3. RESULTS AND DISCUSSION

3.1 MARINE LITTORAL FLORA AND FAUNA

Littoral surveys were conducted in seven areas adjacent to the proposed WWTP storm water outfall, the final effluent point and the alternative outfall location. The areas were the north eastern shore of Muckinish, the western and eastern shore of Inishdaweel, the point and northern shore of Rosmore, the southern shore of Rosgibbileen and a large area at Lisduff (Appendix 1, Figure 1.1).

Seventy one species or higher taxa and 14 biotopes were recorded in total from the seven shores (Appendix 1, Figures 1.3 to 1.9, Appendix 2, Tables 2.1 – 2.7 and Appendix 10). In general all the sites were similar in that they were sheltered boulder shores dominated by the bladder wrack, *Ascophyllum nodosum*.

Muckinish

The north eastern shore at Muckinish consisted of a sheltered boulder shore, approximately 15 m wide. It was dominated by boulders and gravel with the knotted wrack, *Ascophyllum nodosum* in the mid shore and gravel in the lower shore (Appendix 1, Figure 1.3, Appendix 2, Table 2.1). Clay cliffs topped by grazed grassland backed the shore.

The upper shore supported a narrow band of yellow and grey lichens on boulders (biotope code LR.YG) with a band of the black lichen, *Verrucaria maura* (LR.Ver) below this. A narrow but distinct zone of the channelled wrack, *Pelvetia canaliculata* (SLR.Pel) and spiralled wrack, *Fucus spiralis* (SLR.Fspi) were recorded above a large band of *A. nodosum* on boulders (SLR.AscX) (Appendix 11, Plate 11.2). The diversity of species in this biotope was high with 19 species or higher taxa (Appendix 2, Table 2.1). Patches of the serrated wrack, *F. serratus* (MLR.Fser) occurred intermittently on boulders in the sublittoral fringe with tunicates. In between these boulders was gravel with dead maerl with the chequered carpet shell, *Tapes decussatus* (IGS.Sell) at both ends of the shore (Appendix 11, Plate 11.4). Gravel with anoxic mud occurred in the middle (IMX) (Appendix 11, Plate 11.3). The venerid bivalves, *Venerupis senegalensis* and *Dosinia exoleta* were recorded from cores in this zone.

Inishdaweel – West shore

The western shore of Inishdaweel was similar to Muckinish being a sheltered boulder shore with narrow zones of yellow and grey lichens (LR.YG), *V. maura* (LR.Ver), *P. canaliculata* (SLR.Pel) and *F. spiralis* (SLR.Fspi) in the upper shore and *A. nodosum* (SLR.AscX) and *F. serratus* (MLR.FserX) on the lower shore boulders (Appendix 1, Figure 1.4, Appendix 11, Plate 11.5 – 11.11). Similarly, the *A. nodosum* and *F. serratus* biotopes had the highest number of species or higher taxa with 14 and 22 species or higher taxa respectively (Appendix 2, Table 2.2). Patches of gravel with dead maerl and shells with the bivalve, *Venerupis senegalensis* occurred in the lower shore amongst the *A. nodosum* zone (IMX). This biotope became much coarser and sandier towards the southern side of the shore.

Inishdaweel – East shore

The eastern shore sloped more gradually than the west shore. Fine stones and occasional boulders occurred in the upper shore with larger stones and boulders further down the shore. However these were still small compared to the western shore at Inishdaweel and at Muckinish. The shore consisted of two distinct sides with a patchy distribution of *A.*

nodosum (SLR.AscX) occurring on the north east shore and *F. vesiculosus* (MLR.FvesX) on the south east shore (Appendix 1, Figure 1.5). The biotope SLR.AscX was a poorer example than on the west shore as the substrata was finer and the availability of suitable boulders to attach to were substantially reduced. Only 13 species or higher taxa were recorded from this biotope (Appendix 2, Table 2.3). Sand and gravel occurred in between SLR.AscX and MLR.FvesX. A dig in this biotope recorded polychaetes (*Pista cristata* and *Glycera* sp.), with the cockle, *Cerastoderma edule* on the surface and *Tapes rhomboides* (IGS.Sell). In between these shores was a cobble spit which was barren of flora and fauna (LGS.BarSh) (Appendix 11, Plate 11.12). In the upper shore, amphipods occurred in the drift algae (LGS.Tal), followed by a band of barren cobbles (LGS.BarSh), *P. canaliculata* (SLR.Pel) and *F. spiralis* (SLR.Fspi) along the north eastern shore (Appendix 11, Plate 11.13), while the south eastern shore had a reduced biotope list with LGS.Tal in the upper shore, LGS.BarSh and SLR.Pel.

Rosmore Point

The shore at Rosmore Point was backed by clay cliffs with grazed grassland. The shore was gently sloping for approximately 30 m with cobbles and boulders. Moving from the south to north of the shore, the stones and boulders became smaller in size and hosted different biotopes accordingly. A zone of talitrid amphipods occurred in drift algae in the upper shore (LGS.Tal). Other biotopes were quite sparse on boulders with LR.YG, LR.Ver, SLR.Pel and SLR.Fspi occurring in narrow intermittent zones (Appendix 11, Plate 11.14). The thick top shell, *Osilinus lineatus* occurred in the *F. spiralis* zone. A wide band of *F. vesiculosus* occurred on rocks in the midshore (MLR.FvesX) with larger boulders to the south of this zone being covered with a mosaic of barnacles and limpets (ELR.BPat.Sem). The lower shore to the north of the shore was dominated by *A. nodosum* (SLR.AscX) with coarse sand over lying rock in between (Appendix 1, Figure 1.6).

