Lough Mask

Sampling Fish for the
Water Framework Directive -
Lakes 2009

The Central and Regional
Fisheries Boards

ACKNOWLEDGEMENTS

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1 INTRODUCTION

Lough Mask (Plate 1.1, Fig. 1.1) is situated north of Lough Corrib, adjacent to the town of Ballinrobe, Co. Mayo. It is the sixth largest lake in Ireland with a surface area of approximately 8218ha. The length of the lake from north to south is approximately 16km and the width is approximately 6.4km at its widest point (O'Reilly, 2007). The main rivers flowing into Lough Mask are the Cloon, Robe, Owenbrin, Finny, Glensaul, Glentraig and the Keel River, which is the out flowing river from Lough Carra. It is linked to Lough Corrib by the Cong Canal.

Lough Mask is generally a shallow lake with a mean depth of 5m; however it attains a maximum depth of 57m along a long narrow trench on the western shore of the lake (NPWS, 2004). The lake is categorised as typology class 12 (as designated by the EPA for the purposes of the WFD), i.e. deep (>4m), greater than 50ha and high alkalinity (>100mg/l CaCO3). The underlying geology of Lough Mask is Carboniferous limestone, with areas of shale and sandstone, and it is an excellent example of a lowland oligotrophic lake (NPWS, 2004).

Plate 1.1. Lough Mask

Lough Mask, Carra and Cloon make up the Lough Carra/Lough Mask Special Area of Conservation complex. Six habitats listed on Annex I of the EU Habitats Directive are found in this site, including two priority habitats - limestone pavement and Cladium fen (NPWS, 2004). This is also an important site for otter, a species that is listed on Annex II of the E.U. Habitats Directive (NPWS, 2004). The zebra mussel, an invasive species in Ireland, has recently been confirmed in Lough Mask (Liam Gavin, IFI, pers. comm.).

Lough Mask is noted for its populations of brown trout and ferox trout, with the average size of brown trout ranging from 0.6kg to 1.4kg. The larger ferox trout can reach up to 9kg in weight (O'Reilly, 2007). In a previous comprehensive fish stock survey of Lough Mask undertaken by the Central Fisheries Board and the Western Regional Fisheries Board in 1996, five fish species were recorded; brown trout, Arctic char, pike, perch and a single roach (O'Grady *et al*., 1996). Although the methods used in this previous survey are significantly different to the new European standardised techniques developed for WFD fish monitoring in Ireland and used in the current survey, an attempt has been made to draw some comparisons between the two surveys.
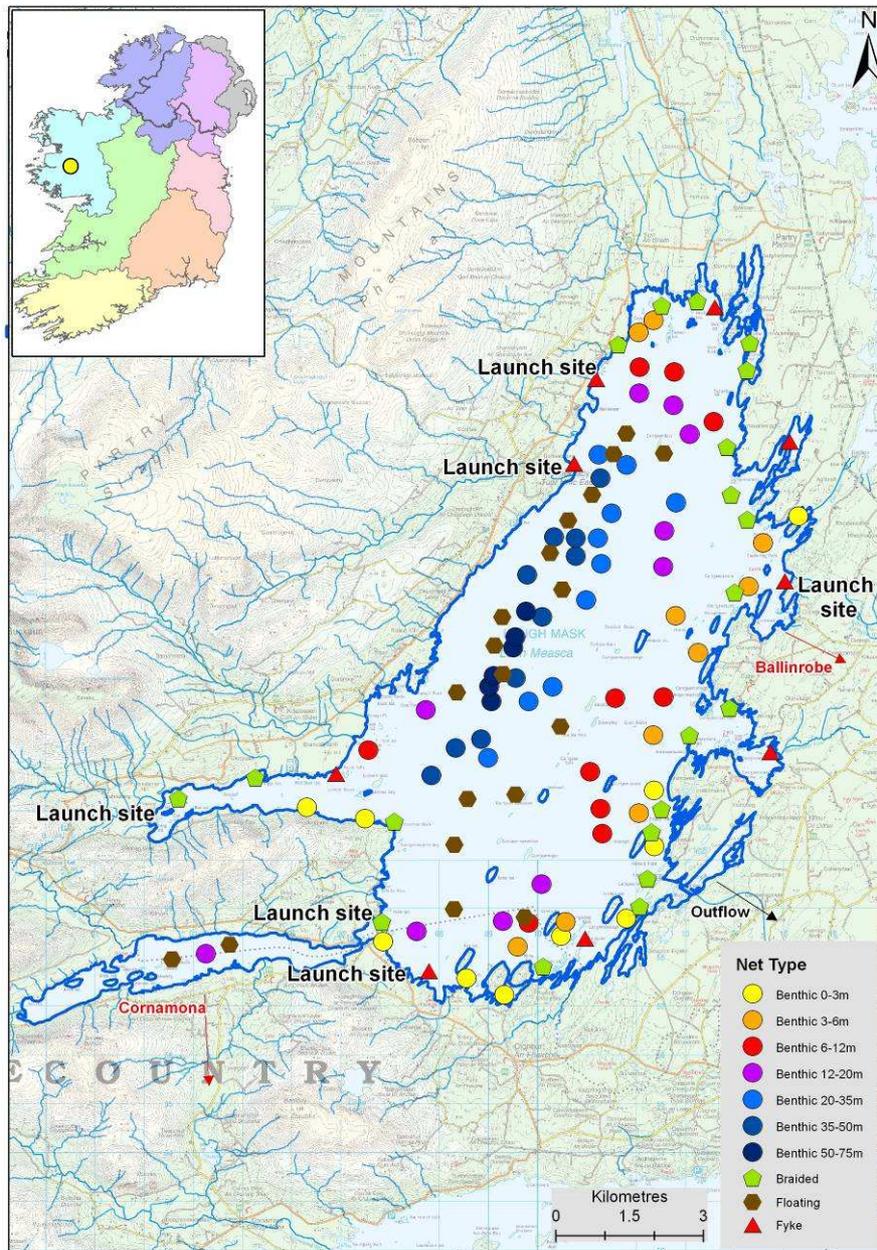

Fig. 1.1. Location map of Lough Mask showing locations and depths of each net

2 METHODS

Lough Mask was surveyed over seven nights between the 8th and the 17th of June 2009. A total of nine sets of Dutch fyke nets, 66 benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (10 @ 0-2.9m, 10 @ 3-5.9m, 10 @ 6-11.9m, 10 @ 12-19.9m, 10 @ 20-34.9m, 10 @ 35-49.9m and 6 @ 50-74.9m) and 20 surface monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed randomly in the lake (95 sites). The netting effort was supplemented using 20 benthic braided gill nets (62.5mm mesh knot to knot) at 20 additional sites. Survey locations were randomly selected in each depth zone using a grid placed over a map of the lake. A handheld GPS was used to mark the precise location of each net. The angle of each gill net in relation to the shoreline was randomised.

