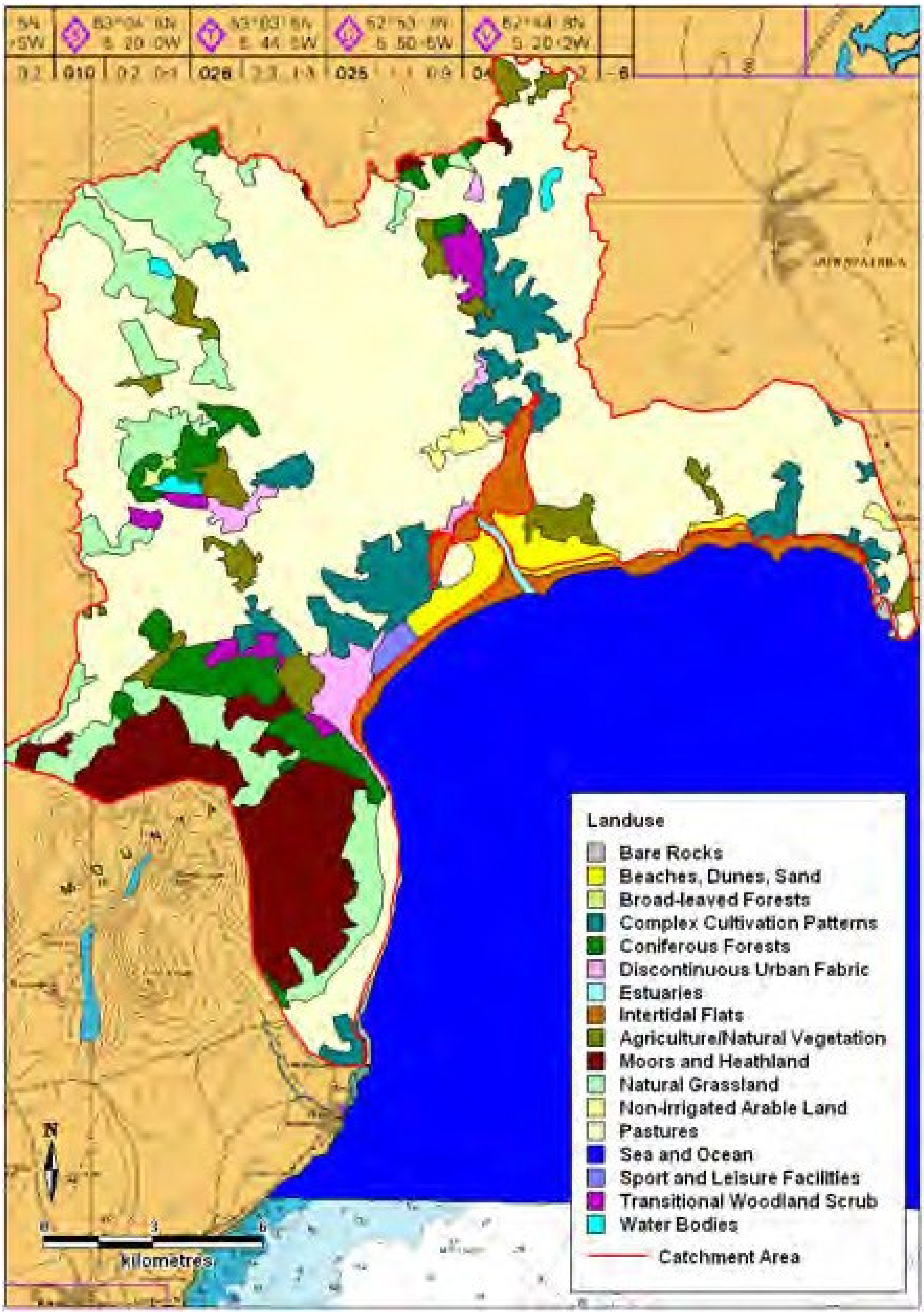


Figure 4.10: Corine land use within the Dundrum Bay Catchment Area (Source: The Loughs Agency).

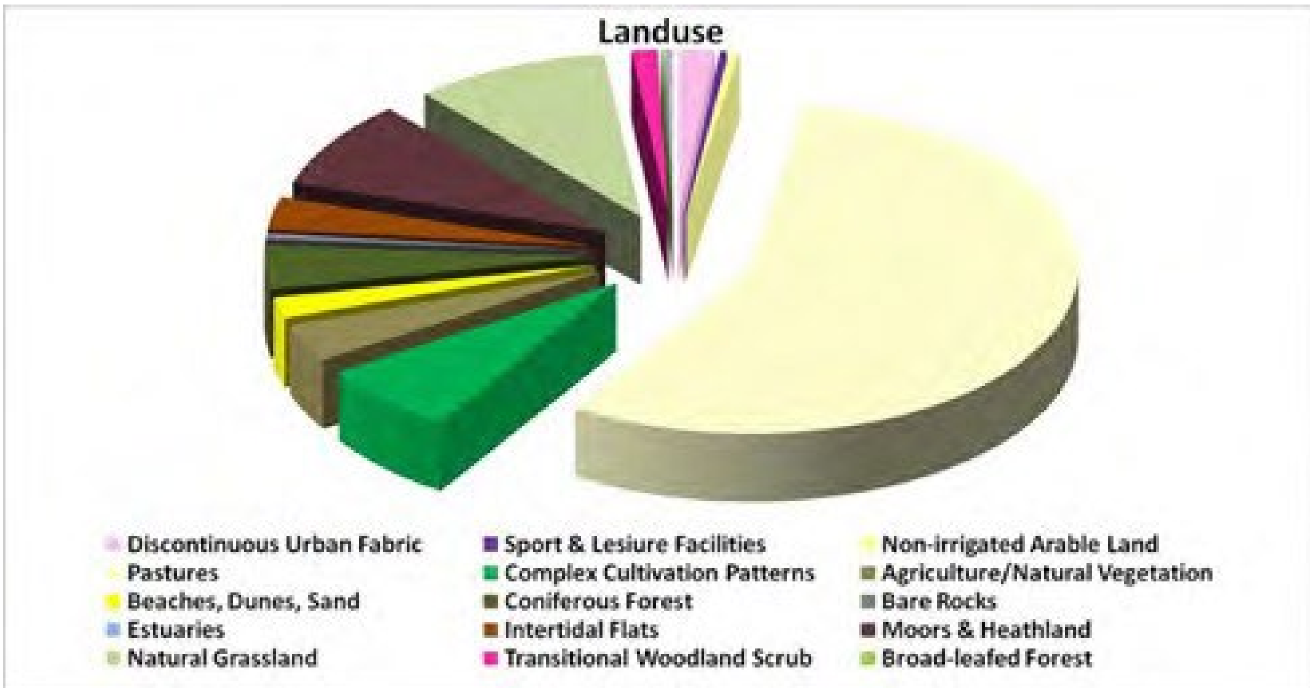


Figure 4.11: Breakdown of land use within the Dundrum Bay Catchment Area.

With regards to the SOAs bordering Inner Dundrum Bay (i.e. Killough, Seaforde, Dundrum and Murlough), Seaforde has the highest number of farms (120), Killough has the largest area farmed (4,591ha), Seaforde has the largest area of total crops (816ha), Killough has the largest total grass and rough grazing area (3,783ha), Killough has the largest quantity of cattle, sheep and pigs (7,827, 13,116 and 3,915 respectively) and Murlough has the highest quantity of poultry (63,000).

Table 4.7: Farm census data for all SOAs within the Dundrum Bay Catchment Area (Source: DARD, 2010).

SOA	No. Farms	Area Farmed (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)	Cattle	Sheep	Pigs	Poultry ('000s)
Annalong	73	1651	30	1602	3665	7243	662	0
Shimna	6	152	5	147	267	0	0	0
Seaforde	120	4565	816	3675	7261	10084	75	35
Murlough	15	848	221	625	1740	716	0	63
Dunmore	109	3459	82	3332	5367	15264	659	40
Dundrum	54	1874	175	1676	3819	3765	62	0
Ballyward	212	7153	130	6966	10861	23682	2778	32
Tollymore	141	4456	93	4337	5795	21269	1207	0
Killough	79	4591	771	3783	7827	13116	3915	41
Drumaness	73	2134	25	2092	4175	2477	5	0
Castlewellan	46	1384	38	1294	1524	5999	0	0
Donard	5	73	0	73	38	477	0	0

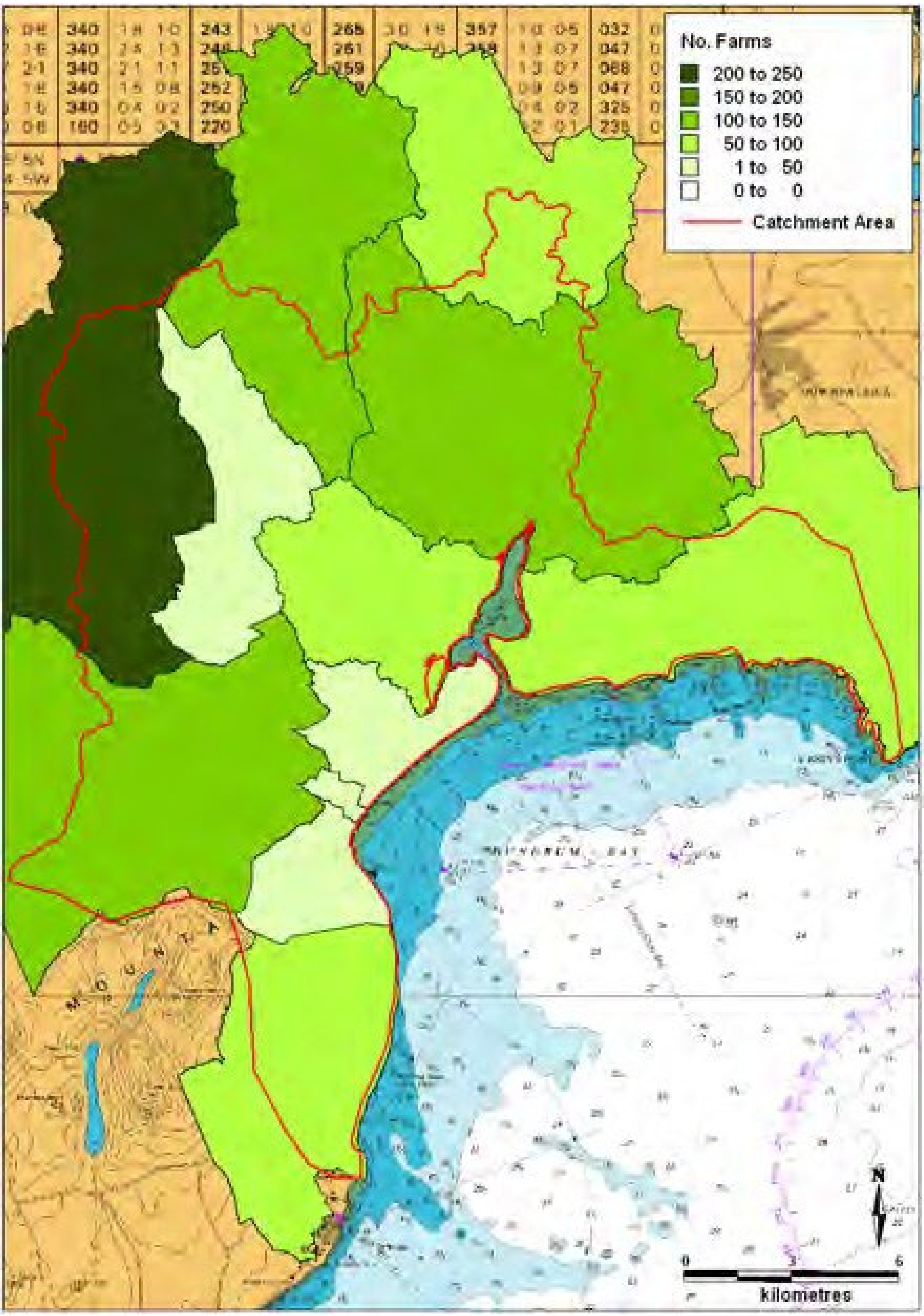


Figure 4.12: Number of farms within the Dundrum Bay Catchment Area (Source: DARD, 2010).

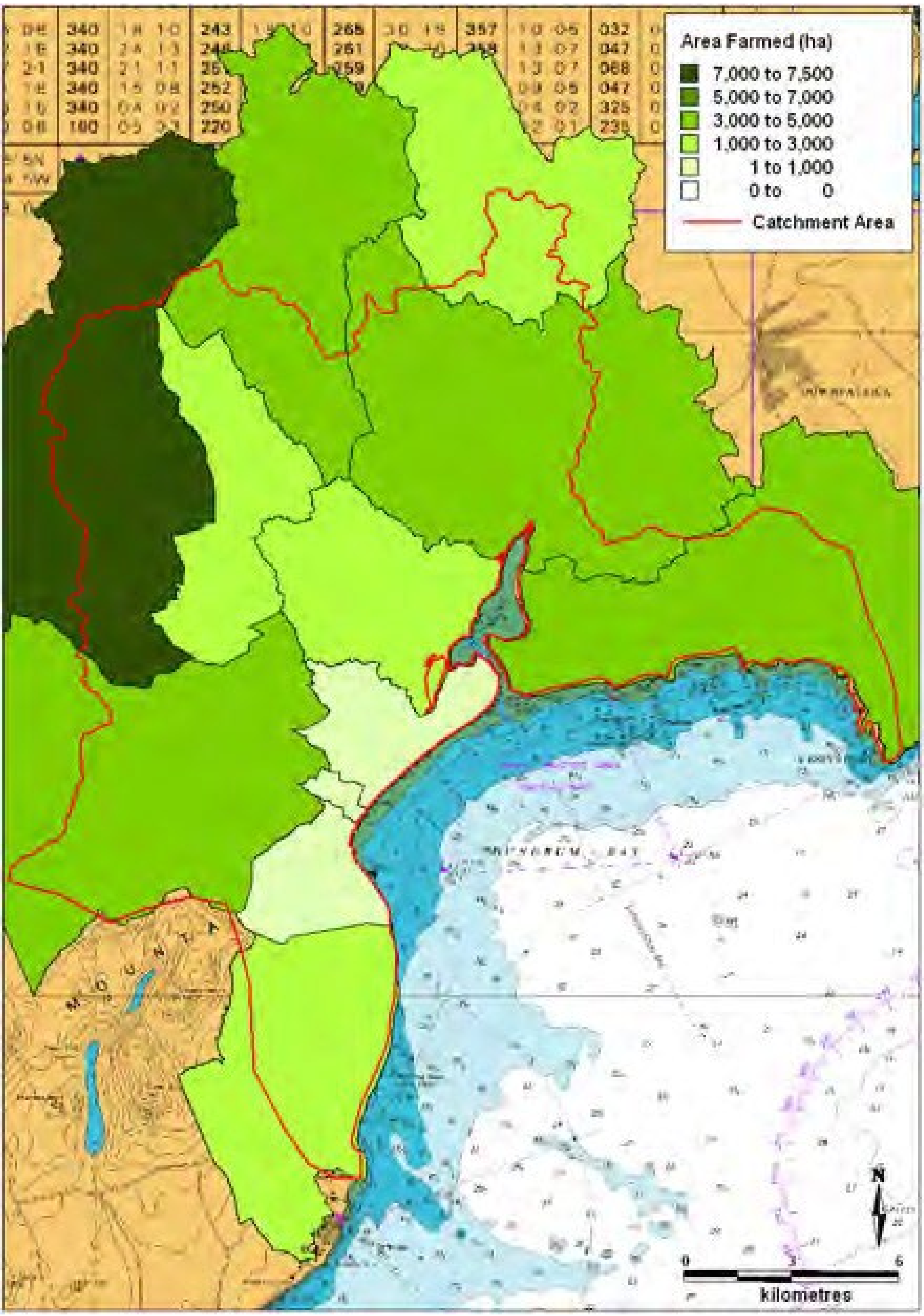


Figure 4.13: Area farmed (ha) within the Dundrum Bay Catchment Area (Source: DARD, 2010).

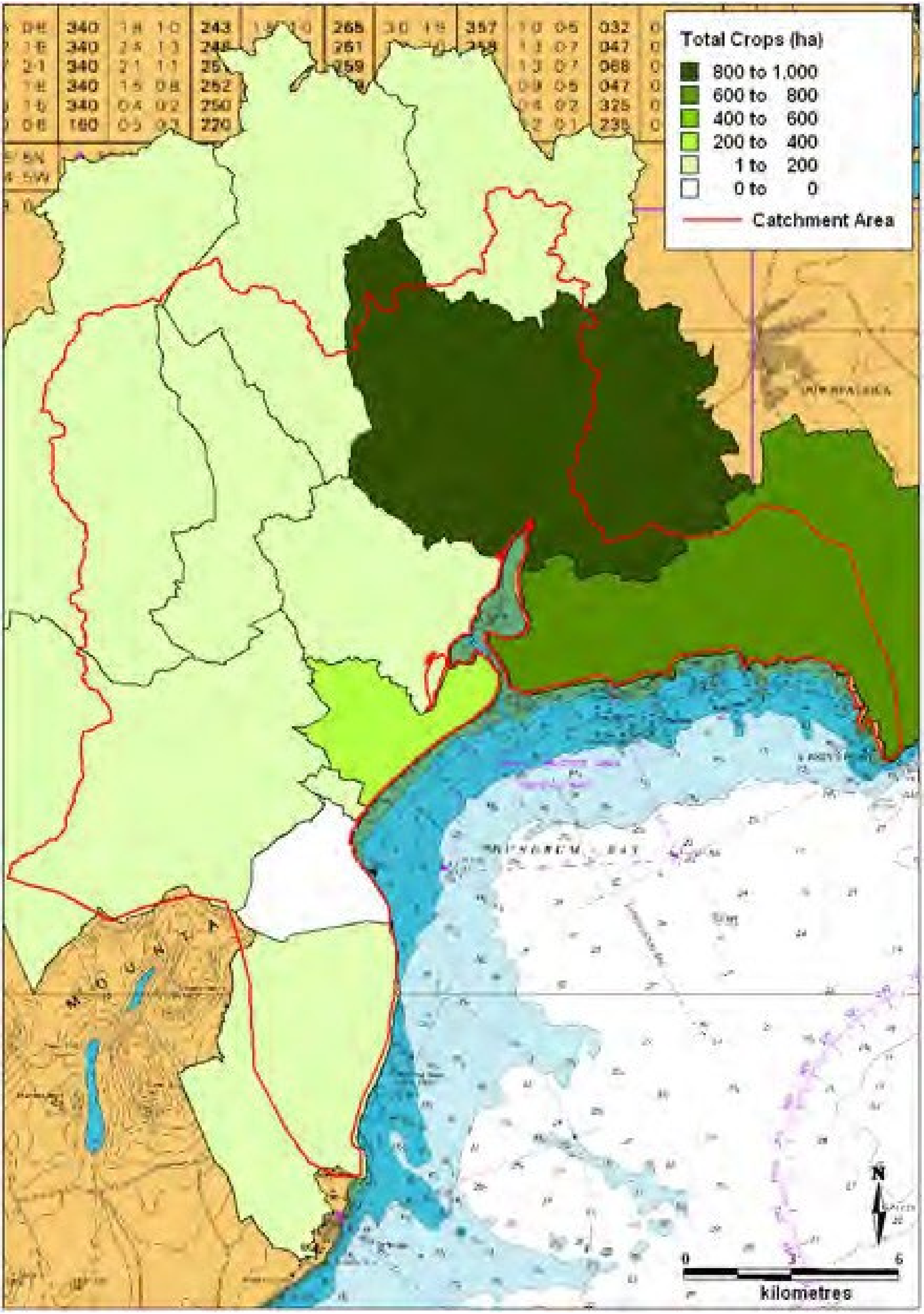


Figure 4.14: Total crops within the Dundrum Bay Catchment Area (Source: DARD, 2010).