Rosmore - North shore

The northern shore at Rosmore sloped gradually for approximately 30 m and was backed by grassy cliffs. Small boulders were present in the upper shore, grading to smaller rocks and cobbles further down the shore. The upper shore consisted of narrow bands of yellow and grey lichens, including *Ramalina* spp. (LR.YG), *V. maura* (LR.Ver), *P. canaliculata* (SLR.Pel) and *F. spiralis* (SLR.Fspi). Below this was an extensive biotope dominated by *F. vesiculosus* (MLR.FvesX) on small stones. Throughout this biotope barnacles and limpets (ELR.BPat.Sem) occurred intermittently on larger boulders, however these were quite sparse. Coarse sandy gravel occurred between the *F. vesiculosus* covered stones and supported polychaetes, *Arenicola marina* (IGS). Mid way along the shore on larger boulders a zone of *A. nodosum* (SLR.AscX) appeared just below the *F. spiralis* and above *F. vesiculosus* (Appendix 1, Figure 1.7).

The sublittoral fringe was varied with either *F. vesiculosus*, *A. nodosum* or *F. serratus* being dominant. These biotopes were patchy and associated with larger stones. Smaller stones were covered in abundant calcareous tubeworms, *Pomatoceros triqueter* and Spirorbidae indet with coralline algae, Corallinaceae indet. (Appendix 11, Plate 11.15).

To the east of the shore at the proposed final effluent outfall the shore was gradually sloping with boulders in the upper shore and cobbles and stones in the lower shore. Narrow zones of lichens (LR.YG) and (LR.Ver) in the upper shore were followed by intermittent bands of SLR.Pel and SLR.Fspi on higher boulders. Barren cobbles where present between biotopes.

A wide zone of MLR.FvesX and MLR.FserX occurred in the sublittoral fringe (Appendix 1, Figure 1.7, Appendix 11, Plates 11.18 – 11.19).

Rosgibbileen

The shore at Rosgibbileen was gently sloping and backed by low clay cliffs covered in grass grazed by sheep. The substrata consisted of cobbles, stones and occasional boulders, with more boulders towards the west side of the shore. The upper shore supported a narrow zone of yellow and grey lichens (LR.YG) to the east of the shore, which became broader moving west with the lichen, *Ramalina* spp. Below this a sparse zone of *V. maura* (LR.Ver) was present on occasional boulders, cobbles and stones. A narrow zone of *F. spiralis* occurred throughout the entire shore but *P. canaliculata* (SLR.Pel) only occurred from the middle of the shore westwards.

In general *A. nodosum* (SLR.AscX) dominated the mid shore; however to the east *F. vesiculosus* (SLR.FvesX) was also dominant. Sandy mud occurred in between this biotope with worm casts. A dig was taken and the lugworm, *Arenicola marina* and the bivalve *Tapes rhomboides* (IMX) were Recorded. A narrow zone of *F. serratus* (MLR.FserX) occurred in the lower shore with gravel and sand in between (Appendix 1, Figure 1.8, Appendix 2, Table 2.6).

Lisduff

The shore surrounding Lisduff consisted of stones and cobbles in the upper shore with extensive mudflats in the mid and lower shore. The shore was gently sloping and backed by low grassland, bracken and trees. The upper shore was characterised by stones, cobbles and occasional boulders on anoxic mud. The horned wrack, *Fucus ceranoides* (SLR.Fcer) ((Appendix 11, Plate 11.22) was common in the upper zone, followed by *F. vesiculosus* (SLR.FvesX) and *A. nodosum* (SLR.AscX). Below this was anoxic mud in the mid and lower shore (LMU.HedMac) (Appendix 11, Plate 11.21). Most of the algae were covered in mud with very little associated fauna.

At the crossing point of the proposed effluent outfall, the shore was steeply sloping with boulders, cobbles and stones in the upper shore covered in *F. ceranoides* (SLR.FcerX), *F. vesiculosus* (SLR.FvesX) and *A. nodosum* (SLR.AscX), which graded down to the river channel (Appendix 11, Plate 11.20). Cores were taken in the mud immediately to the north of the pipeline crossing point on both sides of the river, representing the upper, mid and lower shore (Appendix 11, Plates 11.23 – 11.24). The ragworm, *Hediste diversicolor* and bivalves *Macoma balthica* and *Abra tenuis* were recorded at these sites (LMU.HedMac) (Appendix 2, Table 2.7).

At the location of the proposed storm water overflow pipe, the shore was gradually sloping with barren cobbles in the extreme upper shore (LGS.Bar), followed by a narrow zone of *Enteromorpha* sp. (SLR.EphX) on cobbles. Below this a wide zone (approximately 10 m) of *F. ceranoides* (SLR.Fcer) was patchily distributed on stones and cobbles overlying mud. The lower shore was dominated by *A. nodosum* (SLR.AscX) on stones with stony mud underneath. The stones prohibited taking cores from the mud, however digs were taken and *H. diversicolor* and *M. balthica* were recorded (LMU.HedMac) (Appendix 1, Figure 1.9).

Summary

No species or biotopes recorded from the littoral survey are rare or of particular conservation importance in Ireland (EcoServe unpublished data). The species and biotopes recorded (Hayward and Ryland, 1995) frequently recorded around the Irish coast (Connor *et al.*, 1997a, EcoServe unpublished data).

The peppery furrow shell, *Scrobicularia plana* and Baltic tellin, *Macoma balthica* are recorded from intertidal estuarine conditions and are able to tolerate low salinities in thick mud or muddy sand. They were recorded from the mudflats of Lisduff and are common to all Irish shores (MarLIN, 2004). The ragworm, *Hediste diversicolor* was also recorded frequently at Lisduff. It inhabits muddy substrata in a more-or-less permanent U or J-shaped burrow that may be up to 20 cm in depth and is widespread in brackish water environments throughout north-west Europe (MarLIN, 2004).

The variegated scallop, *Chlamys varia* lives very low on the shore and sublittorally to about 100 m. It is usually found on rocky substrata, often in algal holdfasts (MarLIN, 2004) and was recorded from the lower shore of Muckinish and Inishdaweel west. It is widespread around the coasts of Ireland (MarLIN, 2004).