All fish apart from perch were measured and weighed on site and scales were removed from brown trout, roach, bream and pike. Live fish were returned to the water whenever possible (i.e. when the likelihood of their survival was considered to be good). Samples of fish were returned to the laboratory for further analysis.

3 RESULTS

3.1 Current 2009 survey results

3.1.1 Species Richness

A total of seven fish species were recorded on Lough Mask in 2009, with 969 fish being captured. Perch was the most abundant fish species recorded, followed by roach. Small numbers of brown trout and Arctic char (Plate 3.1) were recorded, along with bream, pike and eels (Table 3.1).

Table 3.1. Number of each fish species captured by each gear type during the survey on Lough Mask, June 2009

Scientific name	Common name	Number of fish captured				
		Benthic mono mulitmesh gill nets	Benthic braided gill nets	Surface mono mulitmesh gill nets	Fyke nets	Total
Perca fluviatilis	Perch	622	4	0	7	633
Rutlius rutilus	Roach	181	52	2	0	235
Salmo trutta	Brown trout	28	7	5	1	42
Salvelinus alpinus	Arctic char	30	0	1	0	31
Abramis brama	Bream	1	13	0	0	14
Esox lucius	Pike	1	6	0	0	7
Anguilla anguilla	European eel	0	0	0	8	8

Plate 3.1. Char captured in Lough Mask

3.1.2 Fish abundance

Fish abundance (mean CPUE) and biomass (mean BPUE) were calculated as the mean number/weight of fish caught per metre of net. For all fish species except eel, CPUE/BPUE is based on all nets, whereas eel CPUE/BPUE is based on fyke nets only. Mean CPUE and BPUE for all fish species are summarised in Table 3.2.

Table 3.2. Mean (S.E.) CPUE and BPUE of all fish species captured on Lough Mask, June 2009

Scientific name	Common name	
		Mean (S.E.) CPUE
Perca fluviatilis	Perch	0.184 (0.034)
Rutlius rutilus	Roach	0.071 (0.013)
Salmo trutta	Brown trout	0.012 (0.002)
Salvelinus alpinus	Arctic char	0.009 (0.004)
Abramis brama	Bream	0.005 (0.004)
Esox lucius	Pike	0.002 (0.001)
Anguilla anguilla	European eel	0.015 (0.009)
		Mean (S.E.) BPUE
Rutlius rutilus	Roach	24.334 (4.629)
Perca fluviatilis	Perch	13.860 (2.519)
Esox lucius	Pike	8.075 (3.940)
Salmo trutta	Brown trout	7.449 (2.390)
Abramis brama	Bream	2.841 (2.718)
Salvelinus alpinus	Arctic char	0.973 (0.492)
Anguilla anguilla	European eel	3.552 (1.745)

* On the rare occasion where biomass data was unavailable for an individual fish, this was determined from a length/weight regression for that species. Standard error is displayed in brackets.

3.1.3 Length frequency distributions

Brown trout (including ferox) ranged in length from 10.8cm to 68.2cm (mean = 28.7cm) (Fig. 3.1). Char ranged in length from 11.7cm to 31.0cm (mean = 18.5cm) (Fig. 3.2). Perch ranged in length from 5.7cm to 44.4cm (mean = 15.5cm) (Fig. 3.3). Roach ranged in length from 10.8cm to 35.1cm (mean = 26.0cm) (Fig. 3.4). Pike ranged in length from 68.1cm to 115.0cm, eels ranged in length from 40.0cm to 61.0cm and bream ranged in length from 28.0cm to 41.8cm.
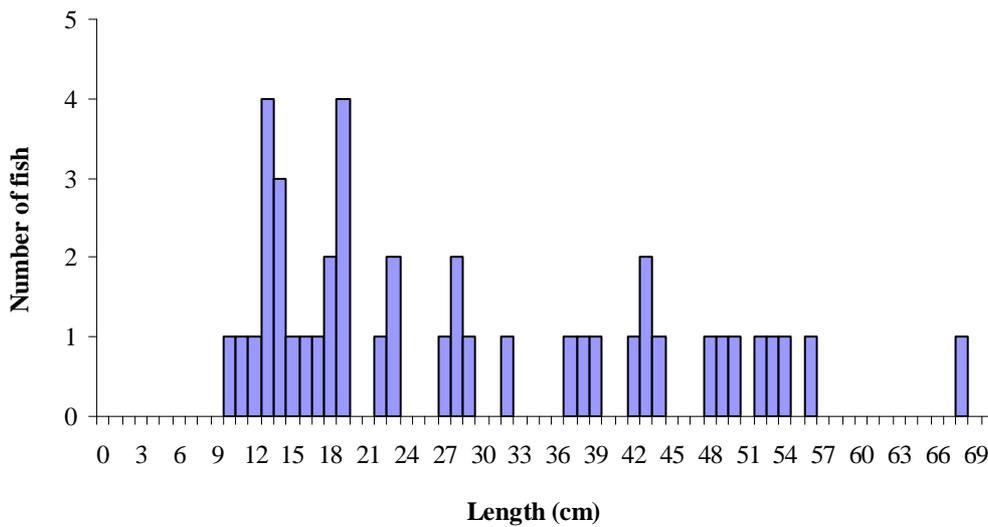

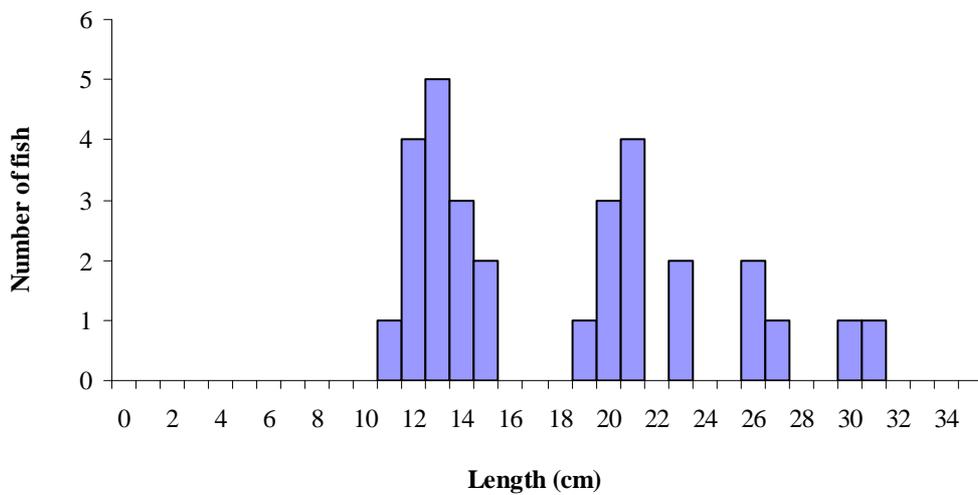**Fig. 3.1. Length frequency of brown trout (n=42) captured on Lough Mask, June 2009**

