



ATEC

aquatic and terrestrial
environmental consultants



Reassessing Otter *Lutra lutra* distribution in Northern Ireland



**For The Environment and Heritage Service (DoE, N.I.).
By Aquatic and Terrestrial Environmental Consultants
Authors: Dr Jane Preston, Dr Paulo Prodöhi, Dr Alex Portig & Professor Ian
Montgomery.
Date: March, 2004**



R26645

Acknowledgements

I would like to acknowledge and thank Professor James Fairley for his time and invaluable advice given during the analysis of Otter spraints.
We would like to acknowledge the assistance of Dr David Kelly & Dr Anita Kirkpatrick for their work throughout this project. Thanks also go to the Environment and Heritage staff at Castle Archdale - namely Ken Moore, Reggie and Thomas for their invaluable assistance collecting spraints in Upper Lough Erne.

<u>Section Details</u>	<u>Page Number</u>
Executive Summary	1
1. Introduction	4
1.1 General Ecology	4
1.2 Spraints and Sprainting behaviour	5
1.3 Otters and Man	6
1.4 Pollution	7
1.5 Distribution in Ireland	8
2. Background to the Survey	10
2.1 Project A - Assessing Otter population diversity and distribution in Upper Lough Erne.	11
2.1.1 Background	11
2.1.2 Methods	12
2.1.2.1 Surveying the shores of Upper Lough Erne for Otters	12
2.1.2.2 Surveying the feeder rivers of Upper Lough Erne for Otters	13
2.1.2.3 Spraint Analysis	13
2.1.3 Results	14
2.1.3.1 Otter Distribution on Upper Lough Erne and Feeder Streams	14
2.1.3.2 Genetic Analysis of Otter Spraints	19
2.1.3.3 Estimates of Abundance	21
2.2 Project B - Reassessing Otter distribution in Northern Ireland	23
2.2.1 Background	23
2.2.2 Methods	24
2.2.2.1 Resurvey	24
2.2.2.2 New Survey	24
2.2.3 Results	25
2.2.3.1 Resurvey - Reassessment of Otter Occurrence at sites previously surveyed in 1980-1981.	25
2.2.3.2 New Survey - Assessment of Otter Occurrence at previously unsurveyed sites throughout Northern Ireland.	30
2.2.3.3 Overall Results	35
2.2.4 Otter Diet	37
2.2.4.1 Background	37
2.2.4.2 Results	38
3. Conclusions & Recommendations	42
References	
Appendices	

Reassessing Otter distribution in Northern Ireland

A sample of 131 of the 258 sites originally found to have signs of Otter activity were re-surveyed. In addition, a sample of 50 'negative' sites were also re-surveyed. Results from this reassessment indicate an overall decline of 9.9% in Otter occurrence since the original survey in 1980-1981. This decline is statistically significant.

The decline has occurred throughout the habitat range. The greatest percentage decline occurred in high uplands and mountains, with drumlin farmland and lakelands showing the least change in Otter occurrence since the 1980s. Similarly, there has been a general decline in Otter occurrence throughout the range of catchments. The greatest decline occurred in rivers in the Mourne and South Armagh with the least decline in the Foyle and Roe systems and in the Lagan, Belfast Lough and East Down catchment.

A total of 441 new sites were surveyed for evidence of Otter activity in order to expand information on Otter distribution in Northern Ireland and to include areas previously not covered in the original survey. Positive signs of Otter activity were found at 65% of sites surveyed. This figure compares favourably to recent surveys of Otter distribution in England (36% occurrence) and Wales (52% occurrence), with Scotland alone having a higher percentage occurrence of Otters (83% occurrence).

The highest percentage occurrence was found around lakes, with coastal sites having the lowest percentage occurrence of Otters. Similar results were obtained when the data were analysed with respect to the Northern Ireland Land Classification (Cooper *et al.*, 1997). Lakelands had the highest percentage occurrence of Otters with mountainous areas having the least. The percentage occurrence of Otters was found to vary considerably with respect to catchment. The highest percentage occurrence was in Lough Melvin, County Fermanagh and around the Foyle catchment with fewest positive signs along the north-east coast and Glens of Antrim.