The bivalve, *Dosinia exoleta* was recorded on the lower shore of Muckinish. It is common off the coasts of Britain and Ireland and burrows in muddy gravel or shell gravel on the lower shore to depths of about 100 m (MarLIN, 2004).

Dead maerl was recorded at the lower shore of Muckinish and Inishdaweel West; however no live maerl was recorded. It is likely that the origin of this maerl is from the live maerl beds of *Lithothamnion corallioides* present in a number of areas within Newport Bay (NPWS, Newport Site Synopsis, site code 002144).

Previous studies of the area are limited to three littoral surveys conducted by the BioMar project in 1995 and 1996 (Picton and Costello, 1998). These sites are however, a considerable distance from the current survey area and are located at Claggan Cove and Carraholly to the south of the survey area and Mullaranny Back Strand to the north west of the survey area (Appendix 2, Table 2.8). Thirty-five species or higher taxa were recorded from these sites, which were dominated by polychaetes and molluscs (Appendix 2, Table 2.8). Species found were typical of sheltered shores around the Irish coast. In general the current survey had a higher number of species or higher taxa than the BioMar surveys, although similar species were recorded.

3.2 MARINE SUBLITTORAL FLORA AND FAUNA

A total of 14 sites were surveyed using the van Veen grab (Appendix 1, Figure 1.2). At each site four replicates were taken (Appendix 3, Table 3.1). The substrata ranged from black anoxic mud with organic matter in Lough Furnace (sites ST1 and ST2) to fine anoxic mud within Newport Bay (sites ST3 – 10 and ST14) and finer sands at sites ST11 – 13, in the narrow reaches of the Newport channel (Appendix 12, Plates 12.1 – 12.15).

In total 52 species or higher taxa were recorded from the sublittoral samples and were mainly characterised by polychaetes (Appendix 3, Table 3.2). The only floral species recorded was the coralline algae, Corallinaceae indet. at site ST7B.

In general the sites in the inner Newport channel and Bay and at Lough Furnace (Sites ST1 – 3 and ST 11- 13) had the lowest number of species diversity, while the outer sites were more diverse (sites ST4 – 10 and ST14). Species diversity ranged from eight species or higher taxa at site ST14A to none at sites ST1, ST3D and ST6C, (Appendix 3, Table 3.2). The unsegmented worms, Sipuncula indet., were particularly common at sites ST6 - ST10. The polychaetes, *Nephtys hombergii* was common at sites ST3 – 6 and ST10, *Glycera* sp. were common at sites ST7 – 10 and *Terebellides stroemi* were common at sites ST5 and ST8 – 10.

Biotopes
Only one main biotope was recorded from the grab samples, 'Infralittoral muds (IMU)' (Appendix 3, Table 3.2). This biotope supports a variety of animal dominated communities, particularly of polychaetes and certain bivalves. Descriptions of this biotope can be found in Appendix 10. It was not possible to assign biotopes to every site particularly those from which no flora or fauna were recorded.

Summary
No species or biotopes recorded from the sublittoral survey are rare or of particular conservation importance in Ireland (EcoServe unpublished data). All the species and biotopes recorded are regularly recorded around Ireland (Connor *et al.*, 1997b, EcoServe unpublished data, Hayward and Ryland, 1995).

Many of the polychaetes recorded are tube dwelling, living in muddy and sandy substrata and belonging to the family Terebellidae, *Terebellides stroemi*, *Trichobranchus glacialis*, *Lanice conchilega*, *Neoamphitrite figulus* and *Pista cristata*. These species are commonly recorded around Ireland (Hayward and Ryland, 1995, MarLIN, 2004). The cat worm, *Nephtys hombergii* also lives in muddy sand in the intertidal and shallow sublittoral zone and is recorded throughout Britain and Ireland (MarLIN, 2004).

Dead maerl was recorded within the mud at sites ST8, ST9, ST10, however no live maerl was recorded. It is likely that the origin of this maerl is from the live maerl beds of *Lithothamnion corallioides* present in a number of areas within Newport Bay (NPWS, Newport Site Synopsis, site code 002144).

Previous sublittoral surveys of the area were conducted in July and August 2002 as part of the habitat mapping survey of the Clew Bay and Islands cSAC conducted on behalf of the National Parks and Wildlife Service and the Marine Institute (pers. com. Francis O'Beirne, Marine Institute). In total, forty-six samples were obtained using a 0.1m^2 van Veen grab and were preserved for granulometric and faunal analysis. Only one sample was acquired per site.
Of these sites, six are in the vicinity of the study area, 4 of which coincide directly with the current study sites. In total 192 species or higher taxa were recorded from those sites and were mainly dominated by annelid worms.

3.3 FRESHWATER FLORA AND FAUNA

Biological water quality
Site 1 (FW1) was located on the Newport River approximately 400 m upstream of the railway bridge (between two weir structures) at approximately the same location as that sampled by the EPA in regular monitoring. Siltation was generally slight at this location. The channel substratum was characterised by a range of sizes from boulders through to gravels and sand. Twelve species or higher taxa of macrofauna, comprising 87 individual organisms were recorded (Appendix 5, Table 5.1). Two percent of the sample was composed of specimens from EPA Group A, 30% was from Group B, the majority, 68% was from Group C. Group A

was represented by a small number of Leuctridae (stonefly species), Group B comprised Ephemeroptera species (*Baetis muticus*), and Trichoptera species (cased caddis larvae from the family Limnephilidae and the Glossosomatidae – *Agapetus fuscipes*). Group C comprised freshwater shrimp (*Gammarus* sp.), the mayfly *Baetis rhodani*, uncased caddis species and the riffle beetles (*Elmis aenea* and *Limnius volckmari*). This site was characterised by a macroinvertebrate community under minor stress from organic pollution. The presence of Group A species, with Group B classed as 'numerous' and Group C rated 'dominant' has resulted in the allocation of a Q3-4 classification being assigned to this site indicating slightly polluted, Class B water.