Fig. 3.2. Length frequency of char (n=30) captured on Lough Mask, June 2009
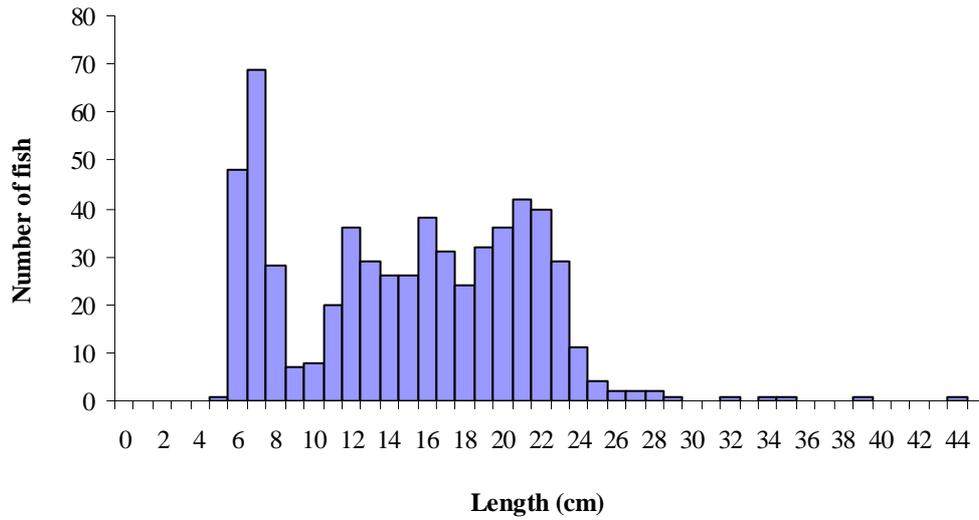
Fig. 3.3. Length frequency of perch (n=597) captured on Lough Mask, June 2009
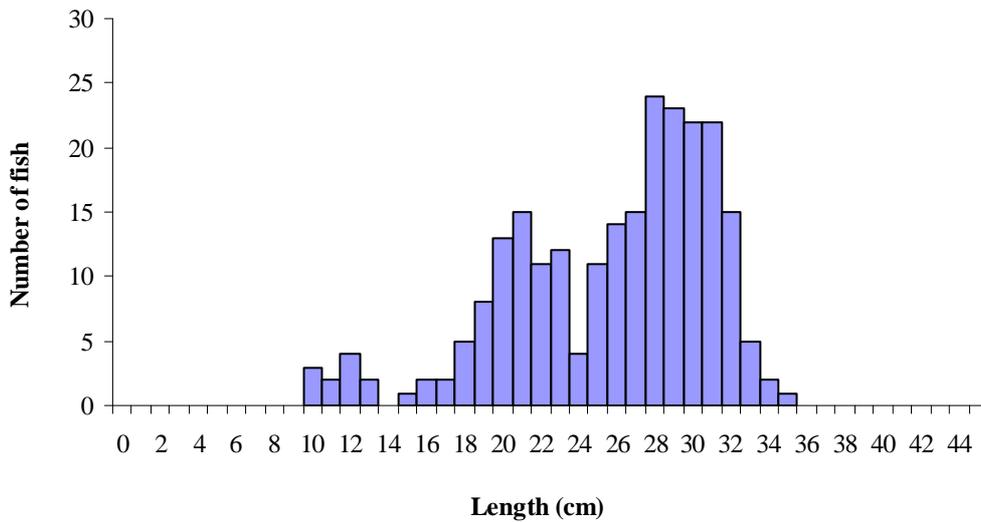
Fig. 3.4. Length frequency of roach (n=238) captured on Lough Mask, June 2009

3.1.4 Fish age and growth

Six age classes of brown trout (including ferox) were present (1+ to 6+), accounting for approximately 36%, 19%, 12%, 14%, 14% and 5% of the total brown trout catch respectively. Mean L4 of brown trout was 39.9cm (Table 3.3) indicating a very fast rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971)..

Ten age classes of perch were present, ranging from 1+ to 10+, with 0+ and 1+ perch accounting for the largest proportion of the population captured and a mean L1 of 5.7cm (Table 3.4).

Ten age classes of roach were present, ranging from 1+ to 10+, with a mean L1 of 3.4cm (Table 3.5). Two age classes of pike were present, ranging from 4+ to 5+ and four age classes of Arctic char were present, ranging from 1+ to 5+. Bream were recorded only in the 4+ and 11+ age classes.

Table 3.3. Mean (±SE) brown trout length (cm) at age in Lough Mask, June 2009

	L_1	L_2	L_3	L_4	L_5	L_6
Mean	7.3 (0.3)	18.4 (0.9)	29.4 (1.5)	39.9 (1.9)	46.1 (3.3)	50.6 (2.4)
N	38	26	18	13	7	2
Range	4.0-11.5	12.7-27.8	20.0-42.9	32.2-56.0	36.4-63.1	48.2-52.9

Table 3.4. Mean (±SE) perch length (cm) at age in Lough Mask, June 2009

	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
Mean	5.7 (0.1)	10.6 (0.1)	15.5 (0.2)	18.9 (0.3)	21.2 (0.4)	23.3 (0.6)	26.2 (1.6)	31.2 (2.1)	33.6 (2.2)	35.2
N	154	135	104	79	49	24	8	4	4	1
Range	4.0-9.0	6.7-15.1	10.3-19.2	12.6-22.6	15.7-26.4	17.6-31.2	19.2-34.3	27.4-37.2	28.7-39.2	35.2-35.2

Table 3.5. Mean (±SE) roach length (cm) at age in Lough Mask, June 2009

	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
Mean	3.4 (0.1)	8.2 (0.1)	14.3 (0.2)	18.7 (0.3)	22.4 (0.3)	25.5 (0.3)	27.8 (1.3)	29.8 (0.3)	30.8 (1.0)	30.6 (1.7)
N	128	121	120	79	65	61	48	35	8	3
Range	2.0-5.4	4.1-11.9	7.3-19.7	12.3-24.4	14.7-27.4	16.9-28.9	20.3-30.9	23.7-32.0	25.4-34.0	27.1-32.5

3.2 Comparison of Lough Mask with Loughs Corrib, Carra and Sheelin

Three other large trout lakes have recently been surveyed for the Water Framework Directive using the same standardised techniques as those used for the current Lough Mask survey. Lough Corrib and Lough Sheelin were surveyed in 2008 and Lough Carra was surveyed in 2009. The differences in the mean CPUE for each lake were assessed for brown trout, perch, roach and pike. The length frequency of brown trout is also displayed for each lake.