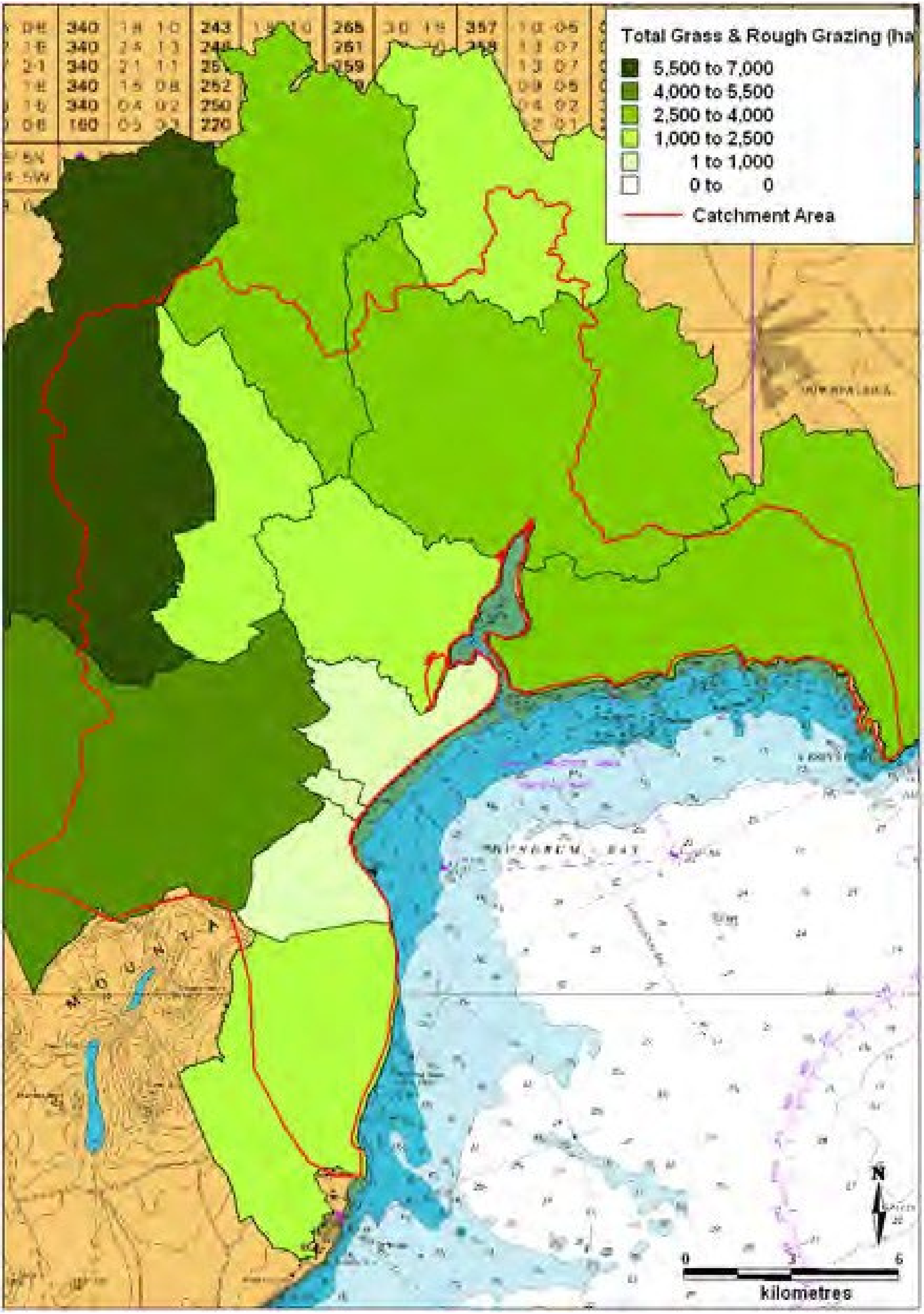


Figure 4.15: Total grass and rough grazing within the Dundrum Bay Catchment Area (Source: DARD, 2010).

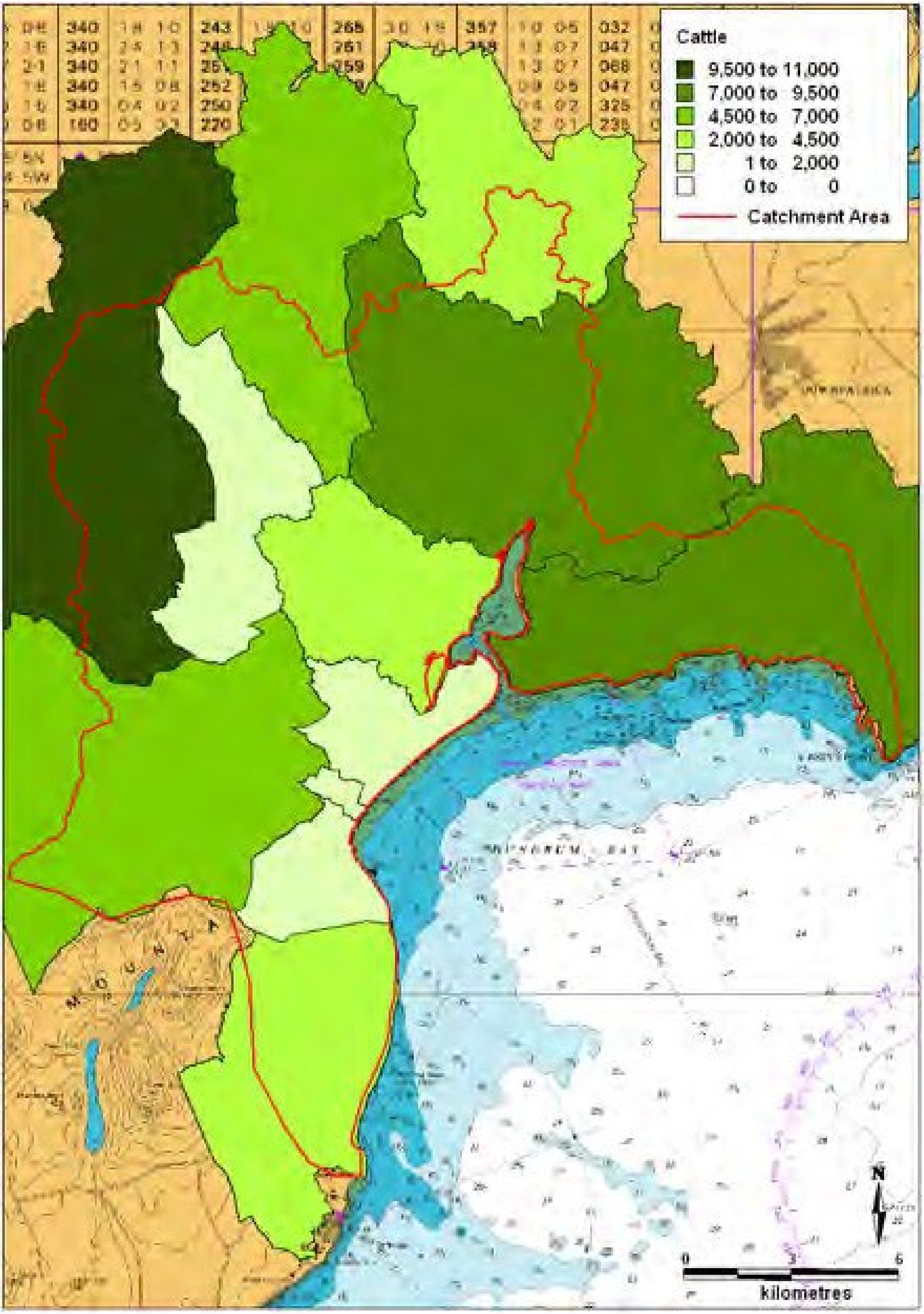


Figure 4.16: Cattle within the Dundrum Bay Catchment Area (Source: DARD, 2010).

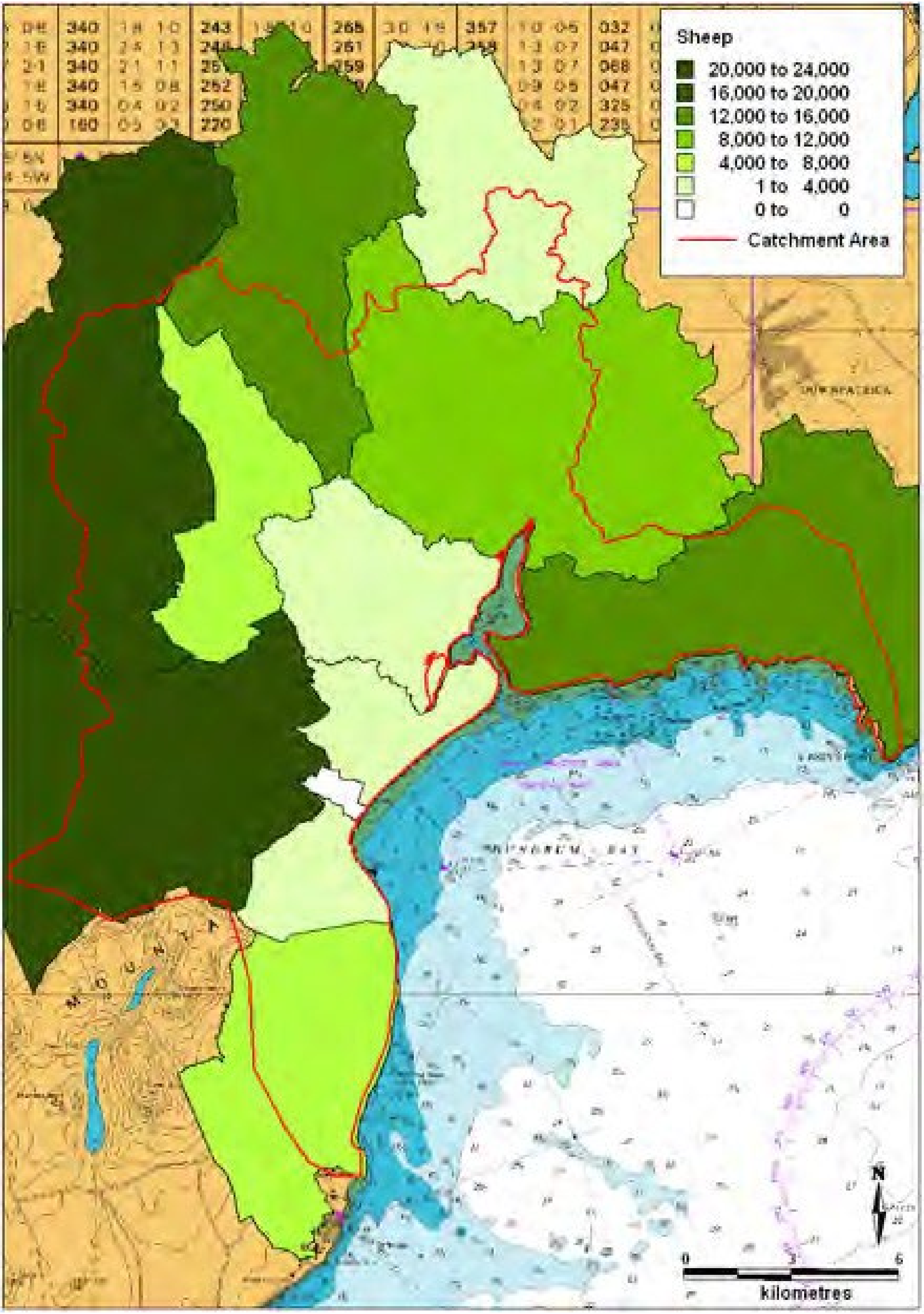


Figure 4.17: Sheep within the Dundrum Bay Catchment Area (Source: DARD, 2010).

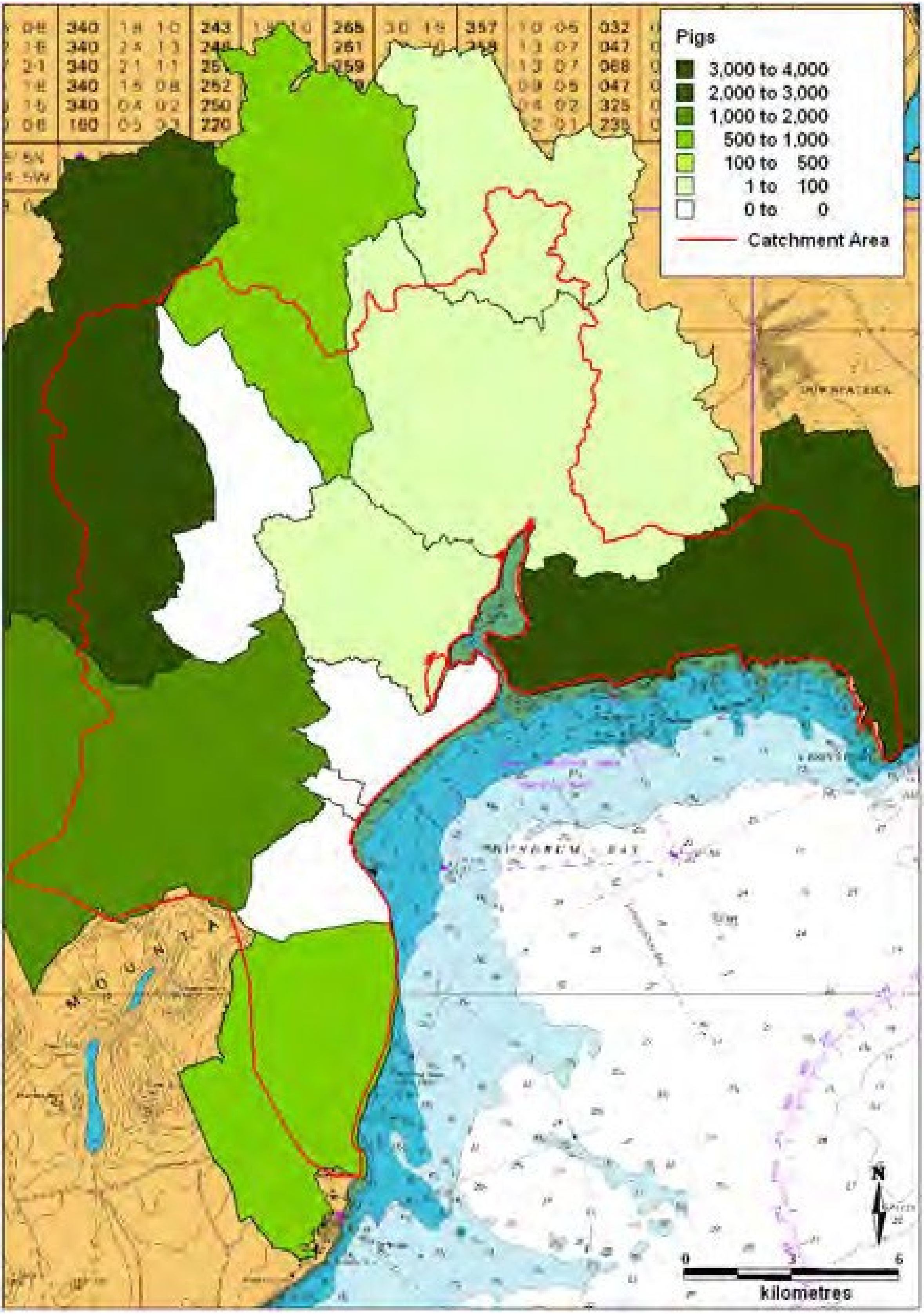


Figure 4.18: Pigs within the Dundrum Bay Catchment Area (Source: DARD, 2010).

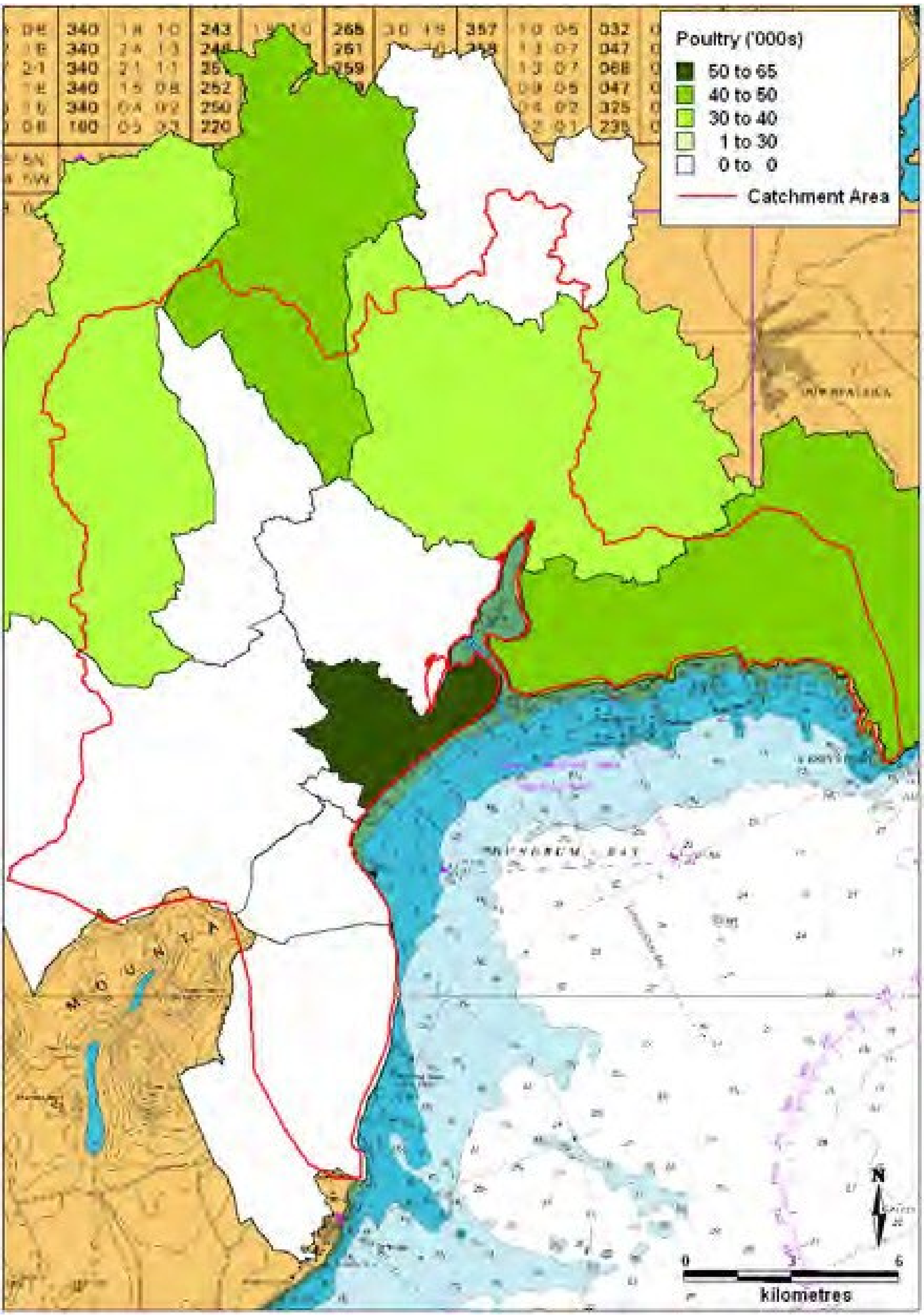


Figure 4.19: Poultry within the Dundrum Bay Catchment Area (Source: DARD, 2010).

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 came into operation on 1st January 2007 to improve the use of nutrients on farms and as a result improve water quality. Both of these Regulations implement the Nitrates Directive (91/676/EEC). 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.