The instream aquatic macrophytic community was poorly developed at this site. Stands of moss, (*Fontinalis* spp.) were recorded on semi-exposed rock. Filamentous green algae were also recorded on channel substratum.

Summary
No rare macroinvertebrate species or species of particular conservation interest were found during the freshwater survey. The assignment of a Q3-4 indicates that the Newport River at this location has suffered slight organic pollution (this determination is reinforced by the presence of filamentous green algae at this site). The EPA sampled the river at approximately this location over the period 1981 to 2000 (Doris *et al.*, 2001). Water quality was rated between Q-value 5, and Q-value 4, both of which represent unpolluted conditions. This site was recorded as Q3-4 during the current survey indicating a slight deterioration in water quality. Seasonal factors may have contributed to the absence of some sensitive forms which could bias the assessment toward a poorer rating.

According to the Council Directive (78/659/EEC) on the quality of freshwater needing protection or improvement in order to support fish life, dissolved oxygen levels should be above 7 mg/l at all times and it is imperative that values remain above 9 mg/l at least 50% of the time. The site surveyed displayed dissolved oxygen levels above 9 mg/l.

The conductivity of freshwaters generally ranges between 50 and 1500 µS/cm. Therefore the conductivity value recorded during this survey (~100 µS/cm) is within normal limits for oligotrophic freshwaters.

*Freshwater pearl mussel (*Margaritifera margaritifera*) survey*
Live freshwater pearl mussels were not encountered in the survey area. One empty paired shell was found and appeared to be washed into the area from upstream as it was found with woody debris material in a marginal stream eddy. River conditions for surveying were generally good during the survey with low flows and good visibility. The river bank was lined by broad-leaved or mixed woodland and scrub at this location resulting in shaded conditions in the river margins. There was minimal bank erosion at this site and substratum was generally un-silted with the presence of filamentous algae being recorded at some locations in the survey area.

Summary
Live freshwater pearl mussels were not recorded in the survey area. A survey in 1995 estimated the population of the pearl mussels within the Newport SAC site at approximately 5,000 individuals. The water quality of the river being very good, the mussels were found throughout the river system in both gravel and rocky bed areas. It should be noted that no

freshwater pearl mussel shells were observed during transitional waters surveys (littoral habitat mapping at low water). However, it is important to note that there is anecdotal evidence of freshwater pearl mussel populations existing in brackish environments (the area within tidal influence) in the UK (Ian Killeen, pers. comm.). The last few decades have seen a sharp decline in the populations of freshwater pearl mussels throughout Europe, leading to concern for their future survival. A combination of river pollution, including eutrophication, a decline in host fish stocks and exploitation by pearl fishers has led to the reduction and extinction of many European stocks.

It is not expected that saline water influences this site; however the degraded biotic index value (Q3-4 when compared with Q4 from previous EPA data) in addition to the absence of pearl mussels at this location, may be an indication that saline intrusion influences ecology in this area from time to time. The survey location (approximately 50 x 50m) in the vicinity of weir structures where river bed disturbance may be a factor may also have accounted for the absence of pearl mussels from the sample.

3.4 FISH, OTTERS AND SEALS

Fish species

Four juvenile pollack (*Pollachius pollachius*), one corkwing wrasse (*Symphodus melops*) and one prawn (Palaemonidae indet.) were recorded in the first of two beach seine hauls taken at the shore in the vicinity of outfall location A. In the second haul at this location two juvenile pollack and two two-spotted gobies (*Gobiusculus flavescens*) were recorded. Results from seine netting at the proposed discharge point are presented in Appendix 4, Tables 4.1 and 4.2. Photographs are presented in Appendix 13, plates 13.1 – 13.6.

Literature review results

A profile of estuarine fish populations as recorded by the Marine Institute during 2004 surveys in the Newport Bay area is presented in Appendix 16, Document 31. A multi-method approached (seine netting, beam and otter trawling) recorded 36 species from Newport Bay in July surveys (24 sites) and 35 species in October (19 sites). Among the more abundant species present in the bay in July were herring (*Clupea harengus*) and goby species, with the common goby (*Pomatoschistus microps*), father lasher (*Myxocephalus scorpius*), 15 spined stickleback (*Spinachia spinachia*), butterfish (*Pholus gunnelus*) and greater pipefish (*Syngnathus acus*) being the best distributed species among sites.

In October relative abundances had changed. Among the more abundant species present in the bay in October were sprat (*Sprattus sprattus*) and again goby species, with the 3-spined stickleback (*Gasterosteus aculeatus*), 15-spined stickleback, sandeel, herring and whiting (*Merlangius merlangus*) being present in smaller but significant numbers. The most distributed species among sites included the common goby, 15-spined stickleback, father lasher, black goby (*Gobius niger*) and corkwing wrasse.

Summary

Estuaries provide a nursery habitat for the larval and juvenile forms of (transitional and marine) fish species, in addition to providing shelter and food for many young and adult fish and shellfish (Little, 2000). These in turn provide food for other levels of the food chain including shore birds, waterfowl, larger fish and marine mammals. Intertidal areas host high densities of benthic fauna in particular worms and molluscs. This in turn can make them important habitats for juvenile fish such as flounder, and juvenile crustaceans such as crabs which may inhabit such habitats in high numbers. The majority of fish in estuaries feed primarily on the benthos and thus live a demersal existence. Estuarine fish can generally be divided into a number of groups (Little, 2000):

- **Estuarine dependant (opportunists)** species typically enter estuaries from the sea for a period each year but do not stay permanently. The majority of these species drift into estuaries as larvae and when as young fish they become demersal, they take advantage of the rich benthic food sources available in sublittoral and intertidal estuarine habitats. Estuaries contain large numbers of '0 group' fish that use them as nursery grounds before migrating to the sea as recruits to adult populations.
- **Marine stragglers** enter estuaries irregularly and are often restricted to the seaward end (usually low in numbers of individuals)
- **Riverine species** come from the freshwater end of the system and are mainly found in low salinity waters.
- **Truly estuarine species (residents)** comprise only a small number of species although they may form a high overall biomass. The gobies are most typical of this group as they are found in estuaries around the year.
- **Migratory species** use the estuary as a route from rivers to the sea or vice versa. Most of these species are anadromous e.g. the lampreys, the shads and the salmon (*Salmo salar*). Eels are catadromous and breed in the sea (*Anguilla anguilla*).