Otter occurrence was also found to vary with respect to river width with a higher percentage occurrence of Otters in larger rivers and significantly fewer Otters in streams less than 2m wide. 14% of sites surveyed in Northern Ireland were judged as being obviously polluted. Otter occurrence was found to be higher at unpolluted (68%) as compared to polluted (57%) sites.

During the current investigation a total of 742 sites were surveyed for the occurrence of Otter activity representing a comprehensive coverage of Northern Ireland and providing a baseline on which future monitoring programmes can be established. The data show a reduction in Otter density not in the overall range of the species. Abundance has been affected in marginal areas more than in optimal Otter habitat. Therefore, the reduction in numbers is likely to be due to some widespread factor such as water quality, since we can discount other more local impacts such as disturbance or afforestation. Changes in agricultural practice and the widespread use of nitrates are the most likely causes for deterioration in water quality throughout Northern Ireland.

Further research is needed to fully investigate the reasons behind the decline in Otter numbers in Northern Ireland over the past 20 years.

Otter Diet

Results from analysis of spraints collected from sites throughout Northern Ireland suggest that Otter diet is composed predominantly of fish with species such as salmonids, sticklebacks and cyprinids comprising over 50% of Otter diet. The dominant prey category is stickleback which is surprising since, in comparisons with

other published analyses of Otter spraints from Ireland, they are normally recorded at much lower percentage frequencies. Non-fish prey include frogs, crayfish, mammals, birds and smaller items (insects, molluscs and invertebrates) with frogs making a significant contribution to the diet.

A 20-year comparison of spraints collected from the same sites indicates differences in the percentage weight of some Otter prey categories. Changes in the percentage weight of salmonids, sticklebacks and eels may reflect smaller individuals of these prey categories now being consumed by Otters compared to the 1980s. In addition, an increase in the percentage weight of non-fish prey categories such as frogs, mammals, birds and insects may reflect larger amounts of these prey categories in the diet of Otters today as compared to 20 years ago. However, further research is needed to fully investigate Otter diet in Northern Ireland.

1. Introduction

1.1 General Ecology

There are 9 species of Otter worldwide. However, the Eurasian Otter *Lutra lutra* has the widest distribution ranging from Ireland to Indonesia and Japan (O'Neill, 1995). Average weights for Otters are 11kg for males and 7.4kg for females (Wayre, 1979). Otters may live for up to 15 years (Kruuk, 1996). Otters are primarily nocturnal and prefer undisturbed areas with foraging occurring almost exclusively in water (Fairley, 2001). Otters have peaks of activity 3-5 hours after dusk or just before dawn (Morrison, 1994). In undisturbed areas they may become diurnal actively foraging in early morning and late evening (Morrison, 1994). In other more disturbed areas Otters sleep during the day on couches formed from bare earth or grass or go to ground in underground chambers known as holts. These can be natural holes or crevices or deliberately excavated (Morrison, 1994). Holts are always well concealed usually with several entrances one of which is often below water level (Morrison, 1994).

There is no defined breeding season for Otters and litter sizes may vary between 1-4 cubs (Wayre, 1979). However, in a study of Otters along a stretch of coast in Shetland, the majority of births occurred in summer (Kruuk, 1996). Copulation generally takes place in water and males play no part in parental care (Kruuk, 1996). Females use natal holts in which to give birth. These can be up to 1km from water, probably to avoid males (Kruuk, 1996). The males or dogs are solitary outside the breeding season, whereas the females or bitches form family groups with their offspring (Morrison, 1994). Otter families break up when cubs are between 10 and 16 months old (Kruuk, 1996). However, in Shetland, females provide fish for their young after weaning until the cubs started to fish for themselves when 5-6 months old (Kruuk, 1996).