4.1.6. Other Pollution Sources

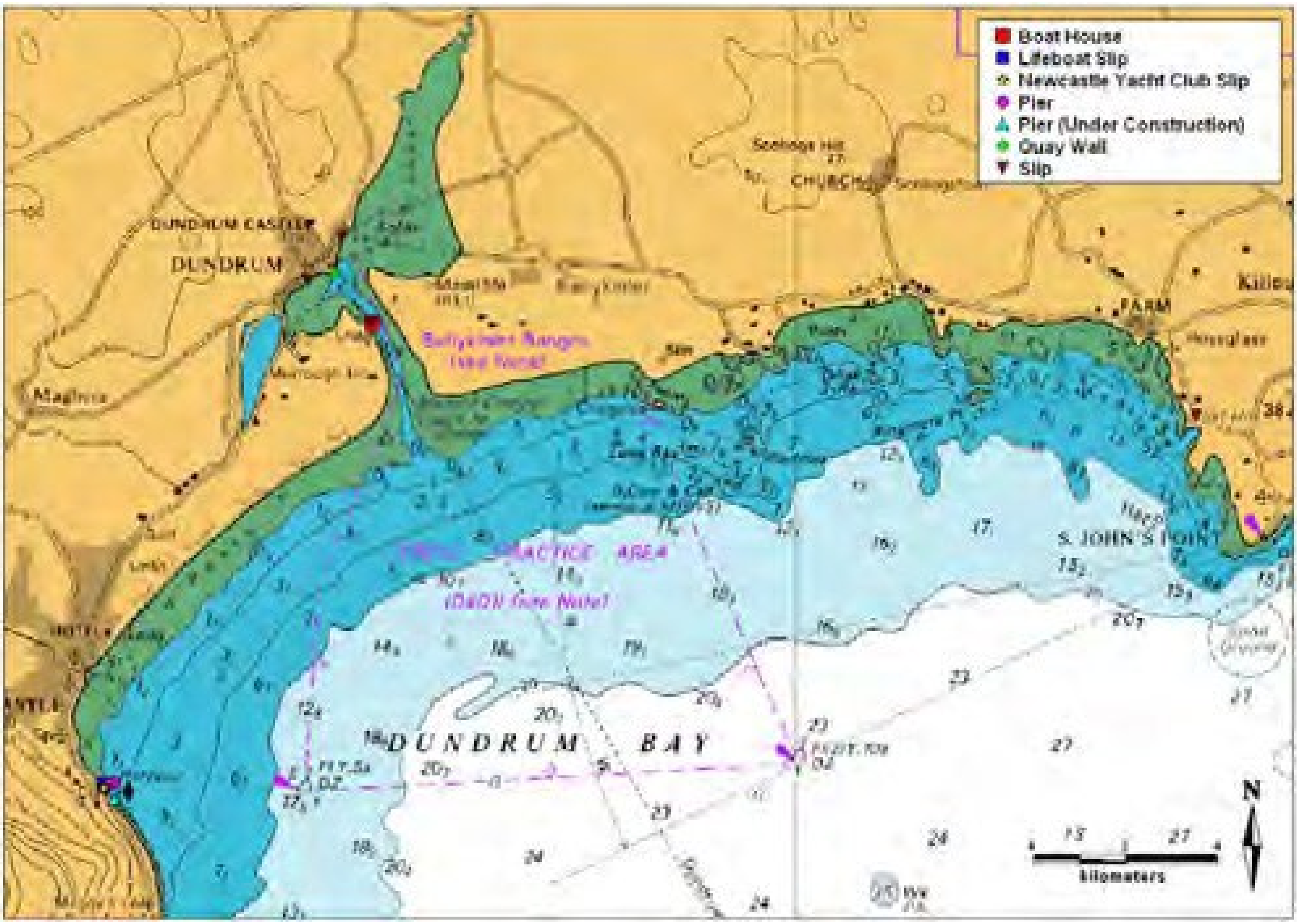
4.1.6.1. Shipping

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

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

Ship sewage originates from water-borne human waste, wastewaters generated in preparing food, washing dishes, laundries, showers, toilets and medical facilities. However, as waste enters the Bay 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 4.19 shows all boat facilities and activities in Dundrum Bay. Dundrum Bay does not have a commercial port. There is no harbour as such in Inner Dundrum Bay; there is a quay wall where a number of small boats tie up. There is a harbour at Newcastle, with a number of slips associated with the lifeboat service and yacht club. A new pier is also being constructed south of the existing harbour at Newcastle. Given the low numbers of vessels using the Inner Bay area, pollution from shipping is insignificant compared with point source discharges from the land.



4.20: Location of all boating facilities and activities in Dundrum (Source: www.nimap.net).

4.1.6.2. Birds

It is important to document the bird populations in the Dundrum Bay 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).

Dundrum Bay is not a designated as a Special Protection Areas (SPA); however it is part of the South Down Coast Important Bird Area (IBA) and is regularly monitored by the British Trust for Ornithology (BTO) as part of the WeBS (Wetland Bird Survey) Project.

Dundrum Bay regularly supports nationally important numbers of common scoter, oystercatcher, sanderling, dunlin and redshank (Crowe, 2005). It also supports substantial numbers of black-headed and common gulls. Table 4.8 shows the most recent BTO WeBS results from the wetland bird surveys that are carried out each year (Holt *et al.,* 2011). The light-bellied Brent Goose is an Internationally Important Species present in this site.

Table 4.8: Total number of water birds in Dundrum Bay between 2005/06 and 2009/10 (Source: Holt *et al*., 2011).

Site Name	05/06	06/07	07/08	08/09	09/10	Mean
Dundrum Inner Bay	8,435	6,565	13,582	8,634	9,270	9,297

Bird populations in the Dundrum Bay 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 Dundrum Bay is higher in the winter months. However, it is also highly likely that these levels are low when compared with land-based discharges.

4.1.6.3. Pollution Incidences

The Dundrum Bay catchment area is located within two NIEA Water Areas – Strangford & Lecale and Carlingford & Mourne. In 2009, there were 280 substantiated water pollution incidents in these two NIEA areas (NIEA, 2009). Forty-two were from industrial source, 47 from farm sources, 101 were sourced from NI Water Ltd, 52 from domestic sources, 4 from transport sources and 34 from other sources. Six of the incidents were chemical in nature, 45 were agricultural in nature, 139 were sewage related, 36 were oil related, 9 were non agricultural waste discharges, 4 were due to a breach of consent and 41 were classified as others. The cause of the incidents ranged from deliberate dumping (9), a breach of consent (6), an accident/emergency (30), equipment failure (71), inadequate equipment (34), negligence (22), poor work practice (40), the weather (15), unknown causes (47) and other causes (6). Of the 280 incidents, 207 were of low severity, 72 were of medium severity and 1 was of high severity. The locations of these incidents were unavailable and it is therefore unknown what quantity of the above incidences occurred within the Dundrum Bay catchment.

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 and OS planning maps accessed through www.nimap.net and from admiralty charts for the area. Figures 4.21 and 4.22 show the freshwater flow, piers, sewers, discharge pipes, runoff, sinks and slipways in Dundrum Bay. These figures also show a number of features which required groundtruthing in the field. The shoreline survey was carried out on the 31st January 2012 by Dr. Mark Costelloe and Gary Ridge (AQUAFACT). A number of the locations shown in Figures 4.21 and 4.22 were groundtruthed and photographed in the field. The shoreline survey was carried out by driving the coastal route around the bay and walking some sections of the intertidal area (See Figure 4.23). All features seen in Figures 4.21 and 4.22 were pre-loaded on to a hand-held GPS (Global Positioning System) unit and were navigated to, confirmed and photographed. Please note that the features numbered 88 to 97 in Figure 4.21 could not be approached due to the presence of a military restricted zone in the area. In addition, any new features not previously identified during the desktop survey were photographed and a GPS reading taken. 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.

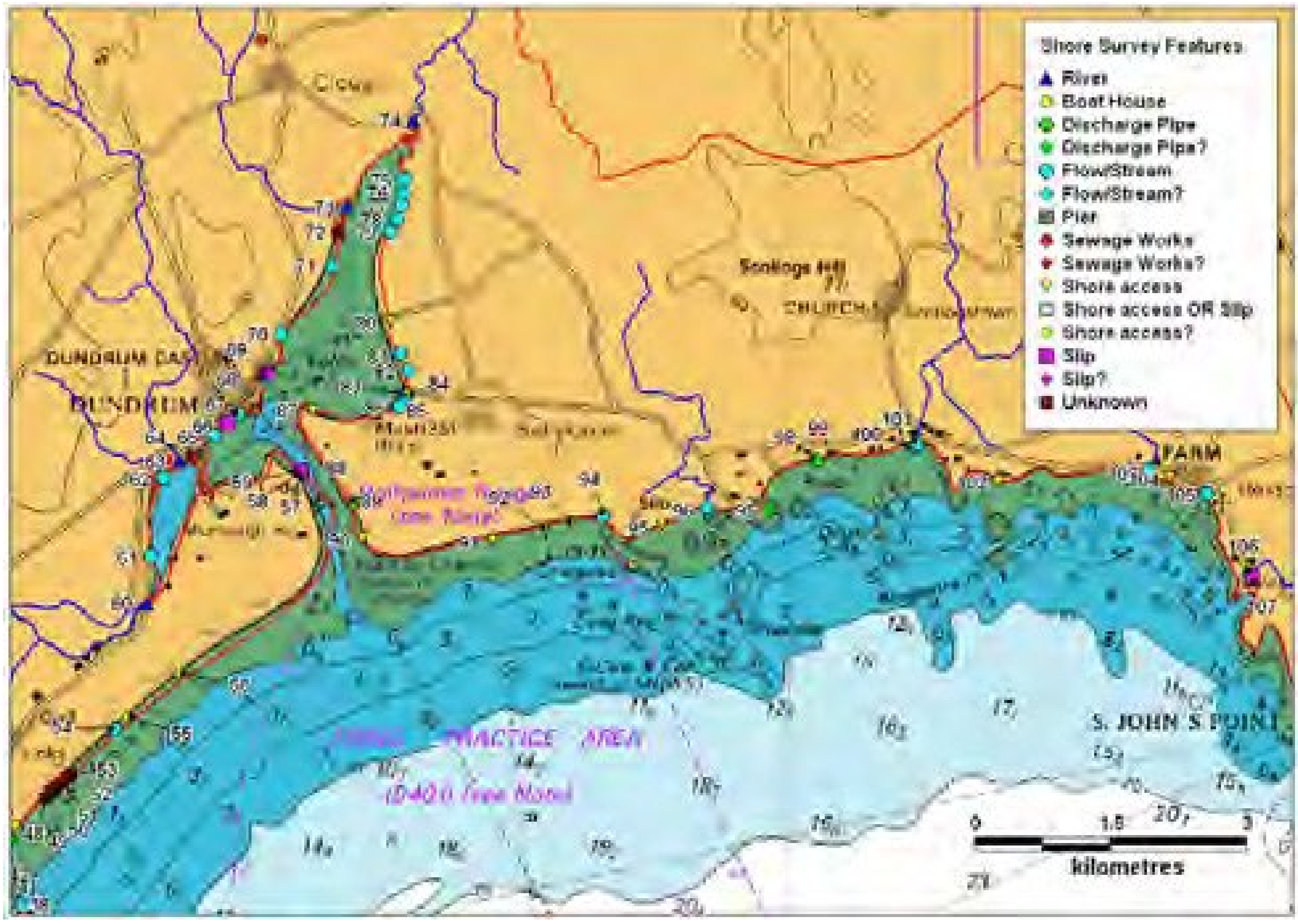


Figure 4.21: Locations of freshwater sources, piers, slipways, sinks, sewers, discharge pipes and runoff /drainage channels identified from the desk-based assessment.

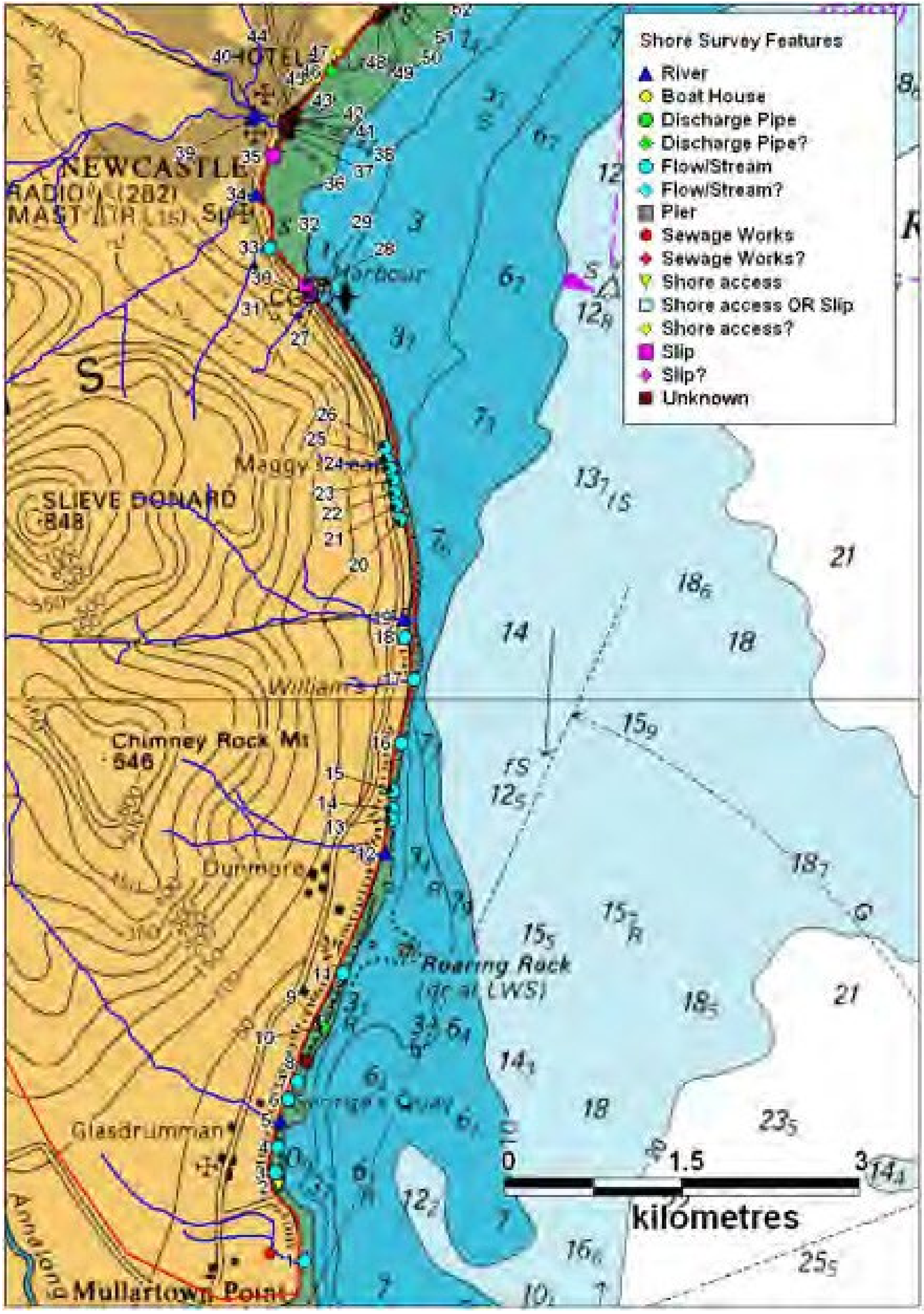


Figure 4.22: Locations of freshwater sources, piers, slipways, sinks, sewers, discharge pipes and runoff /drainage channels identified from the desk-based assessment.

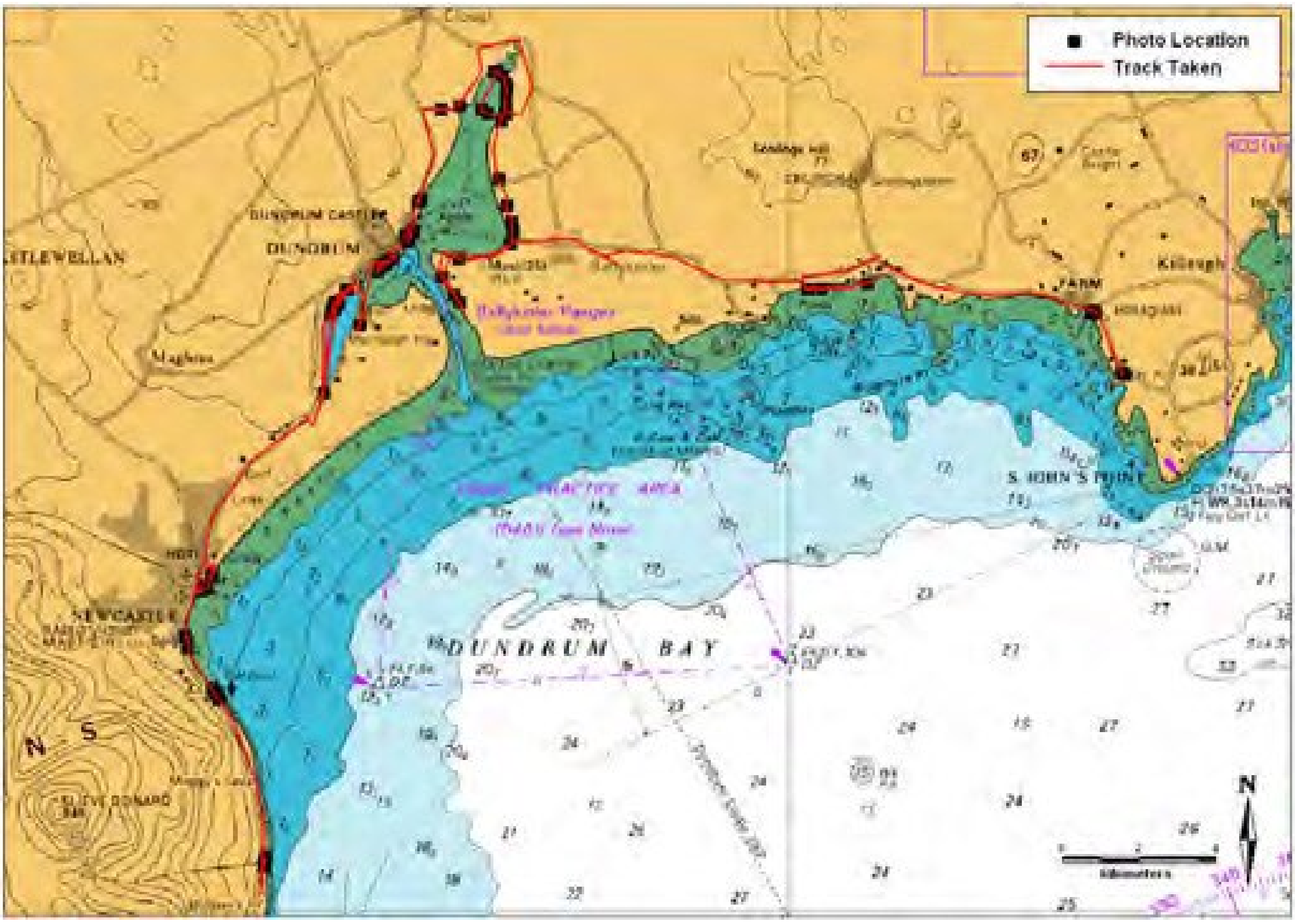


Figure 4.23: Shoreline survey track route and photograph locations.

Figure 4.24 shows the locations of the discharge pipes/outfalls located during the shoreline survey. In total, 13 were identified in the field. Figure 4.25 shows images of these outfall/discharge locations.

Figure 4.26 shows the locations of the rivers/streams/runoff/drainage channels located during the shoreline survey. In total, 27 were identified in the field. Figures 4.27 to 29 show images of these sites.

Figure 4.30 shows the locations of the piers, quays, slipways and shore access points located during the shoreline survey. In total, 22 were identified in the field. Figures 4.31 to 4.33 show images of these sites.