Estuarine fish distribution is often primarily related to salinity tolerance however several factors are at work including physical and chemical habitat characteristics, food source and refuge potential from predators (Little, 2000). Results from seine netting in the vicinity of the primary proposed discharge point provide a snapshot of fish species using this area at a specific time in terms of seasonal, tidal and diurnal cycles. Four pollack, one corkwing wrasse and one prawn were recorded from a first haul. Two pollack and two, two spotted gobies were recorded from a second haul. Multiple fishing samples over various times in the year, the day and the tidal cycle would be required to ascertain a comprehensive picture of fish species using this area. No species of conservation importance were recorded during the EcoServe survey however migratory species of conservation importance (*Salmo salar* and *Salmo trutta*) utilise this area when migrating upstream for spawning.

Marine Institute data for Newport Bay (R. Poole, pers comm.) indicate the presence of a large number (35-36) of species utilizing inner Clew Bay from the period July to October (Appendix 16, Document 31). Most of the species recorded were estuarine opportunists and marine stragglers. The period of time these species spend in the estuary will vary according to season and species habits. It is important to note that the fish component represents a key link in the estuarine ecosystem food web. The only anadromous species recorded by the Marine Institute was the trout (*Salmo trutta*), however Atlantic Salmon populations migrate through this estuarine system into both the Newport River and the Burrishoole system. This species is listed under Annex II and V of the EU Habitats Directive and as such is afforded conservation protection as specified within the directive.

Salmon

There are 14 rivers flowing into Clew Bay: Buncladdy River, Murrevagh River, Bunnahowna River, Owengarve River, Carrowsallagh River, Burrishoole River, Black Oak (Newport) River, Rossow River, Owennabrockagh River, Moyour River, Carrowbeg River, Owenwee River, Owenglasbreen River, and Bunowen River. Several of these rivers could be classified as important salmonid rivers including the Burrishoole, Newport, Owengarve and Carrowbeg. All of the rivers flowing into the bay are short and run off poor quality soils typical of mountainous regions. Although they generally have good quality water, they are susceptible to increases in acidification and sedimentation from afforestation and over grazing.

The Newport River drains a 145 square kilometre catchment including Lough Beltra into Clew Bay. The river gets a good run of spring salmon and many large fish are caught every year (several fish, 16 –22 lbs (7 – 10 kg) in the early 1990's) (O'Reilly, 1998). This system has traditionally been regarded as an excellent spring salmon, grilse and sea trout fishery. The river is characterised by good holding pool habitats. Catches on the two local rod and line fisheries have steadily declined over the last number of years (1998 – 411 fish landed, 2001 – 158 fish landed). Negative impacts of afforestation and overgrazing are evident in this system.

Lough Furnace in the Burrishoole catchment represents the maximum upstream extent of saline intrusion from Newport Bay and represents an important feature within the Burrishoole system for migratory fish species. Lough Furnace is a semi-saline lake with a surface area of 141 ha and forms the lowest point of the Burrishoole system. L. Furnace may be considered an oligotrophic bog lake, typical in many respects in the nature of its surface waters but very different in deeper areas as a consequence of meromictic stratification due to salinity levels (halocline), a thermocline and an oxycline. This results in the development of permanently anoxic conditions in deeper lake areas. The maximum depth recorded from the lake is 21.5m. The lough is invaded by tides through two weirs at the southern end of the waterbody. Much variation is apparently associated with tidal height, winds and the volume of freshwater runoff. Only spring tides cause a reversal of flow into L. Furnace although high water neaps can also affect lower lake areas (Whelan *et al.*, 1998). Vertical gradients of salinity, temperature and oxygen occur throughout the lake. Marked stratification occurs between 3 - 4m, particularly in the main basin of the lough. Stratification is relatively stable in the lake however in 1995, following an abnormally warm and dry summer, stratification in the lake temporarily broke down leading to severe deoxygenation of the surface layers, mixing of the hypolimnion and movement of H_2S into the surface waters. To the best of our knowledge, this is the only documented event of this kind at this site. This phenomenon caused a major fish kill at the local Marine Institute research facility based at the northern end of L. Furnace. For many years, the Marine Institute and formerly the Salmon Research Agency of Ireland Inc. has operated fish census and biological research programmes in the Burrishoole catchment. Over the past 40 years the continuous monitoring of salmon, sea trout and eel stocks has been fully quantitative and represents a unique data set. The Burrishoole system is regarded as a world index site for Atlantic salmon and feeds into international assessments conducted by the International Council for Exploration of the Seas (ICES), the European Inland Fisheries Advisory Council (EIFAC) and the North Atlantic Salmon Conservation Organisation (NASCO).

The Burrishoole system supports a run of both grilse or one sea winter (1SW) and spring or two sea winter (2SW) salmon. The spring fish component normally accounts for <10% of the total run. It has not exceeded 100 fish since the early 1960's. Grilse run from May and reach a peak in July. Migration into the system is primarily influenced by the success of the drift net fishery which has exploited 60 - 80% of the stock. Trap data from the system shows a steady decline in wild spawning escapement, decreasing from an average of 1057 fish (1970 - 1974) to 366 fish for the period 1990 – 1997. Reared smolts derived from the Burrishoole grilse have been released into the system since 1956. Since 1964 when sufficient adults were available, a line-bred Burrishoole ranched stock has been established. This stock provides very high return rates to the coast, relative to other Irish ranched stocks. The Burrishoole system is utilised as one of the key index systems for salmon status in the North Atlantic by the International Council for Exploitation of the Seas.