3.2.1 Brown trout CPUE

There was a significant difference in the mean brown trout CPUE among the four lakes surveyed (Kruskal-Wallis, $P<0.05$) (Fig. 3.5). Independent-Samples Mann-Whitney U tests between each lake showed that Lough Carra had a significantly higher mean brown trout CPUE than Lough Sheelin ($P<0.05$). Although Figure 3.5 shows a considerably higher mean brown trout CPUE in Lough Carra than in both Lough Mask and Lough Corrib, this was not statistically significant.
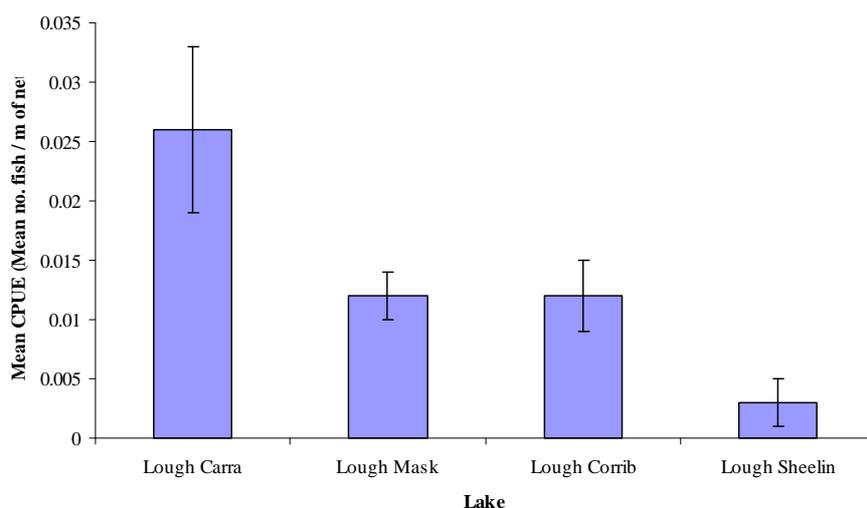

Fig. 3.5. Brown trout mean (±S.E.) CPUE in four large lakes surveyed during 2008 and 2009 as part of the WFD fish monitoring programme

3.2.2 Perch CPUE

There was a significant difference in the mean perch CPUE among the four lakes surveyed (Kruskal-Wallis, $P<0.01$) (Fig. 3.6). Independent-Samples Mann-Whitney U tests between each lake showed that Lough Sheelin had a significantly higher mean perch CPUE than both Lough Mask ($P<0.01$) and Lough Carra ($P<0.01$), but not Lough Corrib. Lough Corrib had a significantly higher mean perch CPUE than Lough Mask ($P<0.05$). Although Figure 3.6 shows a considerably higher mean perch CPUE in Lough Corrib compared to Lough Carra, this was not statistically significant. The mean perch CPUE between Lough Mask and Lough Carra were also not significantly different.
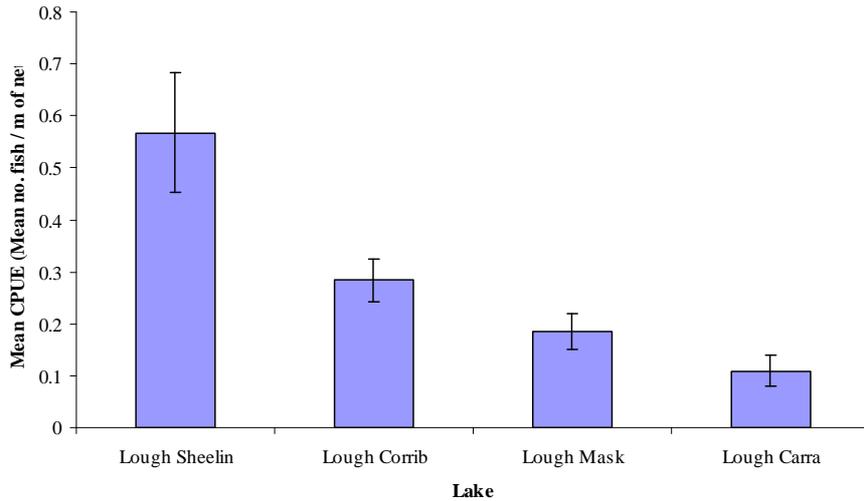
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Fig. 3.6. Perch mean (±S.E.) CPUE in four large lakes surveyed during 2008 and 2009 as part of the WFD fish monitoring programme

3.2.3 Roach CPUE

There was also significant difference in the mean roach CPUE among three of the four lakes surveyed (Kruskal-Wallis, P<0.001) (Fig. 3.7). No roach were recorded in Lough Carra during the 2009 survey and therefore the lake was excluded from further analysis. Independent-Samples Mann-Whitney U tests between each lake showed that Lough Corrib had a significantly higher mean roach CPUE than Lough Mask (P<0.001). Lough Sheelin was not significantly different from either Lough Corrib or Lough Mask.
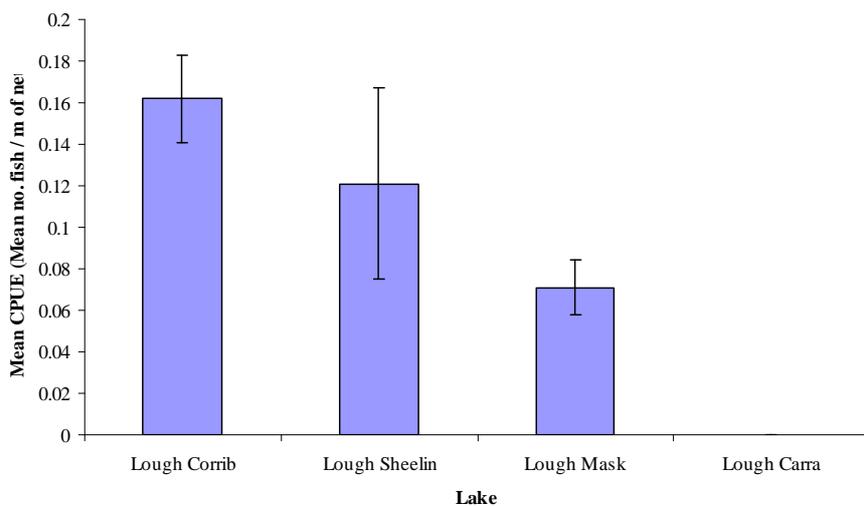

Fig. 3.7. Roach mean (±S.E.) CPUE in four large lakes surveyed during 2008 and 2009 as part of the WFD fish monitoring programme