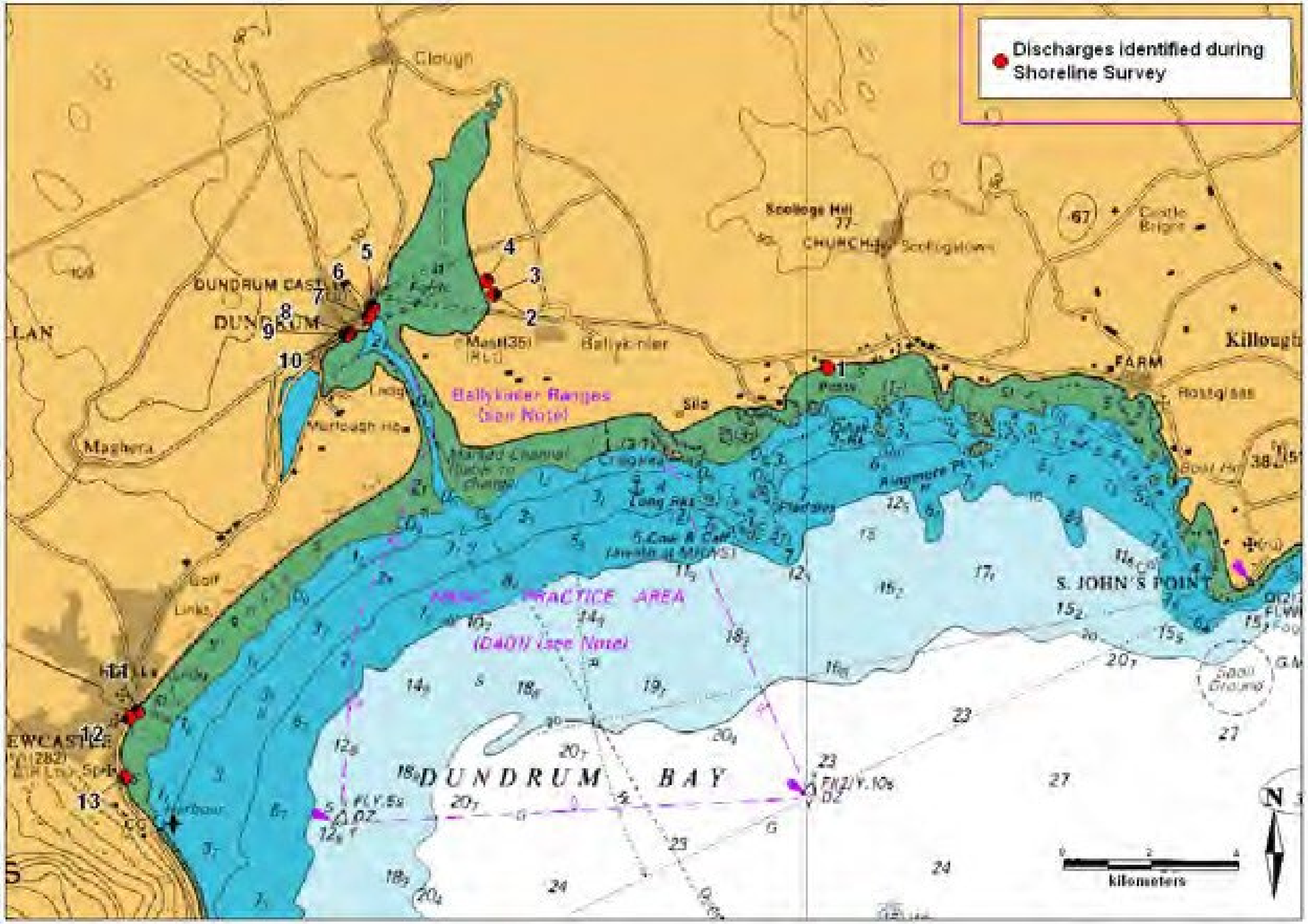
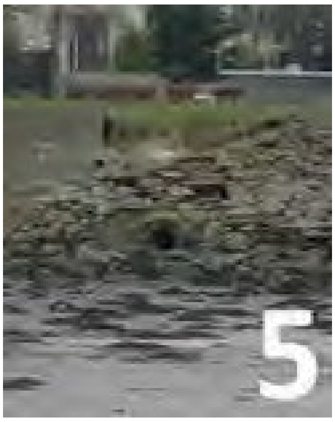
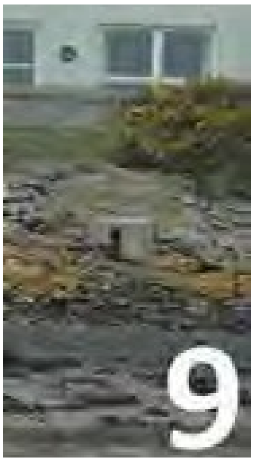


Figure 4.24:

Discharges/Outfalls located during the shoreline survey.





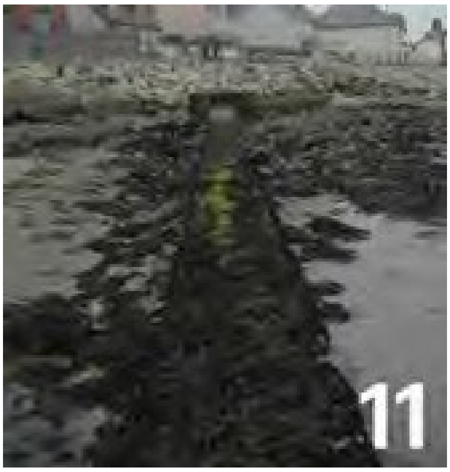


Figure 4.25: Discharges/ Outfalls located during the shoreline survey. Refer to Figure 4.24 for site locations.

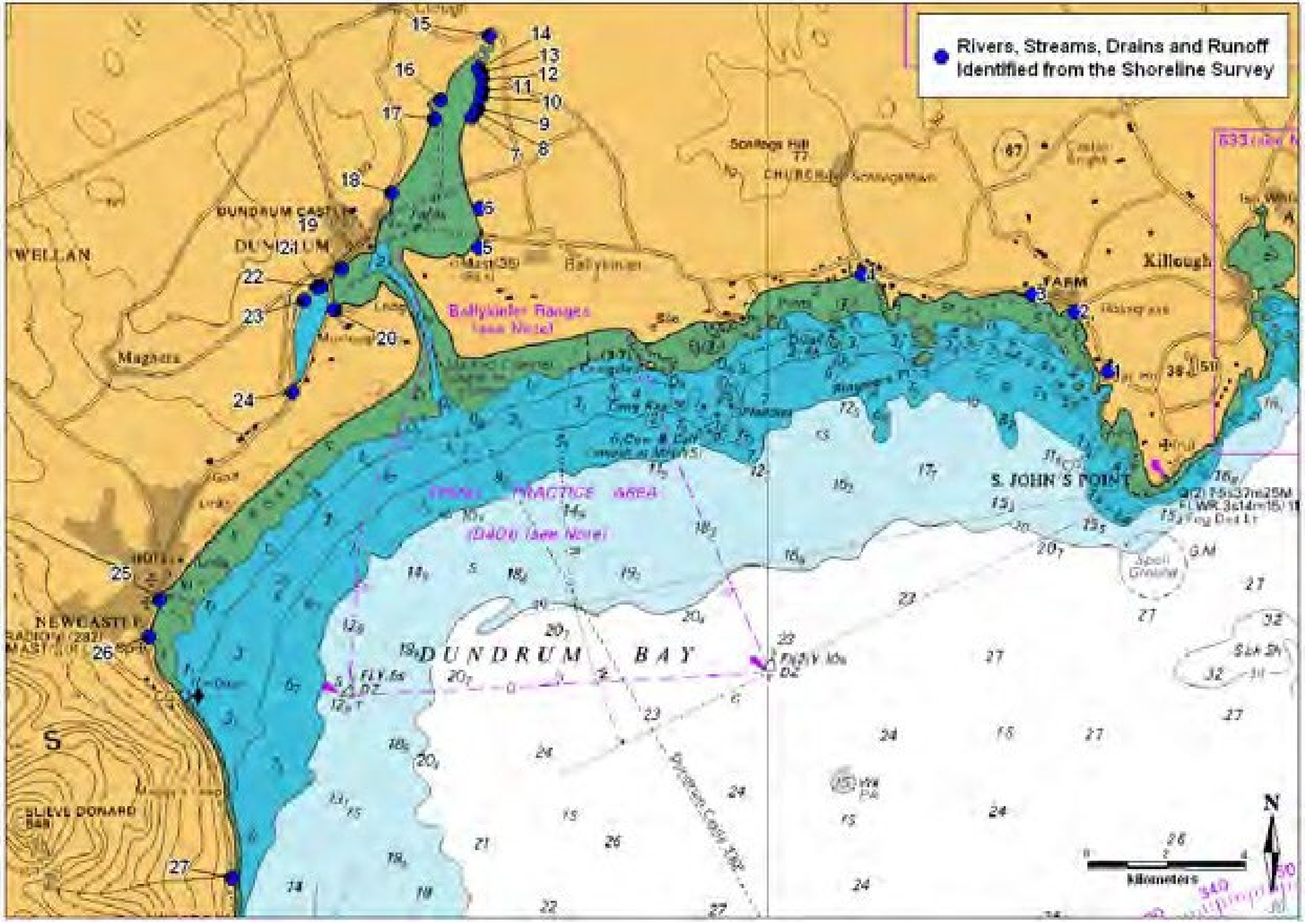


Figure 4.26: Rivers/Streams/ Runoff/Drainage Channels located during the shoreline survey.

Figure 4.27: Rivers, streams, runoff, drainage channels located during the shoreline survey. Refer to Figure 4.26 for site locations.

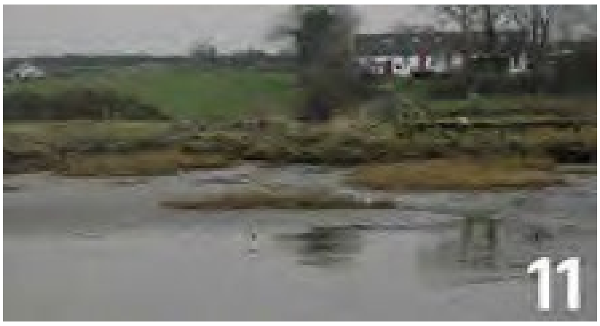


Figure 4.28: Rivers, streams, runoff, drainage channels located during the shoreline survey. Refer to Figure 4.26 for site locations.

Figure 4.29: Rivers/streams/runoff/drainage channels located during the shoreline survey. Refer to Figure 4.26 for site locations.

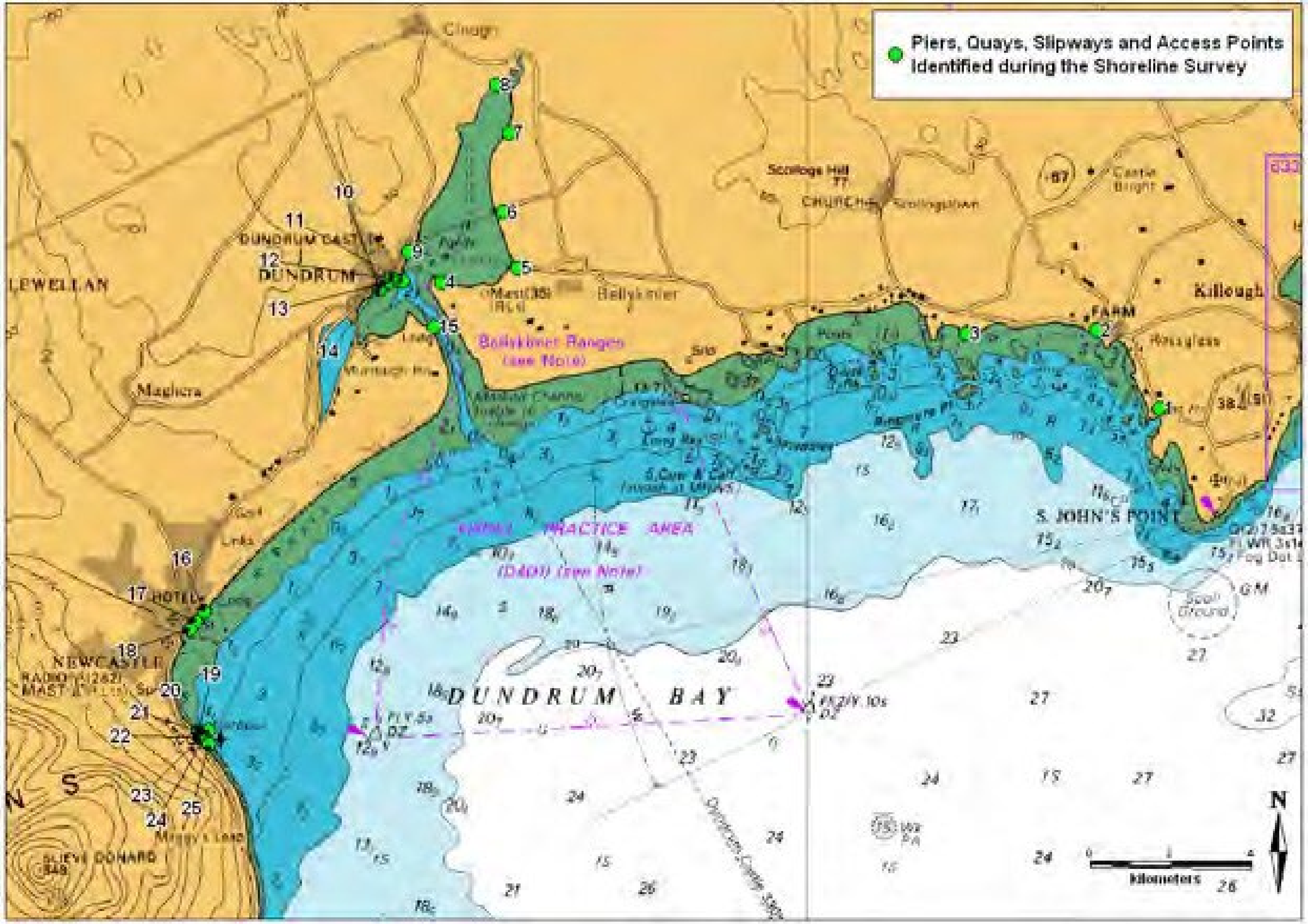


Figure 4.30: Piers, Quays, Slipways and shore access points located during the shoreline survey.

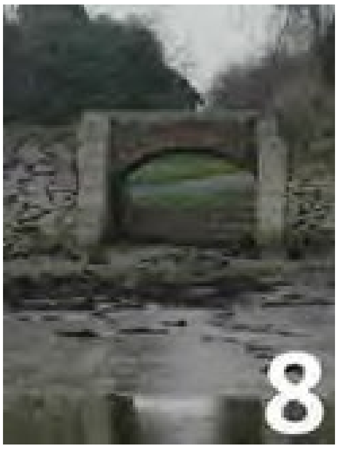


Figure 4.31: Piers, quays, slipways and shore access points identified during the shoreline survey. Refer to Figure 4.30 for site locations.

Figure 4.32: Piers, quays, slipways and shore access points identified during the shoreline survey. Refer to Figure 4.30 for site locations.

Figure 4.33: Piers, quays, slipways and shore access points identified during the shoreline survey. Refer to Figure 4.30 for site locations.

4.3. Locations of Sources

Figure 4.34 shows all watercourses discharging into Dundrum Bay and Table 4.9 provides cross-referenced details for this map. Figure 4.34 shows all WWTWs (Waste Water Treatment Works) and continuous discharges discharging into Dundrum Bay and Table 4.10 provides cross-referenced details for this map. Figure 4.35 shows all pumping stations discharging into Dundrum Bay and Table 4.11 provides cross- referenced details for this map. Figure 4.36 shows all intermittent discharges (CSOs, septic tanks, industrial discharges and discharges located from the shoreline survey) discharging into Dundrum Bay and Table 4.12.

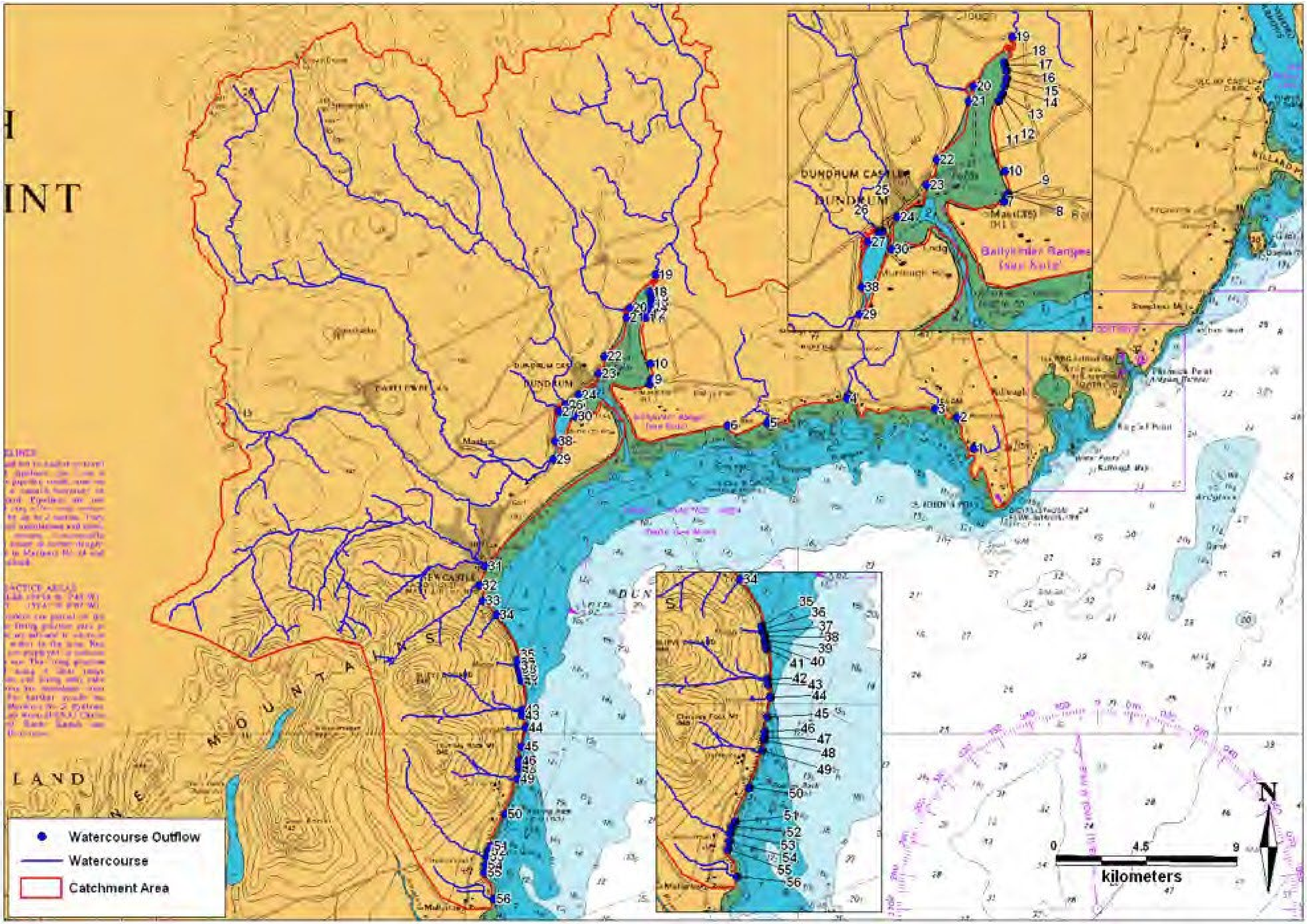


Figure 4.34: Location of all watercourses discharging into Dundrum Bay.

Table 4.9: Cross-referenced table for Figure 4.34 Watercourses.