Otters live in a variety of habitats including coastal and freshwater rivers and lakes. They spend most of their time in or around water and require a special coat to protect them from both the cold and continual periods of saturation. For this purpose they have a thick (about 1cm thick) underfur, with about 500,000 hairs per cm². This underfur is covered by guard hairs around 4cm long (Kruuk, 1996). Otters require freshwater for bathing as salt can dry and damage their coat, presumably interfering with oiling of the underfur and affecting insulation (Fairley, 2001).

Otters live at low population densities compared with other mammals due to habitat requirements and the linear nature of their territories (Jeffries, 1989). Otters that inhabit coastal waters may live at higher densities than those inhabiting stretches of river (O'Neill, 1995). Up to 4 females may inhabit a coastal range of 4-6 km compared to ranges between 10-85 km on rivers with large differences between males and females (O'Neill, 1995). Females often have overlapping territories. Male territories rarely overlap (Fairley, 2001). Aggressive behaviour, though not common, is most often observed between adult males at territorial boundaries. Aggression between females is even less common (Kruuk, 1996).

Otters demarcate their territories with faeces known as 'spraints'. Spraints are highly variable in form and can be black or brown (the latter if containing crustaceans), the colour fading as they weather (Gormally *et al.*, 1983). They have a musty, fishy odour and are usually deposited on topographical features ("seats") (Gormally *et al.*, 1983). Seats are normally on the top of large boulders in the river channel or on raised tussocks of grass along well-used paths and runs. With a little experience it's often possible to predict where sprainting sites will be found. Looking along a stretch of river or a length of coast, it is frequently the landmark that takes the eye - a large, exposed boulder, an overhanging branch or a large side bar on a prominent meander.

Fish make up 70% or more of the Otter diet, which varies according to habitat and prey availability (Wayre, 1979). Salmonids are the favoured freshwater fish although other species such as stone loach and stickleback are also taken in lesser quantities. Frogs may be eaten in spring together with less favoured items such as water beetles. Where they occur in abundance, crayfish may also contribute significantly to the diet. Birds, especially moorhen, (Wayre, 1979) and mammals including rabbit, mole, shrew and hare may be taken (Wayre, 1979). Otters that inhabit coastal habitats may feed on marine fish species such as rockling, eel, wrass and goby (Murphy & Fairley, 1985).

1.2 Spraints and Sprainting Behaviour

The scent in spraints comes from two pairs of anal scent glands, and each individual Otter may have a characteristic chemical signal (O'Neill, 1995). Captive Otters have been observed to produce up to 15 spraints per day (Jenkins & Burrows, 1980). Spraints can be used as an indicator of the ways Otters use habitat, though spraint numbers do not always provide a direct index to Otter numbers (Jenkins &

Burrows, 1980). They are inherently problematic in determining Otter abundance, because as scent marks, their deposition is affected by behavioural and individual variables (Kruuk & Conroy, 1987). In addition, it is unclear whether spraints are deposited solely to differentiate between individual territories or as a means of communication (Kruuk & Conroy, 1987). Of 98 sprainting sites detected on Roundstone Bog, South Connemara, 80.6% lay along Otter runs probably indicating territorial marking by male Otters (Kyne *et al.*, 1990).

Sprainting can also occur in the water with some Otters only rarely sprainting on land (Kruuk *et al.*, 1986). In addition, Otters in Shetland were observed to spraint more frequently in the water during summer months (Kruuk, 1995). Thus, if spraints are absent, it does not necessarily imply that Otters are absent. However, providing sample size is sufficient, spraint densities can be used with care to broadly define the status of an Otter population (Mason & MacDonald, 1987b).