3.2.4 Pike CPUE

There was a significant difference in the mean pike CPUE among the four lakes surveyed (Kruskal-Wallis, P<0.05) (Fig. 3.8). Independent-Samples Mann-Whitney U tests between each lake showed that Lough Corrib had a significantly higher mean pike CPUE than both Lough Mask (P<0.01) and Lough Carra (P<0.05) but not Lough Sheelin. Although Figure 3.8 shows a considerably higher mean pike CPUE in Lough Sheelin compared to Lough Mask and Lough Carra, these differences were not statistically significant.
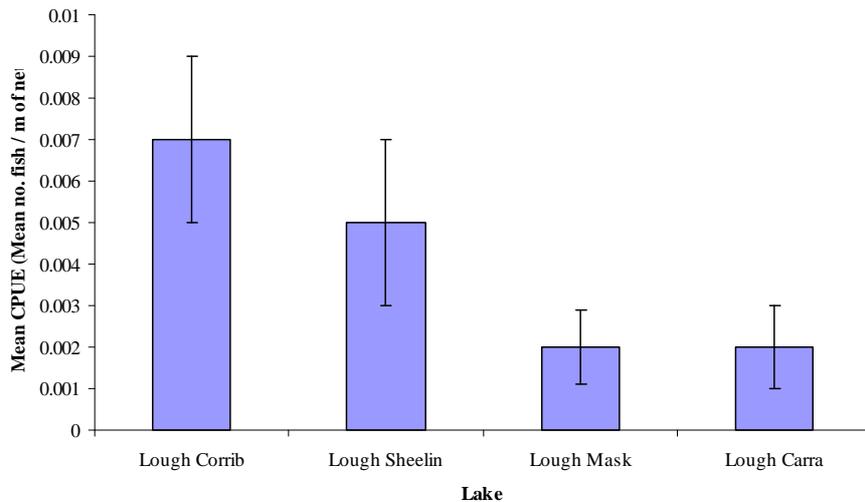

Fig. 3.8. Pike mean (±S.E.) CPUE in four large lakes surveyed during 2008 and 2009 as part of the WFD fish monitoring programme

3.2.5 Length frequency of brown trout (including ferox)

Figure 3.9 below shows the length frequency of brown trout captured in each of the four lakes. Only three brown trout were captured in Lough Sheelin, therefore we cannot conclude much from the length frequency distribution in this lake. Length ranges of brown trout were broadly similar between Loughs Mask, Corrib and Carra, with the exception of a few large individuals (ferox trout) in Loughs Mask and Corrib (Figure 3.9).
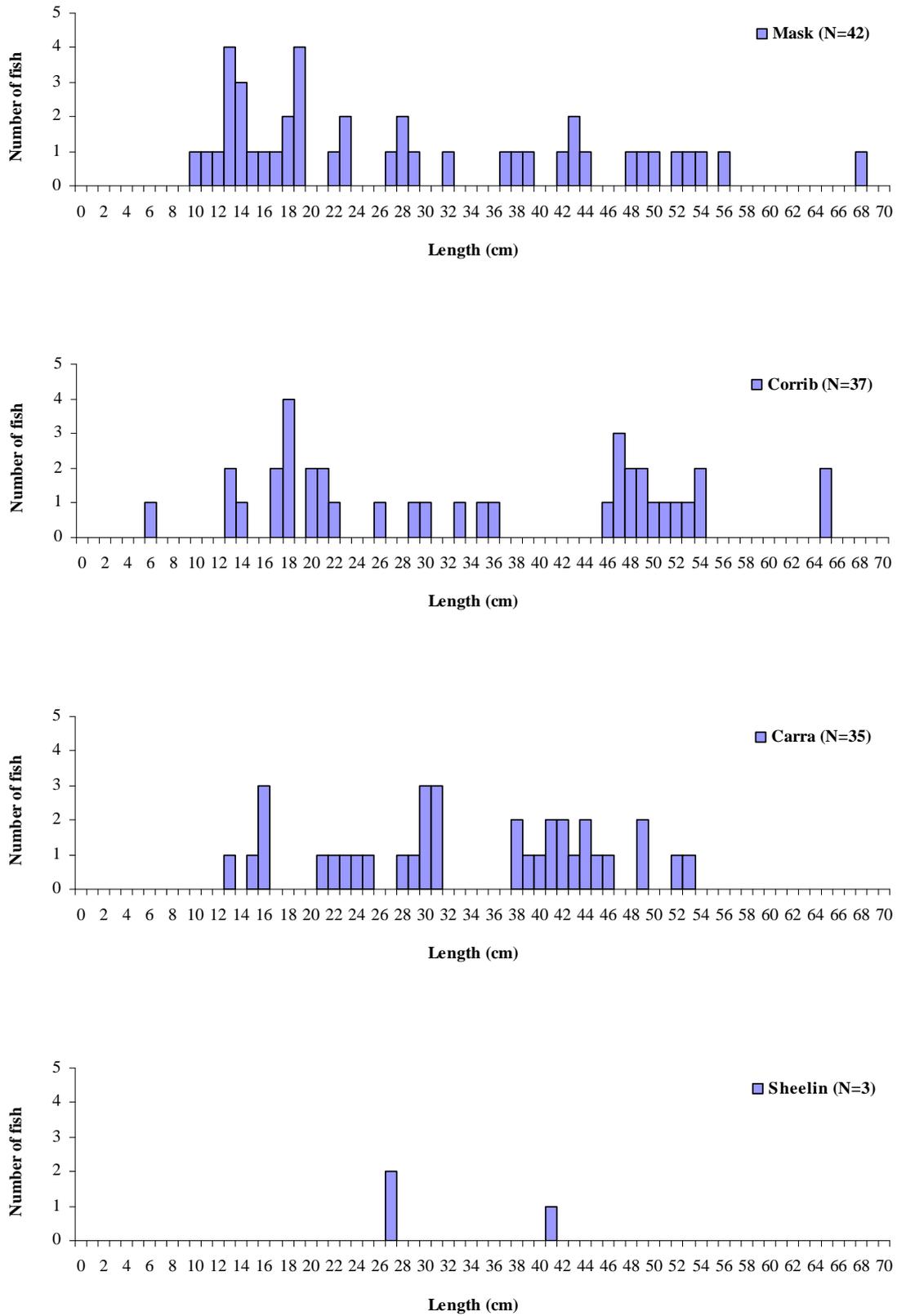
Fig. 3.9. Brown trout length frequencies in four large lakes surveyed during 2008 and 2009 as part of the WFD fish monitoring programme

3.3 Comparison of Lough Mask surveys: 1996 – 2009

Although the methodologies used in the two surveys (1996 and 2009) were considerably different, an attempt has been made to transform the data to give a broad comparison of the two surveys and any major changes in fish populations that have occurred over the 13 year period. However, it is stressed that, due to the complicated nature of comparing these different survey methodologies, the results from this exercise should be taken as a 'rough estimate' rather than an absolute assessment of the differences in fish stocks.

3.3.1 Differences in methodology and transformation of data

In the 1996 survey, large braided multifilament survey gill nets ('O'Grady nets') were used. These gill nets measure 27m long by 2m deep with mesh sizes ranging from 25mm to 62.5mm and are designed to captured fish (particularly brown trout) >19.8cm in length. They were set in chains of seven nets giving a total of 378m^2 of net per site. A total of 150 sites were sampled and the results were expressed as the total number of fish captured divided by the total number of sites (total area of 56,700m^2).

In contrast, the 2009 survey used 12-panel multimesh (5 – 55mm mesh size) monofilament survey gill nets measuring 30m long by 1.5m deep, set individually (45m^2 per site). These were supplemented by a number of 62.5mm fixed mesh braided gill nets measuring 27m long by 2m deep (54m^2 per site). A total of 106 sites were sampled (total area of 4950m^2).