Map ID	Description	Easting	Northing	Longitude	Latitude
1	Stream	351736.1	334960.2	-5.6733	54.24104
2	Drain (dried -up)	351227	335839.2	-5.68066	54.24908
3	Stream	350584.2	336063.4	-5.6904	54.25128
4	Stream	348022.1	336279	-5.72957	54.25396
5	Stream	345731.5	335498.1	-5.76507	54.24761
6	Stream/Drain	344587.7	335379	-5.78266	54.24686
7	Runoff	342298.3	336511.2	-5.81721	54.25767
8	Drain	342353.1	336630.8	-5.81632	54.25873
9	Drain	342374	336652.2	-5.81598	54.25891
10	Stream	342296.6	337100	-5.81696	54.26295
11	Stream	342130.7	338441.3	-5.81887	54.27504
12	Stream	342190.7	338541.1	-5.8179	54.27592
13	Stream	342205.3	338582.4	-5.81766	54.27629
14	Stream	342251.6	338745.9	-5.81687	54.27774
15	Stream	342268.4	338866.7	-5.81655	54.27882
16	Stream/Drain	342274.3	339027	-5.81639	54.28026
17	Stream/Drain	342243.4	339132.5	-5.81681	54.28121
18	Stream/Drain	342212.9	339180.8	-5.81726	54.28166
19	Blackstaff River	342357.4	339669	-5.81481	54.286
20	Unnamed River	341653.5	338698.6	-5.82606	54.27748
21	Flow from River No. 20	341568.2	338416.3	-5.82751	54.27497
22	Stream	340970.4	337274.4	-5.83721	54.26489
23	Stream/Drain	340800.8	336779.6	-5.84005	54.26049
24	Stream	340247.8	336135.3	-5.84883	54.25486
25	Stream	339968.8	335862.7	-5.85323	54.25249
26	Moneycarragh River	339890.9	335844.7	-5.85444	54.25235
27	Stream	339710.2	335648.2	-5.8573	54.25063
29	Carrigs River	339584.9	334258.3	-5.85986	54.23819
30	River input from inside Bridge	340165.7	335515	-5.85038	54.24931
31	Tullibranigan & Shimna Rivers	337682.7	331099	-5.89047	54.21034
32	Glen River	337538.3	330538.1	-5.89293	54.20534
33	Stream	337661.5	330089.5	-5.89125	54.20128
34	Stream	338063.2	329696.6	-5.88528	54.19765
35	Stream/Drain	338692.9	328418	-5.87623	54.186
36	Stream/Drain	338712.1	328316	-5.87598	54.18508
37	Stream/Drain	338738.3	328244.4	-5.87561	54.18443
38	Stream/Drain	339606.5	334780.6	-5.85929	54.24287
38	Stream/Drain	338770.3	328142.5	-5.87517	54.18351
39	Stream/Drain	338780.6	328041.1	-5.87506	54.18259
40	Stream/Drain	338803.9	327932.7	-5.87475	54.18161

Map ID	Description	Easting	Northing	Longitude	Latitude
41	Stream/Drain	338838.7	327808	-5.87428	54.18048
42	Bloody Bridge River	338890.6	326968.8	-5.87387	54.17294
43	Stream/Drain	338905.9	326814.3	-5.87371	54.17155
44	Stream	338998.2	326457.7	-5.87246	54.16832
45	Stream/Drain	338910.5	325907.3	-5.87405	54.1634
46	Stream/Drain	338849.9	325495.9	-5.87517	54.15972
47	Stream/Drain	338839.8	325345.9	-5.87539	54.15838
48	Stream/Drain	338845.7	325264.1	-5.87534	54.15764
49	Crock Horn Stream	338802.5	324966.2	-5.87614	54.15498
50	Stream/Drain	338471.6	323937.8	-5.88167	54.14584
51	Stream/Drain	338110.7	323001.7	-5.88762	54.13753
52	Stream/Drain	338038.9	322849	-5.88879	54.13618
53	Spences River	337981	322664.9	-5.88976	54.13454
54	Stream/Drain	337962.2	322438.1	-5.89015	54.13251
55	Stream/Drain	337938.9	322225.9	-5.8906	54.13061
56	Stream	338212.7	321475.3	-5.88676	54.1238

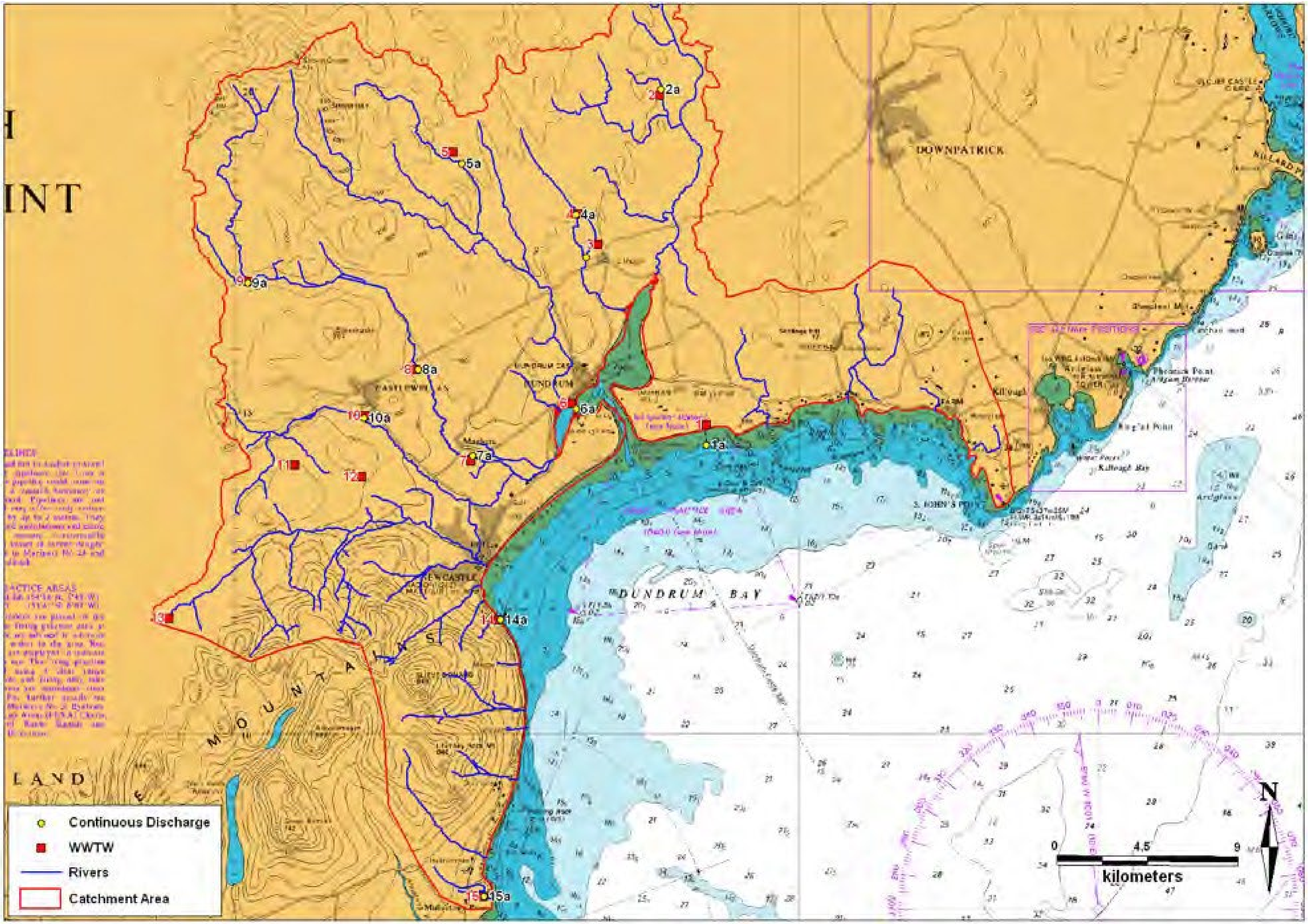


Figure 4.35: Location of all WWTW and Continuous Discharges into Dundrum Bay and its tributaries.

Table 4.10: Cross-referenced table for Figure 4.35 WWTW and Continuous Discharges.

MapID	ID	Easting	Northing	Longitude	Latitude	Receiving Water	p.e	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
1	Ballykinler WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
1a	Ballykinler Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
2	Loughinisland WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Loughinsiland Lake	N/A	N/A	N/A	N/A	N/A
2a	Loughinisland Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
3	Chough WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Stream leading to Dundrum Bay	N/A	N/A	N/A	N/A	N/A
3a	Clough Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
4	Seaforde WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Stream leading to Dundrum Bay	N/A	N/A	N/A	N/A	N/A
4a	Seaforde Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
5	Drumaroad WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Trib. Moneycarragh River	N/A	N/A	N/A	N/A	N/A
5a	Drumaroad Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
6	Dundrum WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Inner Dundrum Bay	2613	N/A	N/A	N/A	N/A
6a	Dundrum Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
7	Maghera WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Carrigs River	N/A	N/A	N/A	N/A	N/A
7a	Maghera Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
8	Annesborough WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Ballybannan River	N/A	N/A	N/A	N/A	N/A
8a	Annesborough Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
9	Leitrim WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Leitrim River	N/A	N/A	N/A	N/A	N/A
9a	Leitrim Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
10	Castlewellan WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Burren River	N/A	N/A	N/A	N/A	N/A
10a	Castlewellan Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
11	Moneyscalp WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
12	Burren Road WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
13	Foffanybane WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A

MapID	ID	Easting	Northing	Longitude	Latitude	Receiving Water	p.e	Treatment	FFT/m^3 /day	DWF/m^3 /day	Discharge Data
14	Newcastle WWTW*	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
14a	Newcastle Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A
15	Unnamed WWTW	[Redacted]	[Redacted]	[Redacted]	[Redacted]	Outer Dundrum Bay	N/A	N/A	N/A	N/A	N/A
15a	Unnamed Discharge	[Redacted]	[Redacted]	[Redacted]	[Redacted]		N/A	N/A	N/A	N/A	N/A

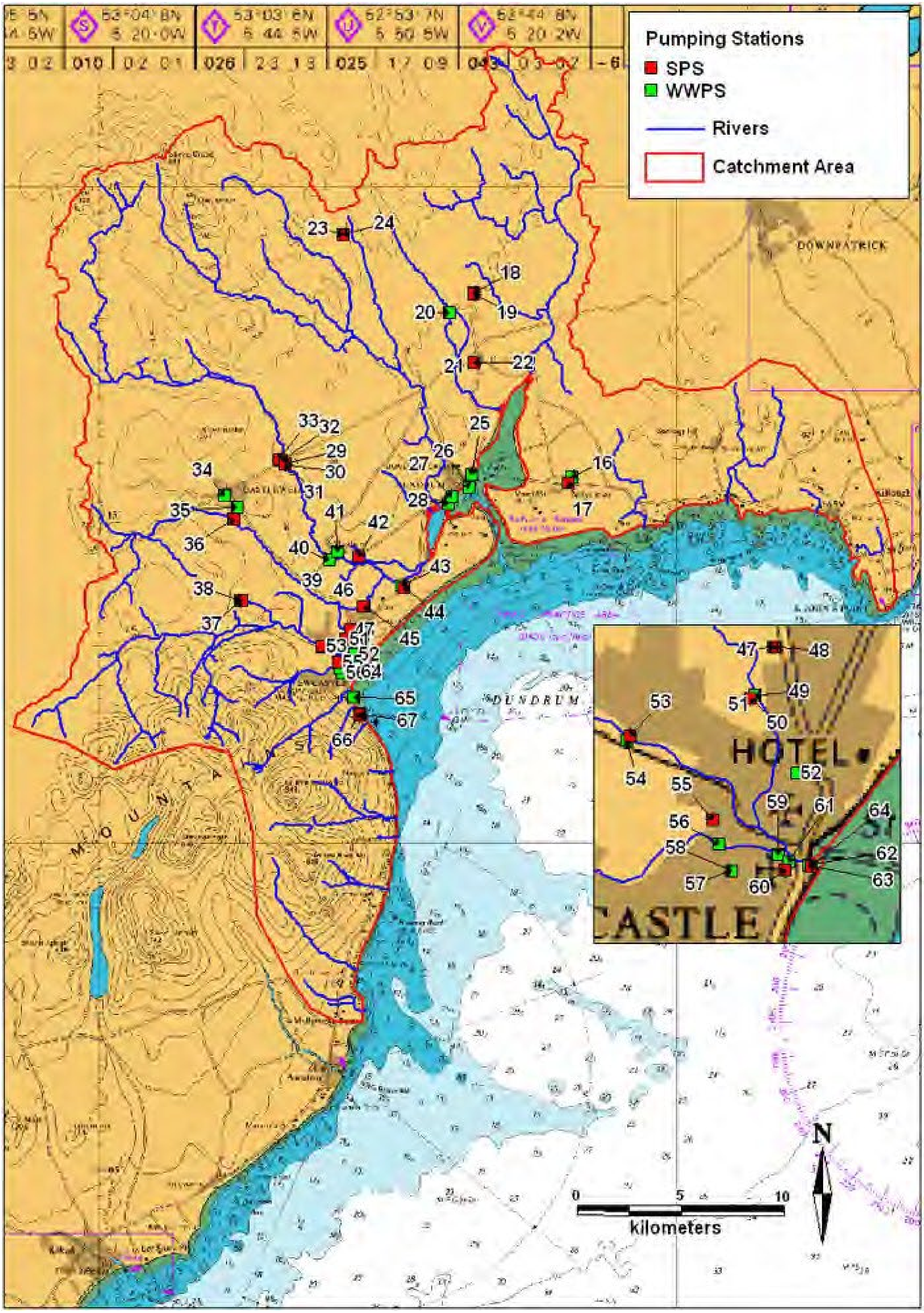


Figure 4.36: Location of all Pumping Stations discharging into Dundrum Bay and its tributaries.

Table 4.11: Cross-referenced table for Figure 4.36 Pumping Stations.

Map ID	Name	Receiving_Waterbody	Funtion	Easting	Northing	Longitude	Latitude
16	Ballykinler Village WwPS	Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
17	Ballykinler Village SPS	To adjacent storm sewer then to unnamed stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
18	Pinetrees WwPS	Unnamed Stream, Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
19	Seaforde SPS	Goes to Road Drainage Pipe then to Unknown Stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
20	Seaforde WwPS	Trib. Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
21	Castlewellan Road (SPS)	Un-named Stream, via adjacent surface water culvert. Tributary to the Irish Sea	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
22	Castlewellan Road WwPS	Trib. Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
23	Drumaroad Village SPS	Rivers Agency Watercourse, Trib. To Moneycarragh River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
24	Chapel Lane WwPS	Unnamed Stream	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
25	Kieltys School WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
26	The Quay WwPS	Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
27	Flynns WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
28	Downshire WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
29	Annsborough Park WwPS	Ballynannan River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
30	Annesborough Park SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
31	Annsborough Park SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
32	Clarkill WwPS	Ballynannan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
33	Bellfield SPS	Ballybannon River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
34	Castlewellan Two WwPS*	Trib. Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
35	Castlewellan One WwPS*	Trib. Burren River	Final Effluent	[Redacted]	[Redacted]	[Redacted]	[Redacted]
36	Castlewellan SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
37	Tudor Heights WwPS	Trib. Shimna River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Map ID	Name	Receiving_Waterbody	Funtion	Easting	Northing	Longitude	Latitude
38	Tudor Heights SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
39	Maghera Dundrine Road WwPS	Trib. Carrigs River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
40	Maghera (Dundrine Road) SPS	Trib. To Carrigs River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
41	Maghera Housing WwPS*	Trib. Carrigs River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
42	Maghera Housing SPS	Un-Named Stream	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
43	Mourneview Newcastle WwPS	Trib. Carrigs River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
44	Mourneview SPS	Cargis River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
45	Murlough WwPS	Trib. Carrigs River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
46	Murlough SPS	Unknown tributary of Carrigs River.	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
47	Burrenview Court SPS	To drainage ditch leading to Burren River.	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
48	Burrenview Court WwPS	Trib. Shimna River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
49	Burren River WwPS	Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
50	Burren River SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
51	Burren SPS	Burren River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
52	Shimna Road WwPS	Trib. Burren River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
53	Rathicillan SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
54	Rathicillan WwPS	Shimna River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
55	Rowleys Meadow SPS	Tullybrannigan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
56	Bryansford Meadow WwPS	Tullybranigan River	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
57	Bryansford Grove WwPS	Trib. Tullybranigan River	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
58	Bryansford Grove SPS	Tullybrannigan River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
59	Castle Park Bowling Green WwPS*	Dundrum Bay	Foul	[Redacted]	[Redacted]	[Redacted]	[Redacted]
60	Castle Park SPS	Dundrum Bay	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
61	Castle Park WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
62	Castlebridge WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
63	Castlebridge WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
64	Castlebridge SPS	Shimna River	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]
65	Black Rock WwPS*	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]

Map ID	Name	Receiving_Waterbody	Funtion	Easting	Northing	Longitude	Latitude
66	Newcastle Harbour WwPS	Dundrum Bay	Combined	[Redacted]	[Redacted]	[Redacted]	[Redacted]
67	Harbour SPS	Dundrum Bay	Unknown	[Redacted]	[Redacted]	[Redacted]	[Redacted]

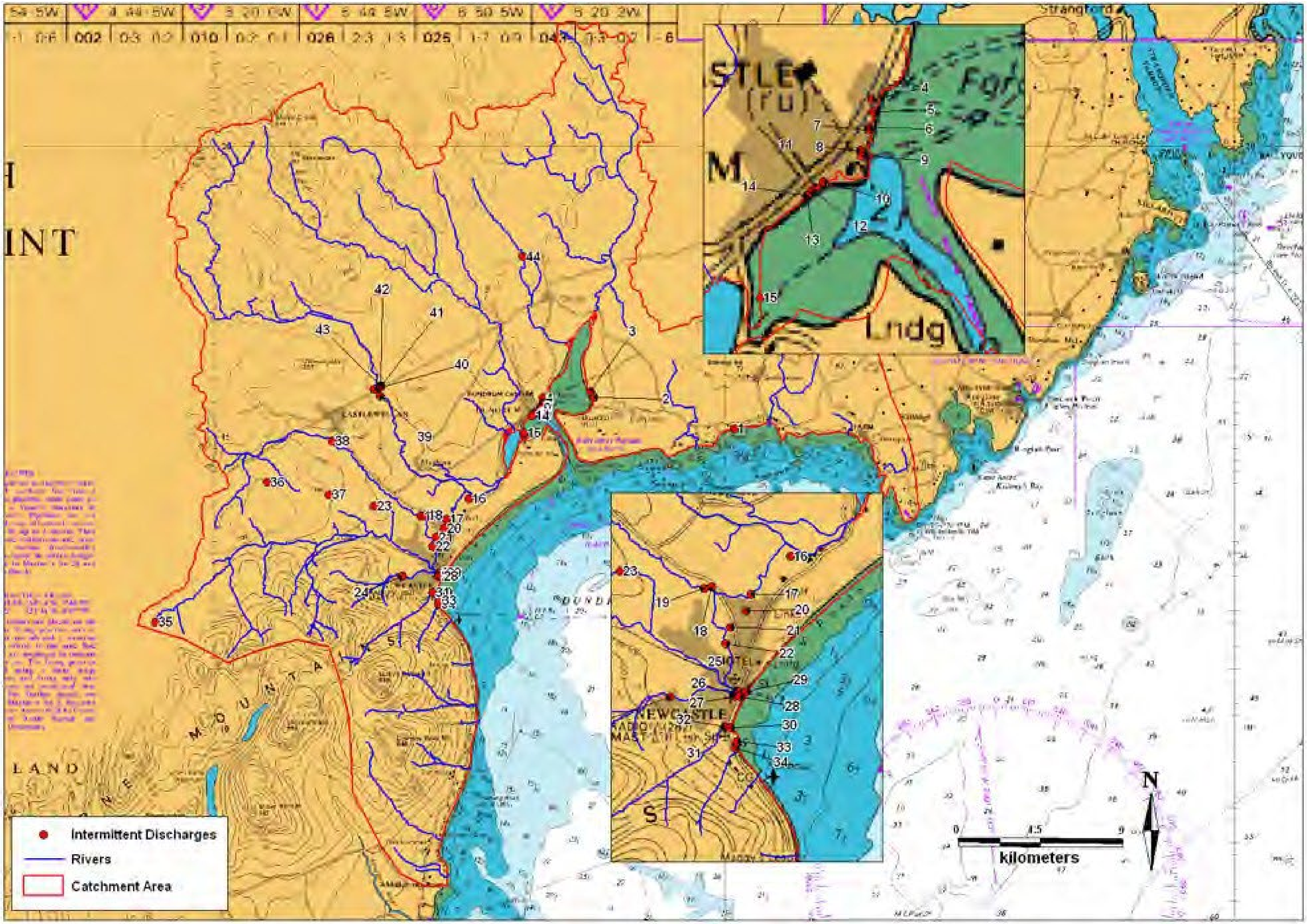


Figure 4.37: Location of all Intermittent Discharges into Dundrum Bay and its tributaries.

Table 4.12: Cross-referenced table for Figure 4.37 Intermittent Discharges.