Sea trout
Burrishoole sea trout run to the sea primarily as 2- and 3-year old fish from March to June each year. Some of these fish return to freshwater in the summer following migration. A further component may not return to the natal river for at least one year. Sea trout migrate back to the sea both as spawned kelts and immature fish which have over-wintered without spawning. While the adult sea trout stock in Burrishoole has been declining since the mid-1970's, there was an unprecedented change from 1987 which culminated in the complete stock collapse and subsequent reduction in migratory juvenile recruitment in between 1987 and 1989. As a result the sea trout enhancement programme was initiated and has subsequently been expanded and achieved an annual ova production of over 2 million in 1997-1998. Fry from this programme have been use to stock 21 catchments in Galway and Mayo.

Fishery activity: (from Clew Bay CLAMS Report, December 2001)
Trawling takes place all year round mainly outside the Inner Bay, primarily for whitefish by boat fishing. During the winter herring fishing sometimes takes place in the outer part of the Bay. Some of the smaller boats occasionally tow for flatfish in the area between Clare Island and the inner islands. During the salmon season some drift and draft net fishing takes place on the outer-bay shores and river estuaries. Some boats have also carried out trials with gurdy jigging rigs for mackerel.

There has long been a tradition in Inner Clew Bay of dredging and the principle species targeted has been the native oyster (*Ostrea edulis*), although scallops (*Pecten maximus*) have also been periodically dredged between the inner islands and Clare Island .

The main fishing activity of many of the boats in the bay is potting. A variety of species are fished at different times of year, the foremost of these being lobster and shrimp and to a lesser extent, crab and prawn. Clew Bay has a long tradition of shellfish gathering and the principle species involved is the periwinkle.

Aquaculture activity:
Aquaculture is a substantial industry in Clew Bay involving the farming of finfish and shellfish such as salmon, trout, native oysters, pacific oysters, mussels, scallops and abalone. Figures for 2001 show that production in the year 2000 for the two sectors was 3,448 tonnes with a first sale value of approximately IR£8.8m (€11m). The industry employs approximately 165 people in the area on a full and part -time basis.

Finfish production:
Finfish (salmon) farming began in Clew Bay 1976. There are currently two finfish farms operating in Clew Bay growing Atlantic salmon (*Salmo salar*) and sea-reared rainbow trout (*Salmo gairdneri*).

Shellfish production:
Intensive farming of shellfish began in Clew Bay in the 1970's, and today the industry involves the production of native flat oysters (*Ostrea edulis*), Pacific or Japanese (cupped) oyster (*Crassostrea gigas*), mussel (*Mytilus edulis*), king scallop (*Pecten maximus*), Manilla clam (*Tapes semidecussatus*), and the European (*Haliotis tuberculata*) and Japanese (*H.*

discus hannai) abalone. All the shellfish species farmed in Clew Bay with the exception of the abalone are bivalve molluscs. Bivalves filter feed plankton and other nutrients from the sea while abalone are grazers that feed on numerous local naturally occurring seaweed. The native oyster, mussel and scallop are the only three from the above that are capable of naturally reproducing in the waters of Clew Bay. The other species are sourced from hatcheries in Ireland or from hatcheries in Britain or France. Native oyster spat and scallop spat are also sourced from Irish hatcheries.

Native flat oyster

The natural flat oyster beds, *Ostrea edulis*, in Clew Bay are of both national and international importance. They are one of only nine such national native oyster beds in the country, of which there are less than 20 such beds in Europe (CLAMS 2000). The Clew Bay Oyster Co-operative Society Ltd. (CBOC) manages the naturally occurring beds of native flat oysters and scallop in Inner Clew Bay. A map showing the extent of the *O. edulis* beds which have been fished in the past and those which are in current production is shown in Appendix 1, Figure 1.13 (Alan Stoney, Clew Bay Oyster Co-operative Society).

Ostrea edulis beds are listed under the OSPAR list of threatened and/or declining habitats within the Celtic Seas (Area III). The purpose of the OSPAR list of threatened and/or declining species and habitats is to guide the OSPAR Commission in setting priorities for its further work on the conservation and protection of marine biodiversity. The inclusion of a species or of a type of habitat on this list has no other significance. *O. edulis* is also listed as a priority species in the UK Biodiversity Action Plan. The principal aims of the UK Action Plan for the native oyster are to maintain the current range of the oyster around the UK coastline and, where possible, increase the population and the number of viable oyster beds. In order to improve the species' chances, a number of laws and directives have been introduced in recent years. In 1987, a ban was imposed preventing the use of TBT-based anti-fouling paints on all vessels less than 25 m in length. The ban was introduced for these smaller vessels as they are more likely to come into the shallower coastal waters than the larger sea-going ships. Shellfish farmers have welcomed the banning of the use of this paint, which is believed to affect the reproduction rates of oysters. There is also a European Directive governing the spread of diseases prevalent among bivalves. The shellfish industry is being encouraged to conduct more environmental impact assessments in areas thought suitable for re-introduction or, in some cases, on former sites that have become derelict (ARKive, 2004).

The native oyster can change sex several times a year and is unlike other bivalve shellfish, in that fertilisation takes place internally with the egg being retained in the gill cavity and the sperm being released free into the sea, before being drawn by the current into waiting female oysters. After fertilisation and brooding the eggs enter a planktonic stage in the sea for 8 – 14 days before finding a suitable hard surface where they settle. Weathered mussel shell, known as cultch is often used as a suitable settlement material in oyster fisheries. The flat oyster needs a sea temperature of between 14 - 22°C for successful spawning and settlement to occur. The oyster fishery has always depended on the natural spatfall for recruitment of young stock, and surveys carried out in 1983 identified the Inishloy area as the most appropriate area to merit tight control by the CBOC. By restricting the fishing in the Inishloy area, a known broodstock of oysters was maintained, and this broodstock was kept at a level sufficient to produce adequate spatfalls in years with favourable summers. The broodstock bed was changed from Inishloy to Rosbarnagh in 1998. The positive identification of *Bonamiasis ostreae* in February 1994 in the Inishloy area, by the Marine Institute's routine monitoring programme, has meant that CBOC has had to carefully manage its stocking densities.