In order to compare the two surveys, CPUE was calculated as the total number of fish divided by the total area (m^2) of gill nets. For the 2009 survey, only the area of gill nets that had mesh sizes comparable to the O'Grady nets was used (i.e. >25mm). Standard errors could not be calculated as only one value was obtained for each survey.

3.3.2 CPUE of brown trout, Arctic char, perch, roach and pike

In the 1996 survey, brown trout CPUE was calculated as 0.004 fish/m^2. In 2009 the brown trout CPUE was greater than twice this previous value – 0.009 fish/m^2 (Fig. 3.10). In contrast, Arctic char CPUE decreased from 0.009 fish/m^2 in 1996 to 0.005 fish/m^2 in 2009 (Fig. 3.11). Both perch and roach CPUE have increased dramatically between 1996 and 2009. Perch have increased from 0.0004 fish/m^2 in 1996 to 0.075 fish/m^2 in 2009 (Fig. 3.12). Only one single roach was captured in Lough Mask during the 1996 survey 0.00002 fish/m^2, however in the 2009 survey roach was the second dominant species by abundance 0.007 fish/m^2 and the most abundant species by biomass (Fig. 3.13). Pike CPUE has increased from 0.0005 fish/m^2 in 1996 to 0.002 fish/m^2 in 2009 (Fig. 3.14).
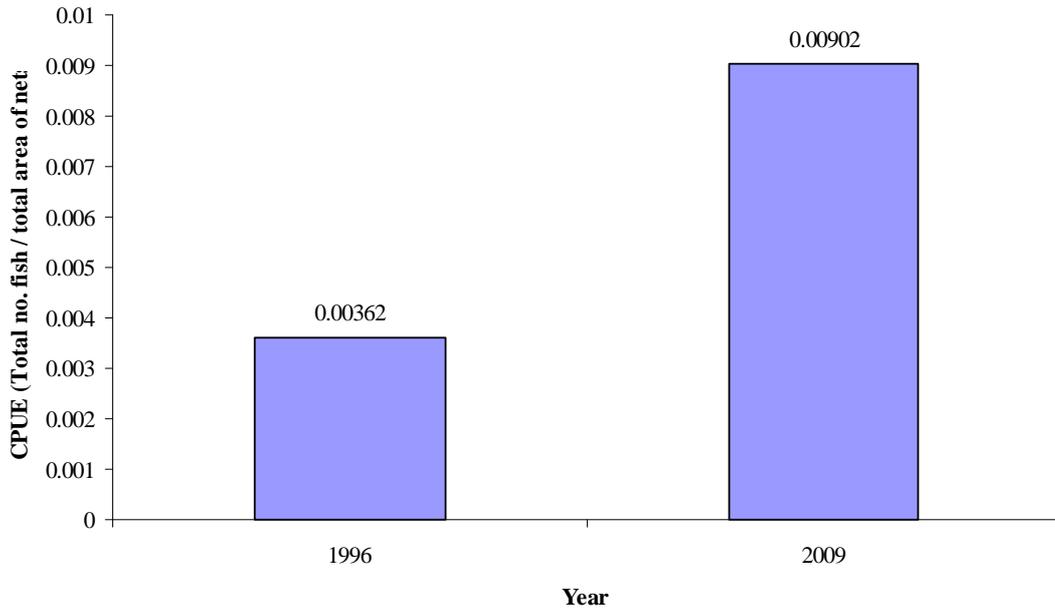
Fig. 3.10. Brown trout CPUE in Lough Mask in 1996 compared to 2009
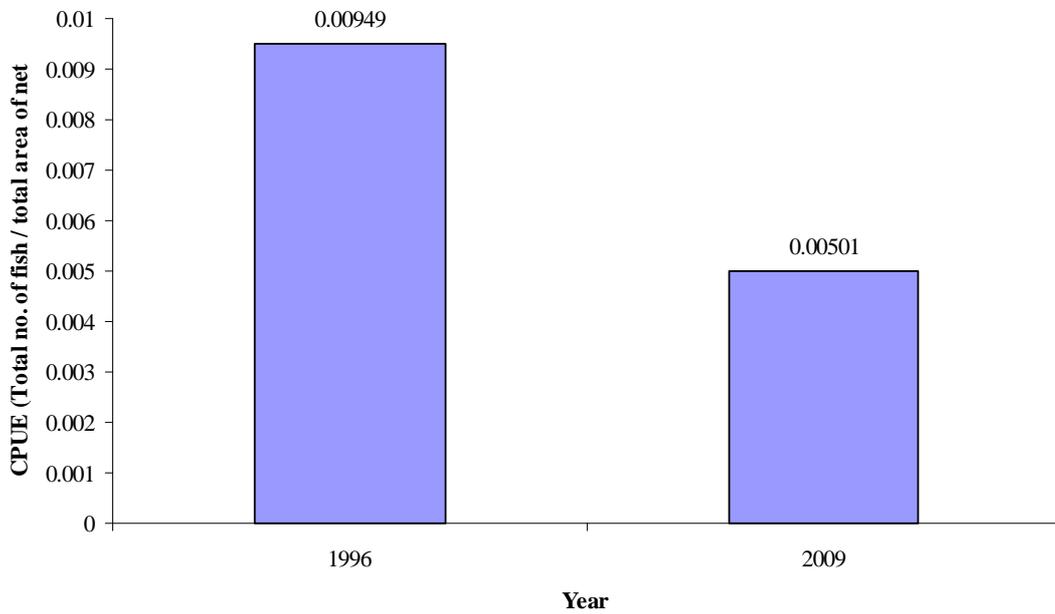

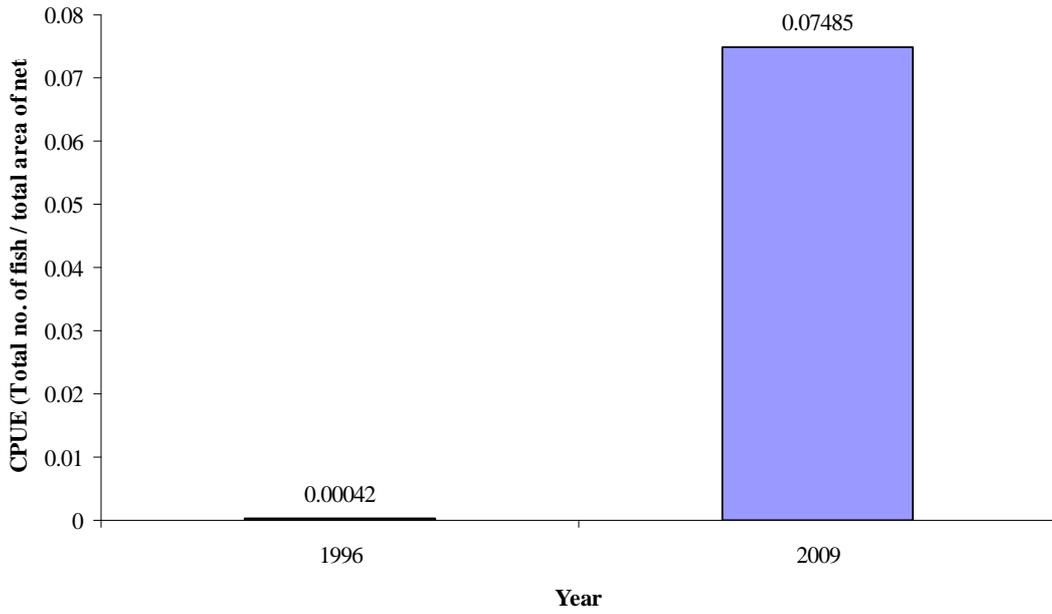**Fig. 3.11. Arctic char CPUE in Lough Mask in 1996 compared to 2009**