MapID	Name	Receiving Waterbody	Easting	Northing	Longitude	Latitude
1	Discharge Pipe	Dundrum Bay	346910.2	336070.7	-5.74672	54.25241
2	Discharge Pipe	Dundrum Bay	342390.4	336919.9	-5.81561	54.26131
3	Discharge Pipe	Dundrum Bay	342296.6	337100	-5.81696	54.26295
4	Main Street Dundrum One CSO	Dundrum Bay	340783	336850	-5.84029	54.26113
5	Main Street Dundrum Two CSO	Dundrum Bay	340794	336780	-5.84015	54.2605
6	Discharge Pipe	Dundrum Bay	340769.9	336693.9	-5.84056	54.25973
7	Discharge Pipe	Dundrum Bay	340769.1	336678.6	-5.84058	54.25959
8	Discharge Pipe	Dundrum Bay	340727.9	336565	-5.84127	54.25858
9	Industrial Discharge	Dundrum Bay	340740	336530	-5.8411	54.25827
10	Murlough Inn CSO	Dundrum Bay	340527	336379	-5.84443	54.25697
11	Discharge Pipe	Dundrum Bay	340485.4	336346.8	-5.84509	54.25669
12	Discharge Pipe	Dundrum Bay	340462.5	336327	-5.84545	54.25652
13	Main Street Dundrum Three CSO	Dundrum Bay	340439	336303	-5.84582	54.25631
14	Discharge Pipe	Dundrum Bay	340433.6	336301.1	-5.8459	54.2563
15	Keel Point CSO	Dundrum Bay	340188	335722	-5.84994	54.25116
16	Industrial Discharge	Carrigs River	338510	333590	-5.87665	54.23248
17	Murlough CSO	Trib. Carrigs River	337821	332902	-5.88752	54.22649
18	Burrendale Hotel Two CSO	Burren River	337125	333017	-5.89813	54.22771
19	Burrendale Hotel One CSO	Burren River	336997	332981	-5.90011	54.22742
20	Mourneview Road	Unknown	337751	332604	-5.88873	54.22383
21	Burrenview Court North CSO	Burren River	337479	332307	-5.89303	54.22124
22	Burren CSO	Burren River	337397	332020	-5.89442	54.21869
23	Barbican Farm Bryansford CSO	Un-named	335498	333244	-5.92296	54.23018
24	Bonnys Caravan Park	Tullybrannigan River	336456	331038	-5.90928	54.21012
25	Valentia Place CSO	Dundrum Bay	337631	331194	-5.89121	54.21121
26	Main Street Newcastle CSO	Dundrum Bay	337608	331109	-5.8916	54.21045
27	Castlepark	Dundrum Bay	337593	331086	-5.89184	54.21025
28	Discharge Pipe	Dundrum Bay	337681.1	331086.9	-5.8905	54.21023
29	Downs Road CSO	Dundrum Bay	337781	331175	-5.88892	54.211
30	Central Promenade CSO	Dundrum Bay	337523	330536	-5.89317	54.20533
31	Shanslieve Drive CSO	Glen River	337427	330536	-5.89464	54.20535
32	Tullybrannigan Road CSO	Glen River	337427	330536	-5.89464	54.20535
33	Discharge Pipe	Dundrum Bay	337650.6	330283	-5.89133	54.20302
34	South Promenade	Dundrum Bay	337631	330173	-5.89168	54.20204
35	Septic Tank		328601	329329	-6.03033	54.1968

MapID	Name	Receiving Waterbody	Easting	Northing	Longitude	Latitude
36	Septic Tank		332040	333920	-5.97565	54.23715
37	Septic Tank		334020	333580	-5.94546	54.23358
38	Castlewellan CSO	Burren River	334086	335291	-5.94368	54.24893
39	Annsborough Park CSO	Ballybannon River	335570	336789	-5.92026	54.26199
40	Mill Hill Two CSO	Via Storm sewer Ballybannon River	335384	336978	-5.92302	54.26373
41	Mill Hill CSO 3A	Tributary of Ballybannon River	335590	337078	-5.91982	54.26458
42	Ballylough Road	Ballybannon River	335588	337085	-5.91985	54.26464
43	Mill Hill One CSO	Ballybannon River	335580	337085	-5.91997	54.26464
44	Seaforde CSO	Trib. Dundrum Bay	340012	341346	-5.85001	54.3017

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 Dundrum Bay (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, Polychlorinated 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 Dundrum Bay, these results are shown in Figure 5.2 (and Table 5.1) below for all 3 sampling points from 2005 to 2009. Faecal coliforms were below 50 cfu/100ml at all sites in all years with the exception of November 2008 when levels of 60 cfu/100ml were recorded at Inner Dundrum Bay 1 and 61 cfu/100ml at Inner Dundrum Bay 3 and in December 2005 when levels of 52 cfu/100ml were observed at Inner Dundrum Bay 1. The Guide value for faecal coliforms under the Shellfish 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 not exceeded at any site in any year.

The averaged seasonal faecal coliform levels from 2005 to 2009 can be seen in Table 5.2. At sites 1 and 2, faecal coliform levels were highest in winter followed by autumn with summer and spring have the lowest values respectively, while at site 3, autumn had the highest level, followed by winter with summer having the lowest values. However, it should be noted that not all seasons from 2005 to 2009 were equally represented (i.e. spring was only sample twice in the 4 year period).

Outer Dundrum Bay contains three bathing water areas, which are sampled monthly for faecal coliforms to ensure strict compliance with the EC Bathing Water Directive (76/160/EEC) (see locations in Figure 5.1). The three locations are Tyrella, approximately 5km east of the entrance channel to Inner Dundrum Bay, Newcastle approximately 5km southwest of the entrance channel and Murlough approximately 1km southwest of the channel. Murlough and Tyrella had excellent[4] water quality in 2010 and 2011. Newcastle

[4] Excellent Water Quality: Total coliforms ≤500 per 100ml of water AND Faecal coliforms ≤100 per 100ml of water AND Faecal streptococci ≤100 per 100 ml of water. Annually 80% (16 out of 20 sampling occasions) must meet the coliform standards AND Annually 90% (18 out of 20 sampling occasions) must meet the faecal streptococci standards

had good[5] water quality in 2011 and a poor[6] water quality in 2010. The water quality in Newcastle is more than likely affected by the discharges from the town, however this effect is localised as the Murlough water quality remained excellent.

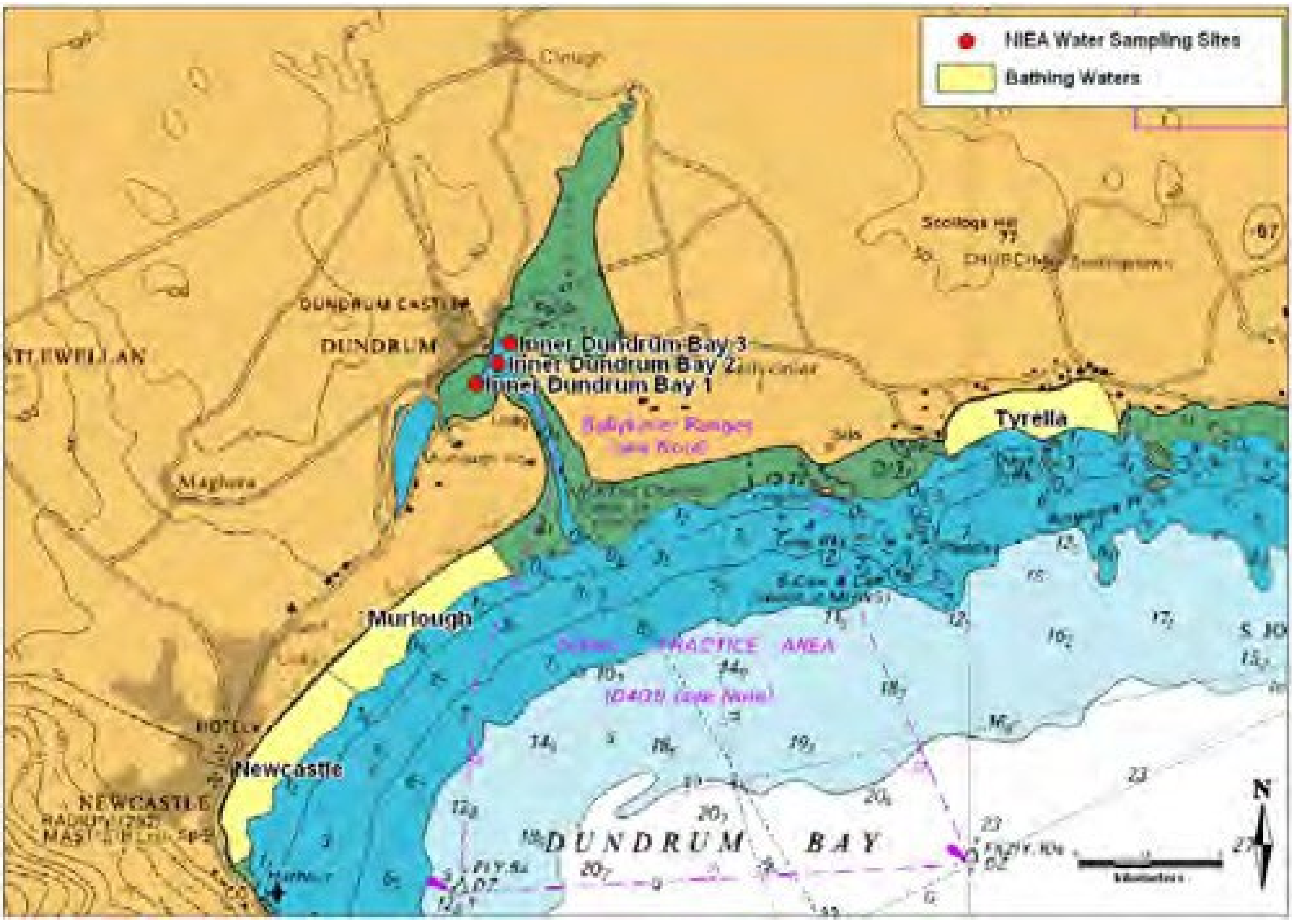


Figure 5.1: Locations of NIEA water sampling points and Bathing Waters in Dundrum Bay.

[5] Good Water Quality: Total coliforms ≤10,000 per 100ml of water AND Faecal coliforms ≤2,000 per 100ml. Annually 95% (19 out of 20 sampling occasions) must meet these standards.

[6] Poor Water Quality: Means the sample failed the standard required for good water quality.

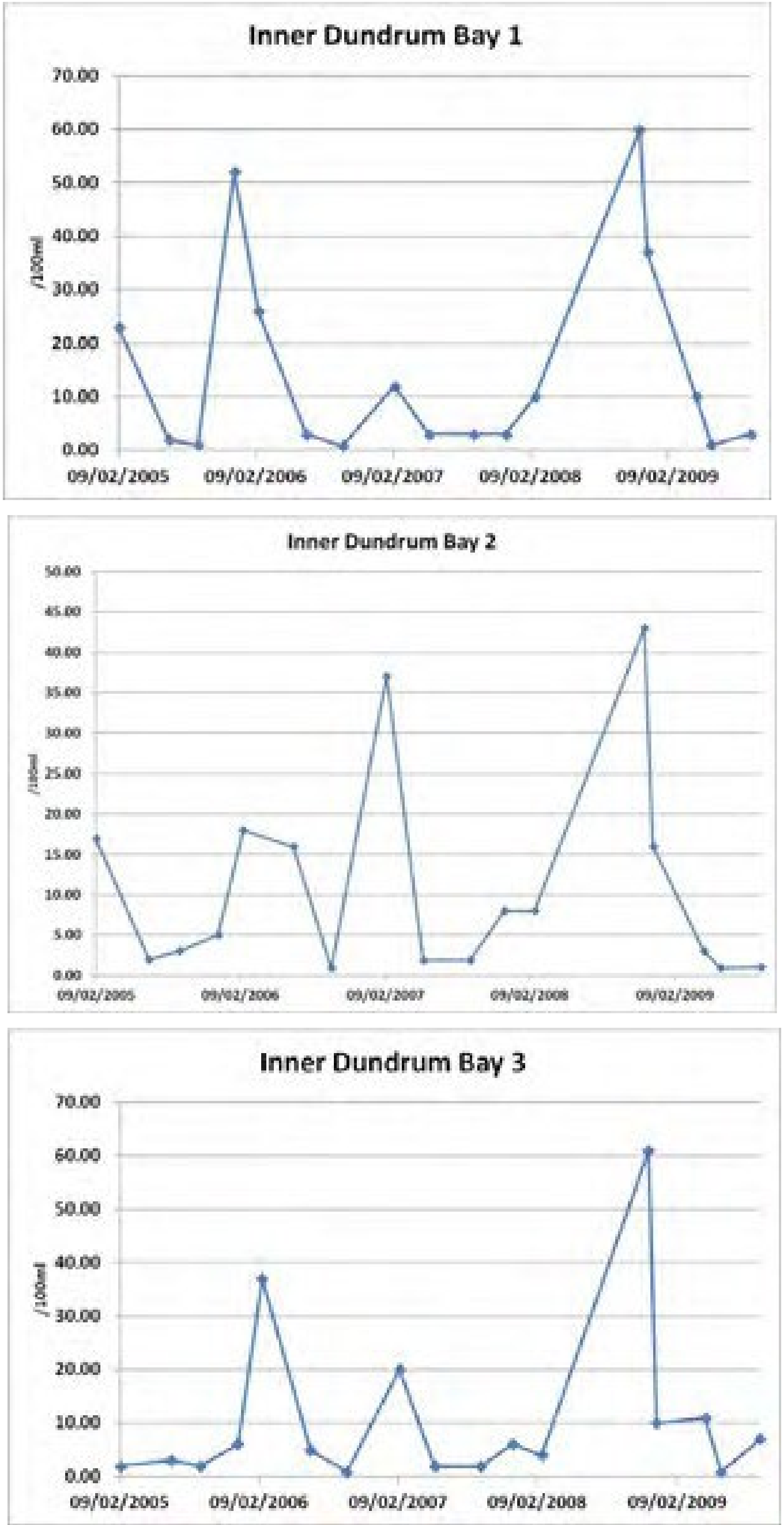


Figure 5.2: Faecal coliform levels in water from Inner Dundrum Bay from 2005 to 2009 (Source: NIEA).

Table 5.1: Faecal coliforms at Inner Dundrum Bay 1, 2 and 3 from 2005-2009 (Source: NIEA).

Date	Inner Dundrum Bay 1	Inner Dundrum Bay 2	Inner Dundrum Bay 3
09/02/2005	23.00	17.00	2.00
22/06/2005	2.00	2.00	3.00
07/09/2005	1.00	3.00	2.00
14/12/2005	52.00	5.00	6.00
15/02/2006	26.00	18.00	37.00
22/06/2006	3.00	16.00	5.00
26/09/2006	<1	<1	<1
12/02/2007	12.00	37.00	20.00
15/05/2007	3.00	<2	<2
11/09/2007	3.00	<2	<2
05/12/2007	3.00	8.00	6.00
20/02/2008	10.00	8.00	4.00
24/11/2008	60.00	43.00	61.00
15/12/2008	37.00	16.00	10.00
23/04/2009	10.00	3.00	11.00
03/06/2009	1.00	<1	<1
14/09/2009	3.00	1.00	7.00

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

Season/Site	Inner Dundrum Bay 1	Inner Dundrum Bay 2	Inner Dundrum Bay 3
Spring	6.50	2.45	6.45
Summer	2	6.3	2.97
Autumn	13.58	9.96	14.56
Winter	23.29	15.17	12.14

5.1.2. Shellfish Flesh Quality

In accordance with Annex II of the EU Hygiene Regulation 854/2004, the Food Standards Agency of Northern Ireland (FSA in NI) is required to establish the location and fix the boundaries of shellfish harvesting areas. 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. FSA in NI currently sample shellfish flesh in the Inner North and Inner South harvesting areas for monitoring and ultimately classification purposes. Inner East was classified up until 2008 for wild cockles but it is no longer classified. Figure 5.3 shows the locations of all monitored beds, past and present.

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

An A classification allows for the product to be placed directly on the market, whereas a B or C classification requires the product to go through a process of depuration, heat treatment or relaying before it can be placed on the market. Dundrum Bay has been classified as a B harvesting area since 2007, there were variations between A and B in the years preceding 2007. Table 5.3 summarises this system. Table 5.4 shows the current and historical (back to 2003) classifications within Dundrum Bay.

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

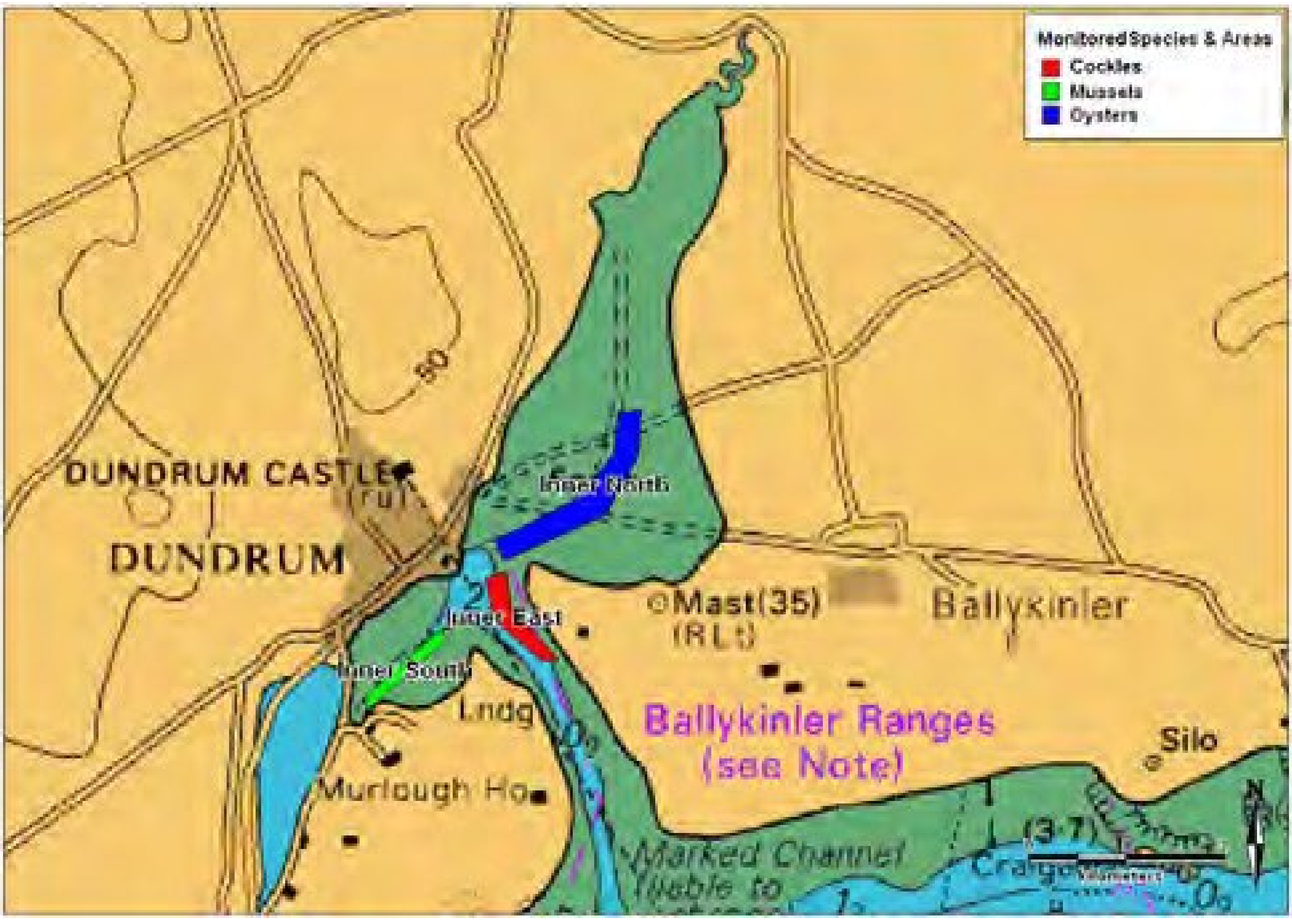


Figure 5.3: **Locations of FSA in NI shellfish monitoring points for classification purposes.**

Table 5.4: Current and historical classification of shellfish beds in Dundrum Bay (2003 – 2012).

Bed Name	Species	Classification									
		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Inner South	Mussels	B	B	B	B	B	B	B	B	B	B
Inner North	Oysters	B	B	A	A	B	B	B	B	B	B
Inner East	Cockles	B	A	A	A	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 conduct 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. In 2010, FSA in NI and NIEA came together to develop a joint chemical monitoring programme which ensures that both departments meet their EU legal obligations (pre 2010, NIEA had in place a historic chemical contaminant monitoring programme). The joint chemical monitoring programme monitors shellfish flesh for chemical contaminants e.g. heavy metals, organochlorides, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), pentachlorophenol (PCP), Tributyl Tin Oxide (TBTO) and dioxins.

Tables 5.5 to 5.7 list the *E. coli* results for Inner South mussels, Inner North oysters and Inner East cockles from 2005 to February 2012. ND in these tables means that *E. coli* levels were Not Detectable. Figures 5.4 to 5.6 show these data in graphical form.

As seen in Table 5.4 above, the Inner North oyster harvesting bed has been classified as a **B** harvesting area since 2003 with the exception of 2005 and 2006 when it was given an **A** classification. Since 2005, there were 61 instances of an **A** result and 22 instances of a **B** result for the Inner North oyster harvesting bed. *E. coli* counts ranged from 310 to 3,500 MPN/100g during the **B** result periods. Since 2005, the Inner North oyster harvesting bed had an **A** result 73.5% of the time and a **B** result 26.5% of the time (See Figure 5.4). The most recent data from Inner South (February 2012) gave an **A** result. Inner North is classified as **B** for 2012.

As seen in Table 5.4 above, the Inner South mussel bed has always had a **B** classification. Since 2005, there were 48 instances of an **A** result, 33 instances of a **B** result and 3 instances of a **C** result for the Inner South mussel harvesting bed. *E. coli* counts ranged from 5,400 to 11,000 MPN/100g during the **C** result periods and from 270 to 3,500 MPN/100g during the B periods. Since 2005, the Inner South mussel harvesting bed had an **A** result 57% of the time, a **B** result 39.3% of the time and a C result 2.5% of the time (See Figure 5.5). The most recent data from Inner South (February 2012) gave a **B** result. Inner South is classified as **B** for 2012.