Pacific or Japanese oyster (cupped oyster)
As the name implies, the pacific oyster is not a native of Ireland but has been farmed successfully in Clew Bay since the completion of the first trials in 1984. It requires temperatures above 18°C, usually in the range of 21 –23°C, to spawn. Although spawning has been observed in Irish waters, natural settlement has yet to be recorded. Seed is sourced from hatcheries here in Ireland, Britain and France. The seed are put in mesh bags that are attached to steel trestles and placed near the low tide mark on the seashore in licensed sites. Oysters are filter-feeding animals deriving their nutrients from the natural phytoplankton and therefore require no artificial feeding. The majority of the sites are located on the northern and southern shores of Clew Bay.

Mussels
The mussel is found all around the Irish Coast. Increase in detection of biotoxins in Clew Bay in recent years has curtailed any expansion into rope grown mussels in the Bay. The method of production used is a long-line and rope suspended culture system. This involves the placing of naturally collected mussel seed into mesh stockings, which are then suspended from floating rope long-lines in the water.

Scallops
Initial trials on scallop farming began in 1993 and continued until 1997 when successful methods were established. Seed scallops that are sourced from natural wild settlement or from a hatchery are initially put into protective enclosures or suspended on long-lines until they are half grown and then they are placed on the seabed in frames until they reach maturity. This produces marketable scallops within a four to five year period.

Abalone
The abalone is not native to Ireland and does not breed in colder waters. Both the European abalone and Japanese abalone have been introduced into Ireland. Trials began on abalone in the early 1980's and Clew Bay is host to the only on-growing sea site in Ireland. The juvenile abalone are put into protective containers and cages and are fed *Laminaria* (kelp) and *Palmaria palmata* (dillisk), by divers, every two weeks in summertime and every four to six weeks in the winter. The growth cycle is about five years.

Lobsters
Trials commenced in 2001 using aquaculture techniques to assist with determining survival rates of juvenile lobsters released into the wild for the restocking of the existing natural lobster fishery. Broodstock from Clew Bay are being used to produce juvenile lobsters at a hatchery in Co. Wexford. These will be released onto the seabed using natural reefs and artificial reefs which are deployed on an existing aquaculture site in the Bay where monitoring diving takes place regularly.

Biotoxin and phytoplankton monitoring:
The current Biotoxin Sampling Programme in Clew Bay consists of seven phytoplankton sites and three weekly sampling locations for farmed shellfish, three locations for native species and additional sites for farmed shellfish species prior to them being harvested.

*The European otter (*Lutra lutra*)*
Walkover surveys were undertaken on September 15th, 16th and November 9th, 2004. Shoreline areas were investigated once generally within two hours of low tide at each shore site. Otter spraints, footprints and possible den locations were investigated and counted on each occasion using the naked eye with the aid of high powered binoculars and a torch in some cases. Location of spraints, footprints and possible dens were recorded on a survey sheet and results are presented in Appendix 1, Figure 1.10, Appendix 6, Table 6.1 and Appendix 14, Plates 14.1 – 14.2).

No otters were seen however otter activity was recorded in the Lisduff area at several locations. Five sprainting sites were recorded as was one otter footprint in newly exposed intertidal mud. Activity was particularly noted in an area adjacent to a possible den. The den was situated below a living tree in a relatively exposed earth bank face (Appendix 14, Plate 14.1).

Summary
The otter *Lutra lutra* is a semi-aquatic mammal, which occurs in a wide range of ecological conditions, including inland freshwater and coastal areas. Populations in coastal areas utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding dens. Coastal otter habitat ranges from sheltered wooded inlets to more open, low-lying coasts. Inland populations utilise a range of running and standing freshwaters. These must have an abundant supply of food (normally associated with high water quality), together with suitable habitat, such as vegetated river banks, islands, reed beds and woodland, which are used for foraging, breeding and resting.

Coastal otters are usually diurnal in habit and forage close to the shore. Over a period of several years (Kruuk 1995) used small numbers of observers to build up information on the resident female otters of a relatively small area (approximately 16 km of coast on the Lunna Ness Peninsula). Diet, home range size and organisation, den use, breeding and population size were recorded and, although less information on male otters was collected, the ratio of adult breeding females to other otters was determined. Some of these data were then used to determine the total population of otters in the Shetland Isles, by counting the number of active dens in 5 km stretches of coastline. Data from coastal otters in Shetland revealed no relationship between spraint density and otter density.

The diet of otters living and feeding on the coast is dominated by fish, but generally to a much greater extent than for those foraging in fresh water. In several studies fish formed more than 90% of the diet (Chanin, 2003). It has been noted in some studies, however, that crabs are taken much more frequently by young otters than by adults, and that as the young otters developed and became more efficient at catching fish, the proportion of crabs in their diet declined. In Shetland, Kruuk (1995) found that crabs were taken rarely, and mainly by inexperienced otters, except in years when fish were scarce.