Fig. 3.12. Perch CPUE in Lough Mask in 1996 compared to 2009
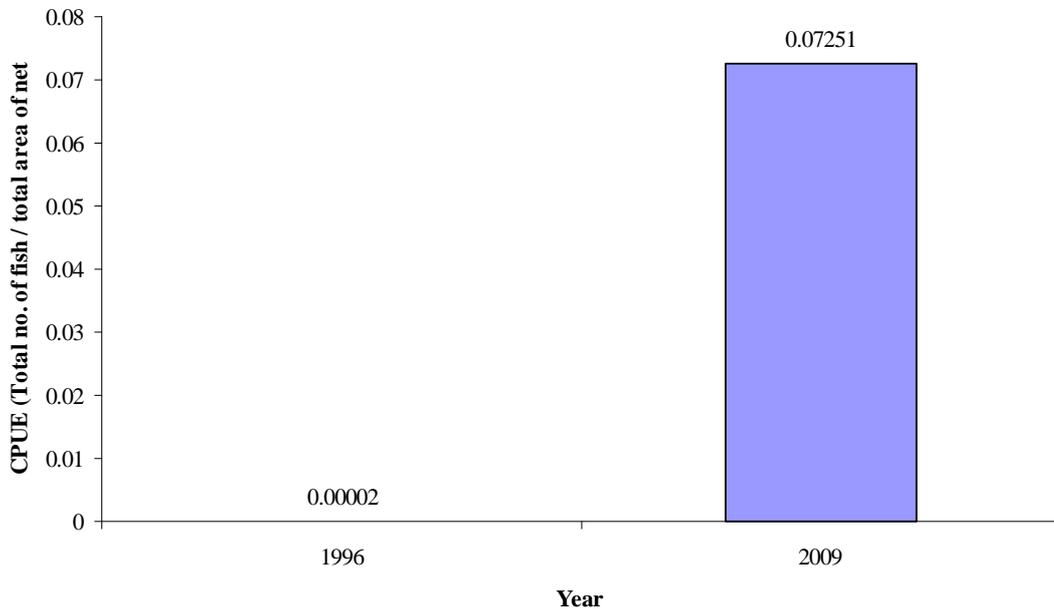

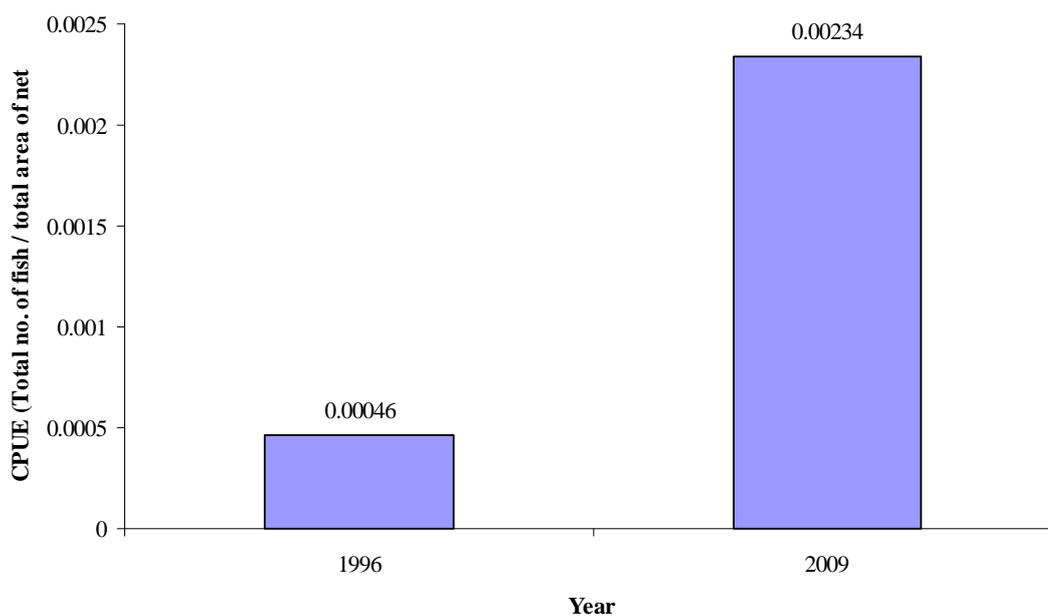**Fig. 3.13. Roach CPUE in Lough Mask in 1996 compared to 2009**

Fig. 3.14. Pike CPUE in Lough Mask in 1996 compared to 2009

3.4 Stomach contents analysis

Feeding studies provide a good indication of the availability of food items and the angling methods that are likely to be successful. However, the value of stomach content analysis is limited unless undertaken over a longer period as diet may change on a daily basis depending on the availability of food items. The food items recorded in trout stomachs during the survey were dominated by bottom dwelling organisms (e.g. *Asellus* sp., gastropods, *Gammarus* sp. and beetle larvae).

4 NEW METHODS - HYDROACOUSTICS

During the summer of 2009, WFD fish survey staff were trained on the use of new hydroacoustic equipment (Plate 4.1) while on site on Lough Mask. Although the data collected during this training exercise is insufficient to conduct any meaningful analyses on spatial distribution and abundance of the fish populations present in Lough Mask, the exercise provided valuable insights into the use of this technology for future fish stock surveys of large, deep lakes. Figure 4.1 below shows a typical echogram from a deep water section of Lough Mask.