As seen in Table 5.4 above, the Inner East cockle harvesting bed was classified as an **A** from 2004 to 2006, **B** in 2003 and 2007 and **B** provisional in 2008. It has not been classified since 2008. Between 2005 and 2007, there were 21 instances of an **A** result and 6 instances of a **B** result for the Inner East cockle harvesting bed. *E. coli* counts ranged from 310 to 1,100 MPN/100g during the **B** result periods. Between 2005 and 20, the Inner East cockle harvesting bed had an **A** result 77.8% of the time and a **B** result 22.2% of the time (See Figure 5.6).

Table 5.5: *E. coli* results from oysters from Inner North from 2005 to February 2012 (Source: FSA in NI).

Date	E.coli (MPN/100g)	Classification	Date	E.coli (MPN/100g)	Classification
30-Jan-12	1700	B	11-Jun-08	500	B
28-Feb-12	50	A	22-Jul-08	20	A
11-Jan-11	80	A	18-Aug-08	3500	B
02-Feb-11	20	A	23-Sep-08	40	A
08-Mar-11	50	A	20-Oct-08	310	B
06-Apr-11	50	A	20-Nov-08	<20	A
10-May-11	20	A	16-Dec-08	<20	A
08-Jun-11	<20	A	10-Jan-07	<20	A
05-Jul-11	2400	B	14-Feb-07	500	B
15-Aug-11	<20	A	07-Mar-07	50	A
28-Sep-11	130	B	03-Apr-07	ND	A
18-Oct-11	330	B	09-May-07	<20	A
22-Nov-11	1300	B	06-Jun-07	40	A
19-Dec-11	90	A	04-Jul-07	310	B
21-Jan-10	80	A	14-Aug-07	310	B
10-Feb-10	200	A	10-Sep-07	<20	A
09-Mar-10	330	B	03-Oct-07	200	A
14-Apr-10	170	A	14-Nov-07	200	A
12-May-10	80	A	04-Dec-07	200	A
09-Jun-10	90	A	25-Jan-06	1300	B
07-Jul-10	<20	A	23-Feb-06	ND	A
05-Aug-10	330	B	22-Mar-06	ND	A
15-Sep-10	20	A	13-Apr-06	70	A
14-Oct-10	130	A	10-May-06	70	A
11-Nov-10	230	A	12-Jun-06	500	B
08-Dec-10	<20	A	19-Jul-06	70	A
21-Jan-09	<20	A	09-Aug-06	500	B
18-Feb-09	70	A	20-Sep-06	110	A
04-Mar-09	500	B	17-Oct-06	<20	A
08-Apr-09	200	A	28-Nov-06	310	B
06-May-09	<20	A	25-Jan-05	40	A
03-Jun-09	200	A	22-Feb-05	ND	A
07-Jul-09	1700	B	08-Mar-05	40	A
03-Sep-09	110	A	19-Apr-05	ND	A
07-Oct-09	20	A	05-May-05	20	A
04-Nov-09	750	B	27-Jun-05	220	A
02-Dec-09	20	A	20-Jul-05	110	A
09-Jan-08	500	B	17-Aug-05	ND	A
06-Feb-08	220	A	06-Sep-05	500	B
05-Mar-08	<20	A	20-Sep-05	500	B
09-Apr-08	<20	A	30-Nov-05	220	A

Date	E.coli (MPN/100g)	Classification	Date	E.coli (MPN/100g)	Classification
07-May-08	<20	A	13-Dec-05	<20	A

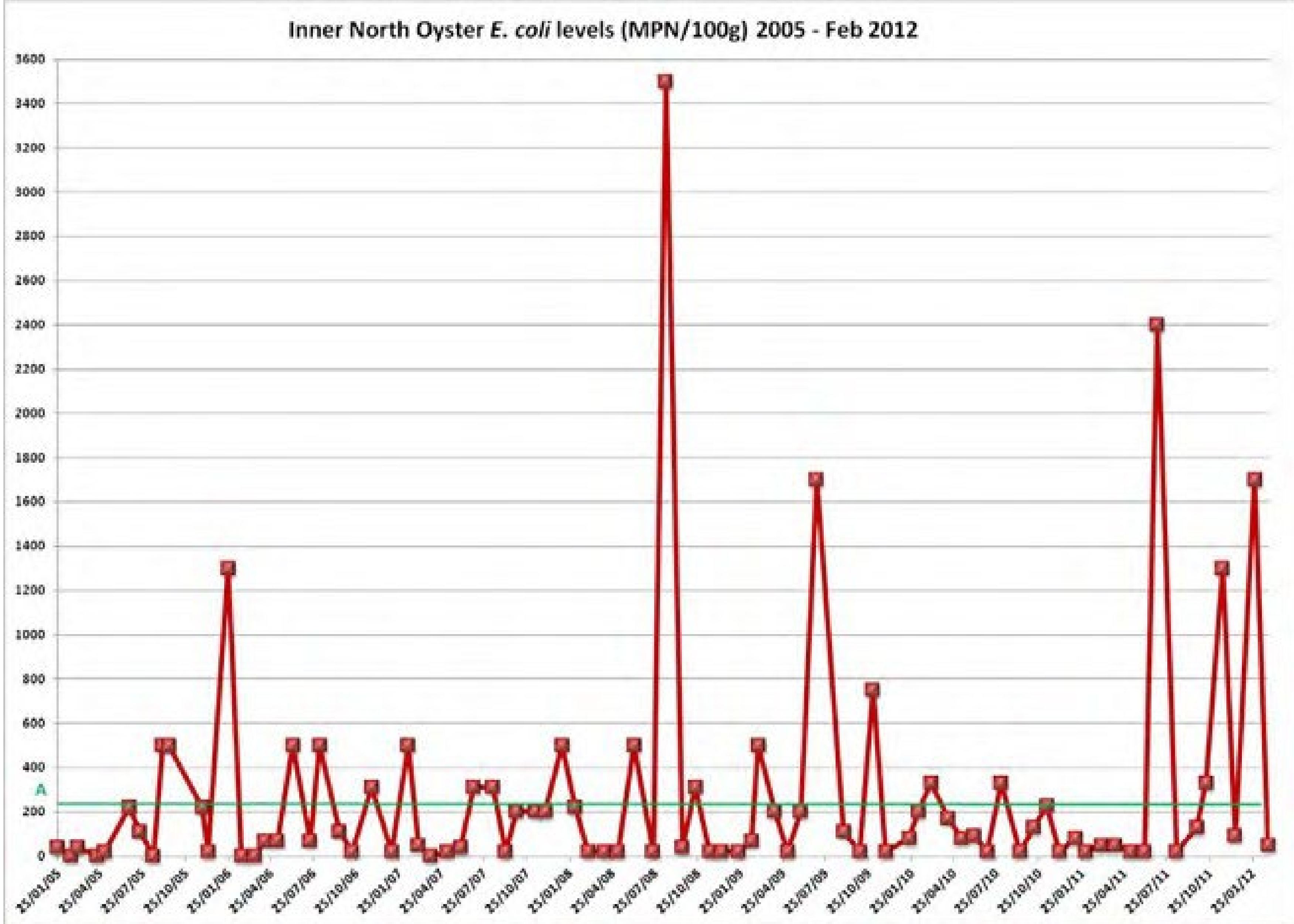


Figure 5.4: *E. coli* levels from oysters at Inner North from 2005 to Feb 2012. (Source: FSA in NI).

Table 5.6: *E. coli* results from mussels from Inner South from 2005 to February 2012 (Source: FSA in NI).

Date	E.coli (MPN/100g)	Classification	Date	E.coli (MPN/100g)	Classification
17-Jan-12	490	B	24-Jun-08	1300	B
14-Feb-12	2400	B	22-Jul-08	40	A
26-Jan-11	80	A	06-Aug-08	3500	B
16-Feb-11	700	B	09-Sep-08	40	A
24-Mar-11	220	B	07-Oct-08	500	B
20-Apr-11	20	A	05-Nov-08	310	B
24-May-11	40	A	03-Dec-08	1300	B
21-Jun-11	330	B	10-Jan-07	2400	B
25-Jul-11	490	B	14-Feb-07	20	A
30-Aug-11	490	B	07-Mar-07	ND	A
12-Sep-11	5400	C	17-Apr-07	ND	A
04-Oct-11	5400	C	23-May-07	<20	A
08-Nov-11	230	A	20-Jun-07	2800	B
05-Dec-11	20	A	18-Jul-07	400	B
26-Jan-10	500	B	29-Aug-07	70	A
24-Feb-10	<20	A	19-Sep-07	200	A
24-Mar-10	20	A	16-Oct-07	40	A
27-Apr-10	800	B	28-Nov-07	40	A
25-May-10	50	A	11-Dec-07	220	A
29-Jun-10	170	A	25-Jan-06	310	B
27-Jul-10	1100	B	23-Feb-06	ND	A
23-Aug-10	790	B	22-Mar-06	ND	A
27-Sep-10	490	B	13-Apr-06	40	A
25-Oct-10	<20	A	10-May-06	160	A
23-Nov-10	1400	B	12-Jun-06	1300	B
14-Dec-10	270	B	19-Jul-06	500	B
07-Jan-09	<20	A	09-Aug-06	3500	B
04-Feb-09	200	A	20-Sep-06	<20	A
25-Mar-09	110	A	17-Oct-06	<20	A
21-Apr-09	40	A	28-Nov-06	40	A
19-May-09	750	B	25-Jan-05	<20	A
16-Jun-09	220	A	22-Feb-05	220	A
27-Jul-09	20	A	08-Mar-05	20	A
18-Aug-09	<20	A	19-Apr-05	500	B
15-Sep-09	<20	A	05-May-05	40	A
04-Nov-09	950	B	27-Jun-05	20	A
17-Nov-09	1300	B	20-Jul-05	20	A
15-Dec-09	200	A	17-Aug-05	500	B
22-Jan-08	500	B	06-Sep-05	11000	C
19-Feb-08	430	B	20-Sep-05	500	B
19-Mar-08	200	A	30-Nov-05	ND	A

Date	E.coli (MPN/100g)	Classification	Date	E.coli (MPN/100g)	Classification
22-Apr-08	310	**B**	13-Dec-05	200	**A**
20-May-08	20	**A**			

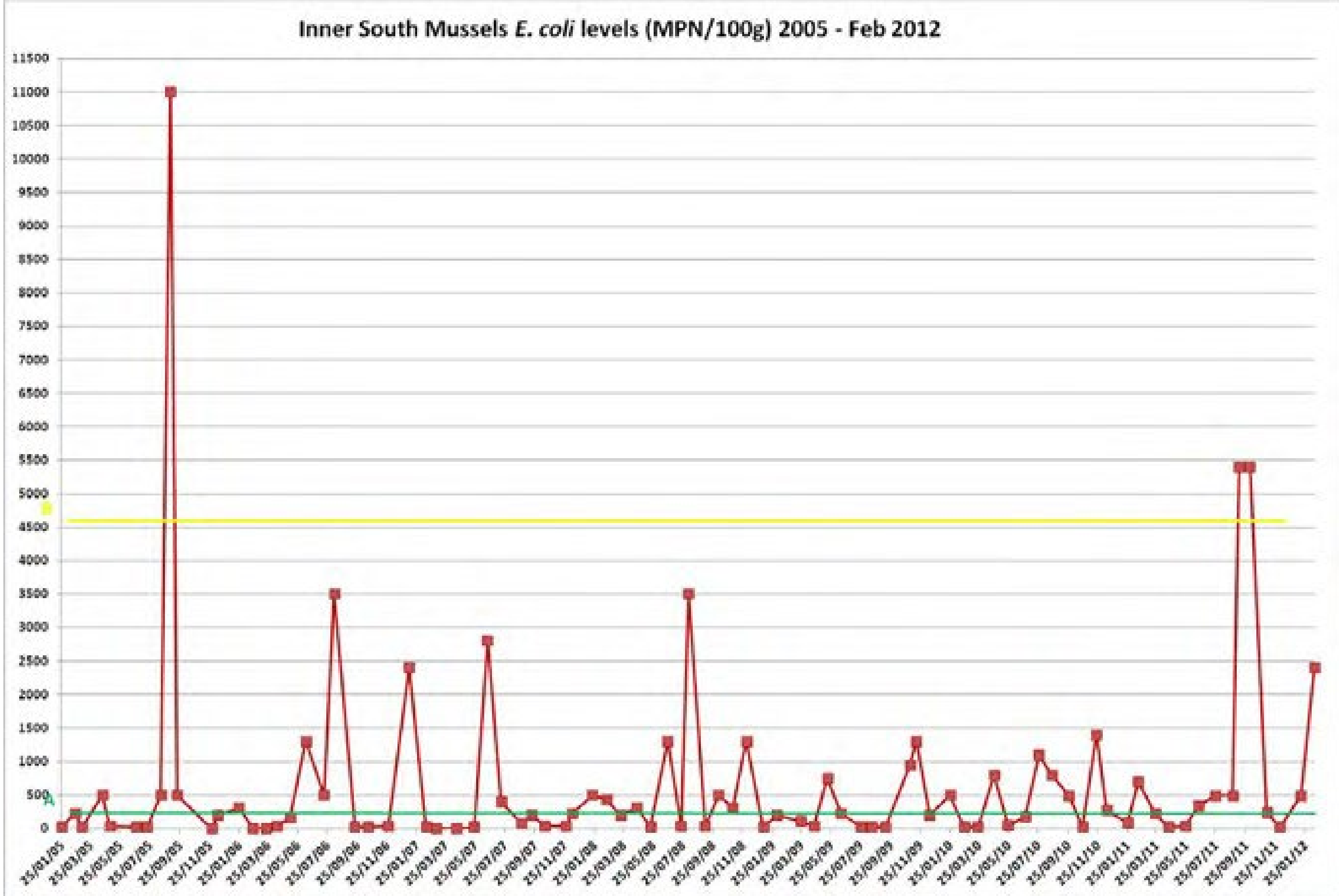


Figure 5.5: *E. coli* levels in mussels in Inner South from 2005 to Feb 2012 (Source: FSA in NI).

Table 5.7: *E. coli* results from cockles from Inner East from 2005 to 2007 (Source: FSA in NI).

Date	E. coli (MPN/100g)	Classification
14-Feb-07	70	A
07-Mar-07	500	B
03-Apr-07	110	A
04-Jul-07	200	A
14-Aug-07	200	A
10-Sep-07	70	A
03-Oct-07	40	A
25-Jan-06	20	A
23-Feb-06	ND	A
22-Mar-06	ND	A
13-Apr-06	50	A
10-May-06	500	B
12-Jun-06	20	A
19-Jul-06	310	B
09-Aug-06	1100	B
25-Oct-06	40	A
25-Jan-05	20	A
22-Feb-05	20	A
08-Mar-05	ND	A
19-Apr-05	20	A
05-May-05	750	B
27-Jun-05	ND	A
20-Jul-05	ND	A
17-Aug-05	20	A
06-Sep-05	500	B
30-Nov-05	20	A
13-Dec-05	20	A

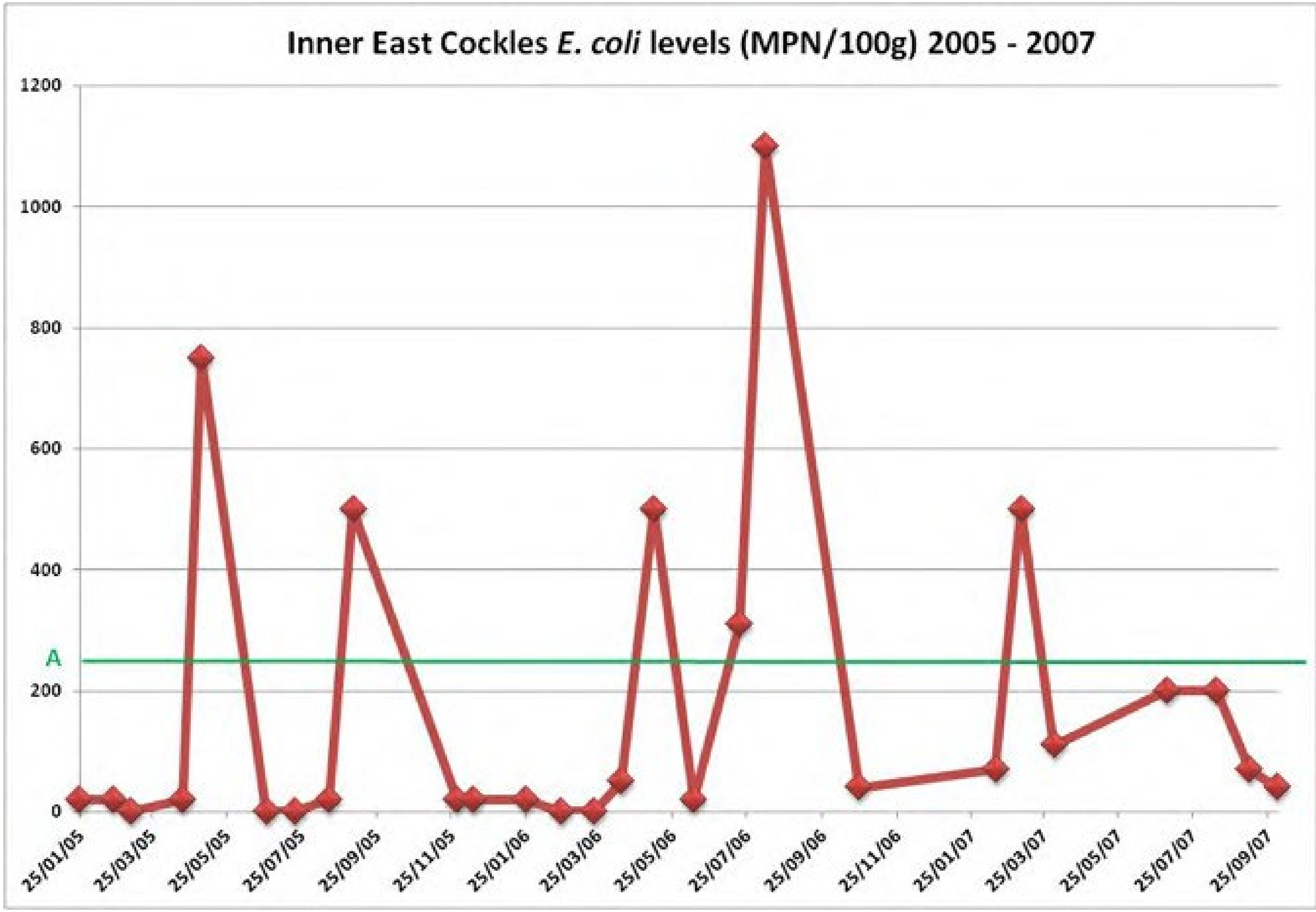


Figure 5.6: ***E.* coli results from cockles at Inner East from 2005-2007 (Source: FSA in NI).**

Table 5.8 shows the summary statistics for the *E. coli* historical data (2005 to 2011) from the 3 shellfish beds in Dundrum Bay. The geometric mean of *E. coli* levels was highest for mussels at Inner South (105.72 MPN/100g) followed by the oysters at Inner North (53.45 MPN/100g).

Table 5.8: Summary statistics of historical *E. coli* data monitored from shellfish beds in Dundrum Bay.

Site	Species	Date of 1st Sample	Date last Sample	Minimum *E. coli* (MPN/100g)	Maximum *E. coli* (MPN/100g)	Median *E. coli* (MPN/100g)	Geometric Mean *E. coli* (MPN/100g)
Inner North	**Oysters**	25/01/2005	28/02/2012	ND	3500	80	53.45
Inner South	**Mussels**	25/01/2005	14/02/2012	ND	11000	200	105.72
Inner East	**Cockles**	25/01/2005	03/10/2007	ND	1100	40	15.51

ND =Not Detectable

Table 5.9 shows the variations of the annual geometric means of *E. coli* for the shellfish beds monitored in Dundrum Bay. Figure 5.7 shows the trend in geometric mean from 2005 to 2011 for all 3 shellfish beds. It can be clearly seen that the geometric mean was highest in mussels from Inner South in 2008 (292.43 MPN/100g) and the lowest was 4.69 MPN/100g from cockles in Inner East in 2003. For all beds since 2005, the geometric mean was below 110 MPN/100g for oysters, below 293 MPN/100g for mussels and below 124 MPN/100g for cockles.