One of the most important factors influencing spraint distribution is bank-side cover (Jenkins & Burrows, 1980; Bas *et al.*, 1984; Mason & Mac Donald, 1987b). This is probably reflective of habitat use by Otters since radio-tracked Otters in East Anglia were found to have spent 53% of surveyed time in woodland adjacent to the river margins (Mason & MacDonald, 1987b). On the coast of Shetland, spraints were associated with holts and habitat features e.g. freshwater pools (Kruuk *et al.*, 1986).

In both freshwater and marine environments, more spraints are found in winter than in summer (Kruuk & Conroy, 1987; Conroy & French, 1987; Kruuk, 1996). Seasonal differences in sprainting behaviour may be related to the availability of food. Kruuk (1996) suggests that spraints are more likely to be signals left to other Otters to prevent competition for food i.e. to signal a section of river that is being, or recently has been fished. Seasonality of sprainting can then be explained since food resources are scarcer in winter, making the reduction of competition even more important (Kruuk, 1996). Thus, a sprainting site may mark a recently fished area where feeding success is unlikely, rather than a marker of specific territories (Fairley, 2001).

1.3 Otters and Man

Historically, Otters were hunted due to their perceived impact on fish stocks in rivers. Otter fur was, and still is, highly prized and river Otters are still trapped in some parts of the United States and Canada (Kruuk, 1986). However, there are some interesting reports of Otters being used by man to catch fish. Otters were

trained to fish in China (609-916 AD), a practice that spread to Malaysia and India, reaching Europe by the 15th century. The earliest English reference to Otters being used to fish is 1618 (Wayre, 1979).

Otter hunting and trapping was at one time widespread in Britain. Local extinctions of Otters were noted in Britain by 1800. Indeed, low numbers of Otters on mainland Britain led to some hunts coming to Ireland (Jeffries, 1989). For example, over 51 days between 1907 and 1909, 54 Otters were killed by the Border Counties Hunt in Counties Wicklow and Wexford (Jeffries, 1989). From 1955 onwards, hunts began to report low success, and reduced numbers of Otters killed (Jeffries, 1989). Analysis of hunt success between 1950 and 1971 shows a decline starting suddenly in 1957/58 and occurring simultaneously in England, Wales and the Scottish borders, though most dramatically in the south east of England (Jeffries, 1989).

Otter hunting with hounds ceased in Britain in 1977-78. Otters are protected in Ireland and since 1982 have been fully protected in Britain under the Wildlife and Countryside Act. In Northern Ireland, Otters are protected under schedule 6, articles 12 and 28 of the Wildlife (Northern Ireland) Order (1985).

1.4 Pollution

The further decline in numbers of British and especially English Otters since the late 1950s is probably due to organochlorine pesticide pollution in combination with other factors such as the destruction of suitable habitat (Hilder *et al.*, 1982; Lunnon & Reynolds, 1991; Kruuk, 1996; Gutleb & Kranz, 1998). The suddenness of the decline suggests that the pesticides may have reached a critical level in the environment in the late 1950s, in particular PCBs (polychlorinated biphenyls) (Mason & Wren, 2001). Dieldrin is generally held to be responsible, but is now generally no longer used (Kruuk, 1996).

Mercury contamination of U.K. fish may also exert sub-lethal effects on Otters. This may be especially the case with eels which biomagnify mercury (Mason *et al.*, 1982). In a study of Otters on Shetland, almost 40% of Otters of 5 years old and over were found to have accumulated enough mercury for potential lethal or sub-lethal effects (Kruuk & Conroy, 1991). Cadmium and lead may also cause problems to Otters in areas of high concentration (Mason *et al.*, 1982; Mason & MacDonald, 1986, 1987a).

Other impacts such as changes in agricultural land use may also have contributed to the population decline. In studies in the late 1980s, Otters were not found on streams draining conifer plantations in upland areas of Wales, where pH periodically fell below 5.5 (Mason & MacDonald, 1987a). This was thought to be due to an absence of fish in forested streams (Mason & MacDonald, 1987a). Furthermore, significantly fewer Otter signs were found on stretches of Scottish Rivers with the minimum pH thought to be detrimental to fish populations (Mason & MacDonald, 1989).