Plate 4.1. Hydroacoustic boat with two transducers (horizontal at fore and vertical at aft) mounted on the port side
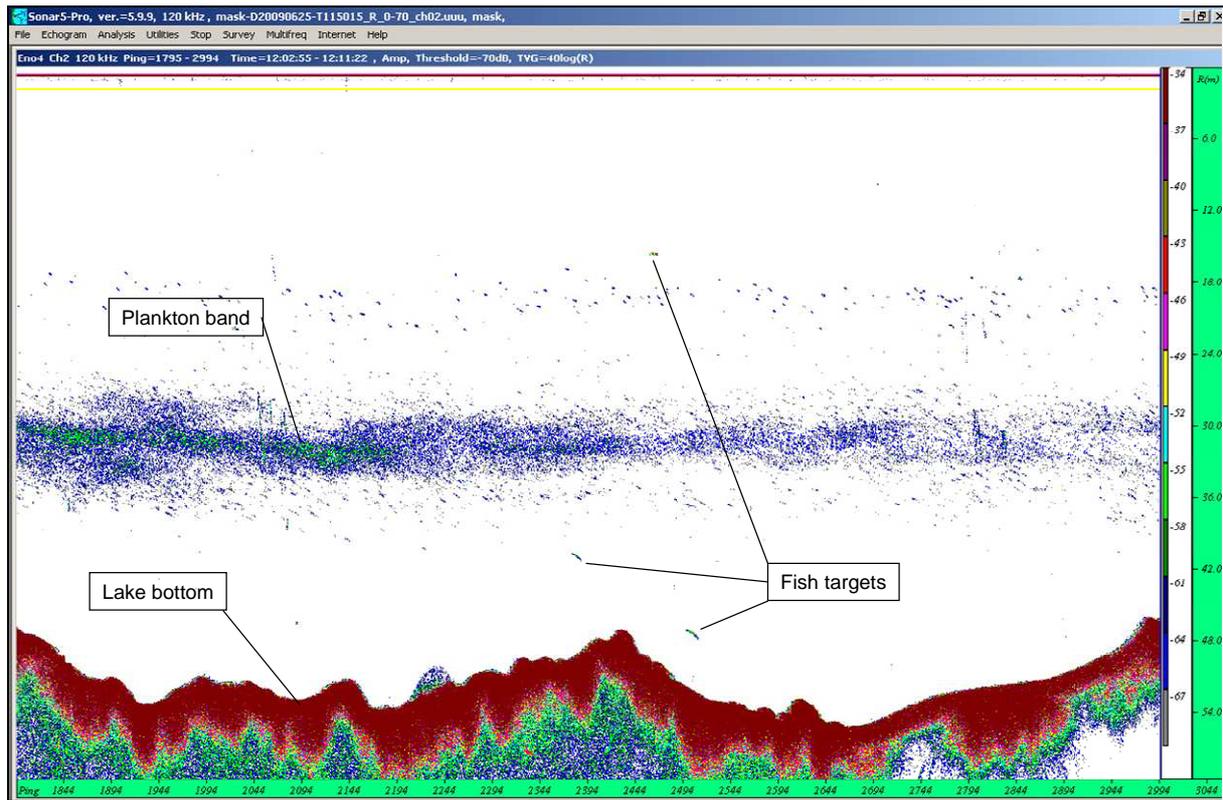
Fig. 4.1. Hydroacoustic echogram from Lough Mask showing fish targets typical of Arctic char in deep water, as well as mid-water targets typical of brown trout above the plankton band.

5 SUMMARY

Perch was the dominant species in terms of abundance (CPUE) in Lough Mask, followed by roach, eel, brown trout, Arctic char, bream and pike. In contrast, roach had the highest biomass (BPUE) followed by perch, pike and brown trout.

The mean CPUE for perch in Lough Mask was within the lowest third when compared with all lakes surveyed for the WFD to date that contained perch (Kelly *et al*., 2007a, 2007b, 2009, 2010). Perch growth was also relatively slow, with the mean L1 of perch in Lough Mask being lower than many of the lakes surveyed for the WFD to date that contained perch (Kelly *et al*., 2007a, 2007b, 2009, 2010). The number of perch has increased significantly when compared to the previous survey conducted in 1996. Although, as highlighted previously, the methodology is somewhat different between the two surveys, there is still substantial evidence that perch numbers have increased dramatically.

Perhaps more alarming is the level of increase there has been in the roach population in the 13 years between the two surveys. In 1996 only a single roach was captured; however, in the 2009 survey roach made up a significant proportion of the fish abundance. Furthermore, roach was the dominant species by biomass.

The CPUE of eels in Lough Mask was low when compared to all lakes surveyed for the WFD to date that contained eels (Kelly *et al*., 2007a, 2007b, 2009, 2010).

The mean CPUE for pike was also relatively low (within the lowest quartile) when compared to all other lakes surveyed for the WFD to date that contained pike (Kelly *et al*., 2007a, 2007b, 2009, 2010).

Although the abundance of non-native fish species (particularly perch and roach as indicated above) have increased dramatically from 1996 to 2009, the abundance of brown trout does not appear to have been negatively affected. In contrast, there appears to have been an increase in the brown trout population size. As previously stated, however, the methodology employed in these two surveys was significantly different so any comparisons made must be done with caution. Nevertheless the brown trout stocks, although lower than Lough Carra, are still comparable to Lough Corrib and are in a healthier state than Lough Sheelin. The mean L4 of brown trout in Lough Mask was 39.9cm and this, according to Kennedy and Fitzmaurice (1971), categorises them as very fast growing.

The food items recorded in trout stomachs during the survey were dominated by bottom dwelling organisms (e.g. *Asellus* sp., gastropods, *Gammarus* sp. and beetle larvae) indicating that many of these trout may not have been available to most anglers fly fishing at the time of sampling using traditional fly fishing methods.

Lough Mask is one of twelve lakes surveyed for the WFD to date where the presence of Arctic char has been confirmed (Kelly *et al*., 2007a, 2007b, 2009, 2010). However, Lough Mask is within the lowest quartile of these lakes in terms of char abundance (CPUE). Lough Mask is possibly one of the

last high alkalinity lakes in Ireland to still contain Arctic char. They are now considered extinct from the other large western lakes, where they were once found - Lough Corrib and Lough Conn (Igoe *et al.,* 2003). The Arctic char recorded in Lough Mask were aged using otoliths and the age classes 1+, 2+, 3+ and 5+ were present, indicating recruitment success in at least the previous three years..

Classification and assigning lakes with an ecological status is a critical part of the WFD monitoring programme. It allows River Basin District managers to identify and prioritise lakes that currently fall short of the minimum "Good Ecological Status" that is required by 2015 if Ireland is not to incur penalties.

A WFD multimetric fish classification tool has been developed for the island of Ireland (Ecoregion 17) using CFB and Agri-Food and Biosciences Northern Ireland (AFBINI) data generated during the NSSHARE Fish in Lakes project (Kelly *et al*, 2008). Using this tool and expert opinion on non-native/alien species, Lough Mask has been assigned an ecological status classification of Good based on the fish populations present.

The EPA has assigned an overall status of Good to Lough Mask in an interim draft classification. This is based on physico-chemical parameters and biotic elements such as macroinvertebrates, macrophytes and fish.

6 FUTURE WORK

As part of Inland Fisheries Irelands' WFD monitoring programme it is planned to undertake a fish stock survey on Lough Mask every three years, with the next survey planned for June 2012. In addition to the standard gill netting survey a detailed hydroacoustic survey will also be undertaken.

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