Table 5.9: Variation of annual geometric means of *E. coli* from shellfish beds monitored in Dundrum Bay.

Site	Species	2005	2006	2007	2008	2009	2010	2011
Inner North	Oysters	9.83	27.65	44.01	83.70	109.94	93.74	91.58
Inner South	Mussels	62.68	27.39	29.86	292.43	114.20	199.40	262.03
Inner East	Cockles	4.69	13.37	123.22	-	-	-	-

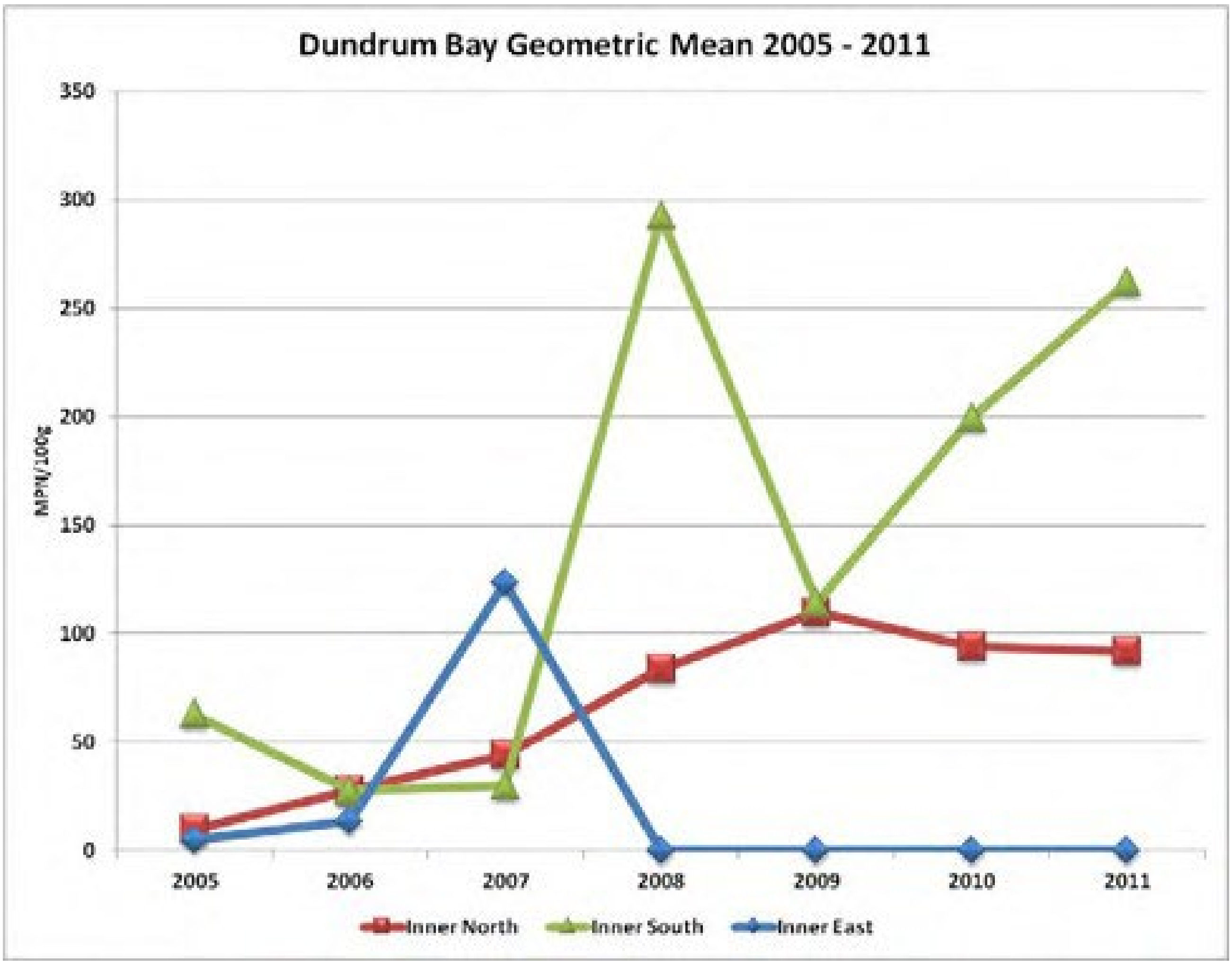


Figure 5.7: Trend in geometric mean of *E. coli* levels from 2005 to 2011 for all 3 beds in Dundrum Bay.

In order to identify any significant differences in *E. coli* levels annually from 2005 to 2011, a one-way analysis of variance (ANOVA) was performed on all *E. coli* results from shellfish flesh from the various 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. Only the years with ≥8 results per species were used in this analysis, therefore mussels and oysters in 2012 and cockles in 2007 were not included in this analysis. The ANOVA analysis revealed that no significant annual differences were observed in Dundrum Bay.

As seen in Section 4.1.2 Tourism, significant seasonal differences were seen between spring and summer and spring and autumn in the oyster flesh *E. coli* levels and between spring and summer in the mussel flesh *E. coli* levels. It is believed these seasonal differences are due to increased rainfall levels. No significant seasonal differences were observed between species.

5.2. Current Data

5.2.1. Sampling Sites & Methodology

Eleven water sampling points were sampled within Dundrum Bay on the 30th January 2012. As there are only two licenced (and classified) sites within Dundrum Bay and they are sampled monthly by FSA in NI, there was no requirement to re-sample these sites. The weather on the sampling day was dry with approximately 7/8th cloud cover.

The predicted high water levels on the 30st January 2012 were at 04:04am and at 16:19pm at Newcastle (4.4 and 4.6m respectively). Predicted low water levels on the 30th were at 9:40am and at 22:13pm (1.2 and 1.3m respectively).

The weather for the 10 days before sampling was a mixture of strong and light winds with rain occurring on all days (Met Office, 2012)

Of the 11 water samples collected, 5 were taken from within the Inner Bay, 2 in the entrance channel and 4 in the Outer Bay area.

All water samples were collected on the same day (30/01/2012) and collection was timed with high water in order to allow access to the Inner Bay area. AQUAFACT's RIB was used for the sampling. Sampling collection began at Station D1 and ended at Station D11. Figure 5.8 shows the water sampling sites. The coordinates of these stations can be seen in Table 5.10.

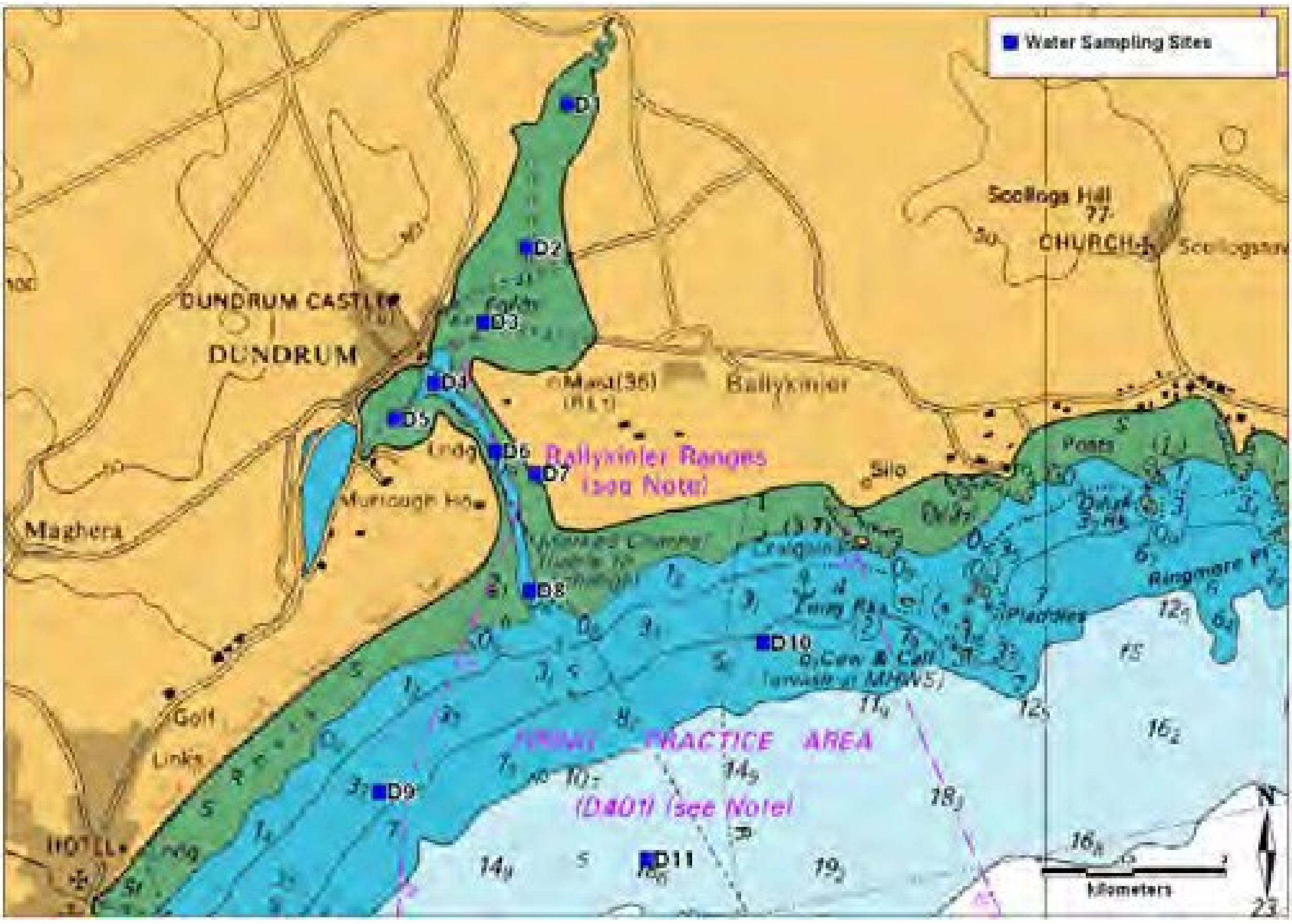


Figure 5.8: Location of all shellfish sites sampled in Dundrum Bay on 30th January 2012.

Table 5.10: Water sample site coordinates

Station	Easting	Northing	Longitude	Latitude
D1	341992.8	338899.5	-5.82077	54.27919
D2	341655.1	337524.1	-5.8266	54.26694
D3	341262.5	336803.3	-5.83296	54.26058
D4	340813.7	336219.2	-5.84011	54.25546
D5	340446.3	335861.9	-5.84591	54.25235
D6	341410.2	335585.9	-5.83126	54.24961
D7	341808.4	335379.8	-5.82526	54.24765
D8	341789.7	334278.1	-5.82607	54.23776
D9	340414.2	332315.9	-5.84806	54.22053
D10	344016.8	333845.7	-5.79214	54.23326
D11	342974.7	331754.5	-5.8091	54.21478

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 the water samples (Colilert method). Northern Ireland Water is a UKAS (United Kingdom Accreditation Service) certified laboratory.

5.2.2. Microbial Analysis Results

Table 5.11 shows the water sample analysis results (Refer to Appendix 1 for result certificates). Figure 5.9 shows in graphical form the *E. coli* results from across the Bay. Highest *E. coli* levels (6,700 MPN/100ml) were from site D7 located within the entrance channel. This was a military restricted area and while the water sample was collected from the main body of water (and not directly from a discharge pipe), the high levels do imply that a discharge pipe is discharging nearby, however access was restricted and the discharge could not be located. However, while these *E. coli* levels are high, levels fall back to <20 level within 450m north and 1km south of the site. Levels within the Inner Bay area at Site D3 were also elevated (1,340 MPN/100ml); this is assumed to be the results of discharges from Dundrum town. Again, levels fall back to <20 MPN/100ml within approximately 750m of the site.

Table 5.11: Water *E. coli* results for Dundrum Bay.

Station	*E. coli* MPN/100ml	Total coliforms MPN/100ml
D1	1	36
D2	11	57
D3	1340	3040
D4	0	23
D5	0	260
D6	9	35
D7	6700	9600
D8	1	17
D9	0	16
D10	0	15
D11	0	11

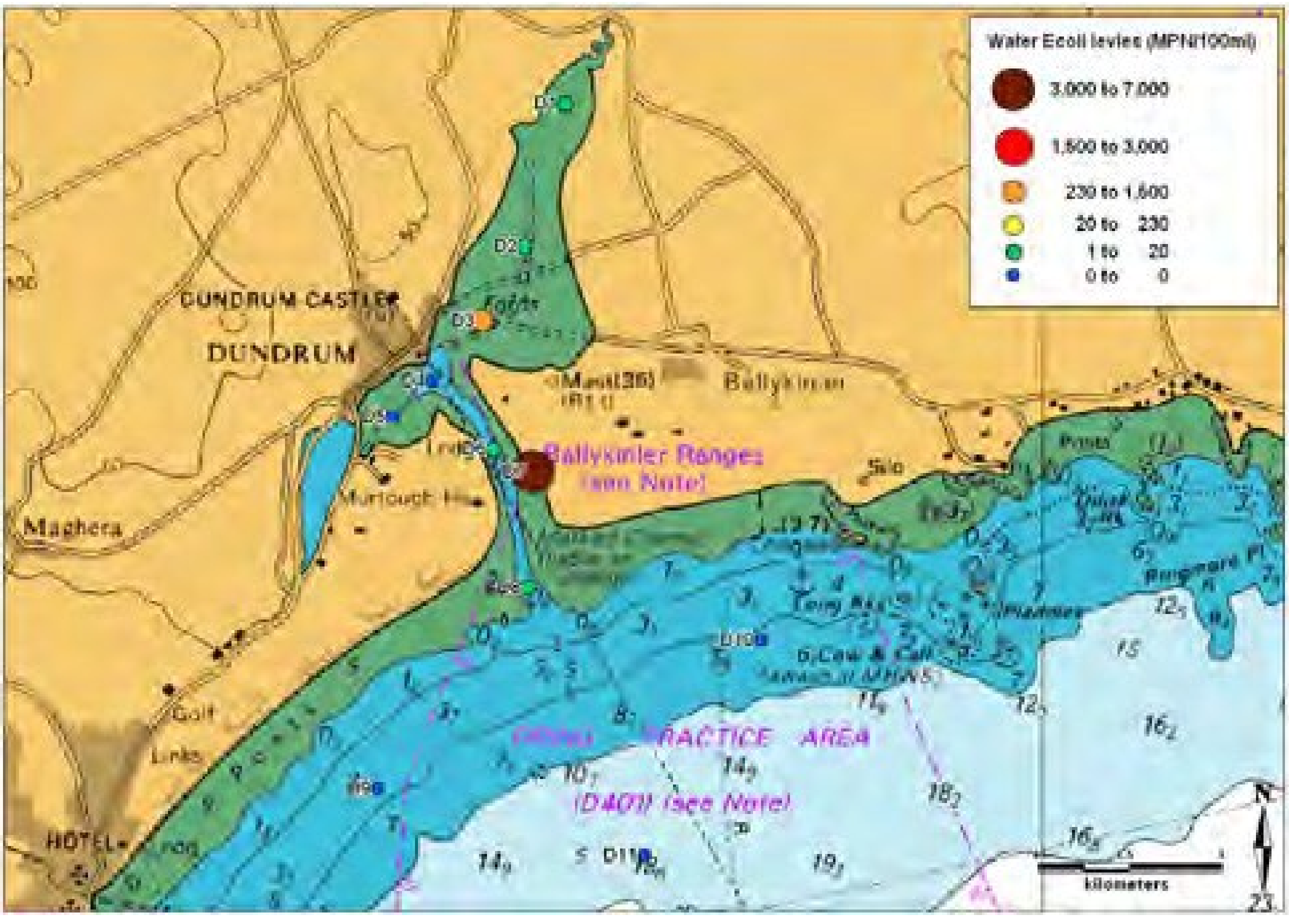


Figure 5.9: Water *E. coli* results from Dundrum Bay (sampled on 30th January 2012).

The *E. coli* results from the shellfish flesh collected in January 2012 can be seen in Table 5.12 below.

Table 5.12: Shellfish flesh *E. coli* results for Dundrum Bay from January 2012.

Harvesting Bed	Species	Date	*E. coli* (MPN/100g)
Inner North	Oysters	30/1/2012	1700
Inner South	Mussels	17/1/2012	490

6. Expert Assessment of the Effect of Contamination on Shellfish

Dundrum Bay is located within a predominately rural catchment, mostly used for agricultural purposes. Dundrum town is the largest population centre on the shores of Inner Dundrum Bay and the population does not increase significantly due to tourist numbers. The quay in Dundrum village is used by a small number of local boats. The main pollution sources in the harbour area arise from point source discharges from sewers in the town. There are three main rivers flowing into Inner Dundrum Bay, with 2 smaller streams and numerous drains and runoff also entering the Inner Bay area.

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. Dundrum Bay has been historically been categorised as a B classification for mussels and predominantly B for oysters.

No interannual trends were identified from the historical shellfish data i.e. no significant variation in *E. coli* levels was evident since 2005, however seasonal differences were observed between spring and summer and spring and autumn for oysters and between spring and summer for mussels. These differences have been linked to variations in rainfall levels during the different seasons. Depending on local hydrographic conditions, the fate of contaminants can vary from place to place. In Dundrum Bay the following summaries the fate of contaminants.

Inner Dundrum Bay is a shallow sheltered bay area; it is almost entirely intertidal with the exception of the entrance channel. As a result there is a complete exchange of water twice a day. The hydrodynamics of the Inner Bay involve the simple flooding of water into the bay on the rising tide and the subsequent ebbing out of water into the Outer Bay area on the falling tide. In addition, there is a relatively high level of freshwater flowing into the Inner Bay. Currents within the Inner bay are weak, with the exception of the entrance channel where where tidal flows can reach approximately 1.5m/s on both the flood and ebb tide. In addition, strong flows of up to 3m/s occur between its stanchions of the Downshire Bridge.

The intertidal nature of the Inner Bay allows for the complete water exchange twice a day, the result of this is as follows: the contaminants flowing into the Inner Bay from the rivers and streams get redistributed around the Inner Bay on the flooding tide and the flooding tide can bring in contaminants from the Outer Bay area, however latter is believed to be negligible given the fact that excellent bathing water quality at Murlough is not impacted upon by the poor bathing water quality in the neighbouring Newcastle area. It is believed the contamination levels in the Inner Bay are a direct result of the freshwater input and point sources entering the Inner Bay. In addition, the freshwater input can result in the localised decrease in salinity and increase in turbidity levels, however giving the tidal nature of the area these variations are temporary localised and small scale. Given the sheltered tidal nature of the Inner Bay, wind has a negligible influence on water movements and the distribution of contaminants. This all explains why for the past 10 years Dundrum Bay has predominantly been classified as a B area, which means that the shellfish must be subject to purification, relaying or cooked by an approved method.

As a result of this, Inner Dundrum Bay has been classified as one Production Area with an RMP for oysters and an RMP for mussels. Further details on the Production Area 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

As Inner Dundrum Bay is an isolated and sheltered bay with a simple hydrographic regime and a historical uniform classification across the bay, the identification of Production Area (PA) boundaries and Representative Monitoring Points (RMP) is a straightforward task. The proposed production area for Inner Dundrum Bay can be seen in Figure 7.1 below and itse coordinates can be seen in Table 7.1

Production Area 1 (PA1) encompasses the entire Inner Bay area and only extends as far into the channel as the Designated Shellfish Waters do. It covers and area of 3.11km^2. The entire area is intertidal with complete water exchange twice a day. There is a steady and relatively high level of freshwater input from 3 main rivers. Two RMPs have been selected for this Production Area, one for oysters RMP O1 and one for mussels RMP M1. The locations of these RMPs can be seen in Figure 7.1 and their coordinates can be seen in Table 7.2.

Figure 7.1: Production Area, RMP and Licenced/Classified harvesting area in Dundrum Bay.

Table 7.1: ProductionArea coordinates.

Corner Point	Easting	Northing	Longitude	Latitude
1	342249.3	339143	-5.81671	54.28131
2	342189.7	339368.8	-5.81752	54.28335
3	341263.2	335625.2	-5.8335	54.25
4	341303.2	336090.7	-5.83267	54.25417

Table 7.2: Coordinates of RMPs.

RMP	Easting	Northing	Longitude	Latitude
O1	341135	336586.8	-5.83501	54.25867
M1	340534.1	335880.4	-5.84456	54.25249

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

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 laboratory. 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.

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Appendix 1

Water Sampling *E. coli* Results

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Certificate of Analysis

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