Once off surveys of otter signs at specific sites can only produce a brief reflection of otter activity levels in any area. It is clear from the current study that there is an occupied otter territory indicated by the presence of spraints (otter droppings) of varying ages found on rocks, stones and tree stumps and footprints in mud above high water in the embayed mudflat at Lisduff. Evidence of otter activity was also recorded in the vicinity of a burrow beneath an exposed tree root in the same area which may be used as a lying-up place or den by coastal otters using this area – no tracks or feeding signs were found around the burrow entrance. The otter (*Lutra lutra*) is strictly protected in the Republic of Ireland (ROI) under the wildlife Acts, 1976 and 2000. This species and its habitats are listed under Annex II and IV of the EU Habitats Directive as being of community interest. This Directive requires Ireland to establish Special Areas of Conservation for conservation of this species. The Clew Bay complex and the Newport River cSAC's are both currently designated in the ROI with the otter as a qualifying interest and the current study indicates particularly high activity levels in the embayed area to the north of the proposed storm water discharge point.

*The harbour (common) seal (*Phoca vitulina*)*

Boat-based survey of harbour seals were undertaken within the study area on September 15th, 16th and October 19th, 2004 with additional observations in early November 2004. Shoreline areas and intertidal rocky outcrops were investigated once within two hours of low tide on each day when haul outs were most likely to be in use. Harbour seals were observed several times both in groups and as individuals during the survey trips. Seals were observed and counted on each occasion using high powered binoculars. Seal numbers, locations and photos were recorded and are presented in Appendix 1, Figure 1.11, Appendix 6, Table 6.2 and Appendix 14, Plates 14.3 – 14.5).

Summary

The Clew Bay complex is one of seven Special Areas of Conservation (SAC's) currently listed in the Republic of Ireland with the harbour seal as a qualifying interest (i.e. one of the factors meriting designation was the importance of the site for the harbour seal). Harbour seals feed at sea but regularly haul out on to rocky shores or inter-tidal sandbanks to rest, or to give birth and to suckle their pups. Many of the most important haul-out areas are around the west coast of Ireland. These include Bantry Bay, Kenmare River, Galway Bay, Sligo Bay and the Donegal Coast but Carlingford Lough is currently very important and historically Strangford Lough has had a large population. Although young seals travel distances of several hundred kilometres, adults appear to remain faithful to favoured haul-out areas from year to year. The particular sites used may, however, vary with the seasons. Harbour seals travel up to 50km from haul-out sites to feed and may remain at sea for several days. Since systematic recording began by National Parks and Wildlife Service, harbour seals have frequently been recorded (often in substantial numbers) within Clew Bay (Lyons, 2004). During the harbour seal survey 2003, harbour seals were observed on all coastlines of the Republic of Ireland, including a number of offshore islands. Collated aerial and ground-count figures yielded a 2003 minimum population estimate for the ROI of 2905 harbour seals. A total of 316 harbour seals were recorded from County Mayo regarded as representing 11% of the total count with 96 being recorded from island shores within Clew Bay. A personal communication from local charter fishing boat skipper Mary Gavin-Hughes indicates frequent sightings of seals in the vicinity of Newport in inner Clew Bay, particularly popular haul-out locations in this area include the west end of Muckinish, Freaghillanluggagh and Illanascraw.

Harbour seal hunting modes are poorly understood, but they are known to eat a wide variety of fish, including whiting, *Pollachius* spp., haddock, *Trisopterus* spp. (Jane Gilleran, pers. comm., in Lyons 2004), herring, sandeels and flatfish. Shrimps and squid are also sometimes eaten. Females give birth to a single pup in June or July each year. Pups are very well developed at birth and can swim and dive when just a few hours old. This enables harbour seals to breed in estuaries where sandbanks are exposed for only part of the day. Mothers feed their young with extremely rich milk and pups grow rapidly, doubling their birth weight during the three or four weeks that they suckle.

3.5 WATER, SEDIMENT AND TISSUE ANALYSES

Water, sediment and biological tissues analyses from the baseline survey are discussed in terms of relevant legislative standards and international guidance levels for parameters of water quality.

Water quality

Results for water analyses are presented in Appendix 8, Table 8.1.

Nutrients
Elevated nutrient concentrations are part of a suite of indicators used to assess eutrophication. Conventionally, monitoring is restricted to winter months (Dec-Feb) to estimate the maximum nutrient concentration and thus, depending upon retention, to indicate nutrients in the body of water available to support algal growth. Guidelines on water quality in Irish estuaries are available (Marine Institute 1999) (Table 1). It should be noted that any guidelines can only be applied cautiously as many parameters display considerable variability both temporally and spatially.

Table 1. Water quality indices applied to Irish estuaries (QSR 1999, L = low, M = moderate and H = high levels. For DO, L = depressed conditions, M = normal and H = supersaturated).

Parameter	L	M	H	This study
BOD mg/l	< 3.0	3.0 – 5.0	> 5.0	< 2
Oxidised nitrogen (0 – 20 psu) mg N/l	< 1.0	1.0 – 3.0	> 3.0	< 2
Oxidised nitrogen (> 20 psu) mg N/l	< 0.2	0.2 – 1.0	> 1.0	< 2
Orthophosphate mg P/l	< 0.05	0.05 – 0.15	> 0.15	< 0.01
Total ammonia mg N/l	< 0.2	0.2 – 1.0	> 1.0	< 0.1
Un-ionised ammonia mg NH3/l	< 0.02	0.02 – 0.05	> 0.05	--
Chlorophyll 'a' mg/m^3	< 10	10 – 25	> 25	< 10
Dissolved oxygen % saturation	< 70	70 – 110	> 110	89 – 95 39 -60*

* Lower in deep water beneath oxycline in Lough Furnace

Biochemical Oxygen Demand
Biochemical Oxygen Demand (BOD) levels were below 2 mg/l for water at all sites surveyed (ST2, ST5, ST12 and ST14). These levels are below I/PV values for A1 surface waters (Surface Water Regulations, 1989) and for salmonid waters (Salmonid Water Regulations, 1988) and indicate low ambient levels according to Marine Institute, 1999 (Table 1).

Chemical oxygen demand
Chemical Oxygen Demand (COD) levels were below 5 mg/l for water at all sites surveyed (ST2, ST5, ST12 and ST14) which would be expected.