Results from a survey of Otters in the early 1990s found a significant relationship between pollution and Otter distribution (Lunnon & Reynolds, 1991). A later study in south-west Scotland and northern England found the distribution of Otters to be inversely correlated to the mean concentration of pesticides and PCBs, suggesting organochlorines may still be exerting a negative impact on Otters (Mason, 1993).

The drastic decline in Otter numbers in Britain was not repeated in Ireland where pesticide use was never so extensive (Jeffries, 1989; Lunnon & Reynolds, 1991). Here, the destruction of riparian habitat during arterial drainage schemes in the 1960s and deterioration in water quality due to eutrophication may have had a greater impact on Otter numbers.

1.5 Distribution in Ireland

In 'A guide to Belfast and the Counties of Down and Antrim' published by the Belfast Naturalist's Field Club in 1874, the Otter was described as still maintaining its hold in suitable retreats 'in spite of the war waged against it' – an obvious reference to the Otter being hunted and killed as a pest species in Northern Ireland. The account continues – 'It is recorded from the river Lagan, and is still occasionally seen near Shaw's Bridge. It is frequently taken on the wooded shores of Lough Neagh. Mr Wadds, steward of Castle Dobbs, states that six have been killed there within the past few years. They have also been seen at natural places along our coasts.'

In a subsequent publication by BNFC for the meeting of the British Association in 1902, Otters were described as 'quite common' and - 'particularly numerous around Downpatrick, Ballycastle, and round Lough Neagh. From a small section of Co. Down we have over 30 records. They are occasionally taken in the sea.'

The Vincent Wildlife Trust carried out the first systematic study of Otters and their wetland and coastal habitats throughout the Republic of Ireland and Northern

Ireland in 1980 and 1981. In an extensive survey conducted by Peter and Linda Chapman, 2373 sites were surveyed throughout Ireland for signs of Otter activity. The survey employed methods used during the surveys of Wales (Crawford *et al.*, 1979), Scotland (Green & Green, 1980) and England (Lenton *et al.*, 1980). The basic unit area of the survey was the 10km square of the Irish National Grid and alternate 50km squares were surveyed. A near even spatial distribution of the survey points and a thorough coverage of all areas surveyed was achieved by spacing the sites to be surveyed approximately 5 to 8 km along rivers, streams, lake shores, canals and the coast. A representative sample of wetland and coastal habitat types present in each 10 km square was chosen whenever possible. Survey points were frequently located at bridges, fords, piers etc... which provided good access. Otter sightings, spraints and tracks were accepted as proof of Otter presence, while well-worn paths, rolling spots, fish remains and reported sightings were noted on the survey sheet but not considered as evidence (Chapman & Chapman, 1982).

The survey recorded Otters to be widely distributed in a diverse range of wetland and coastal habitats. Signs of Otter activity were recorded at 92% of sites surveyed. Only 4% of inland sites surveyed were described as polluted (Chapman & Chapman, 1982) and there was a significant relationship between polluted sites and the presence/absence of Otters (Chapman & Chapman, 1982).

A total of 332 sites were surveyed in Northern Ireland (Figure 1). Signs of Otter activity were recorded at 78% of sites surveyed (Figure 1). Otters were found to be evenly distributed throughout the region's inland habitats. Otters were not recorded along coastal stretches of Antrim and Down but were found along the Ards Peninsula and Strangford Lough (Figure 1).

In a follow-up survey, Lunnon & Reynolds (1991) resurveyed a sub-sample of 268 Chapman sites throughout Ireland. The percentage of positive sites fell from 92% to 89.5%. In analyses of data from this survey, no significant relationship was found between the distribution of Otter signs and human disturbance. However, a significant relationship was found between bankside cover and the distribution of Otter signs with the cover at 21 of the 24 negative sites recorded as low.

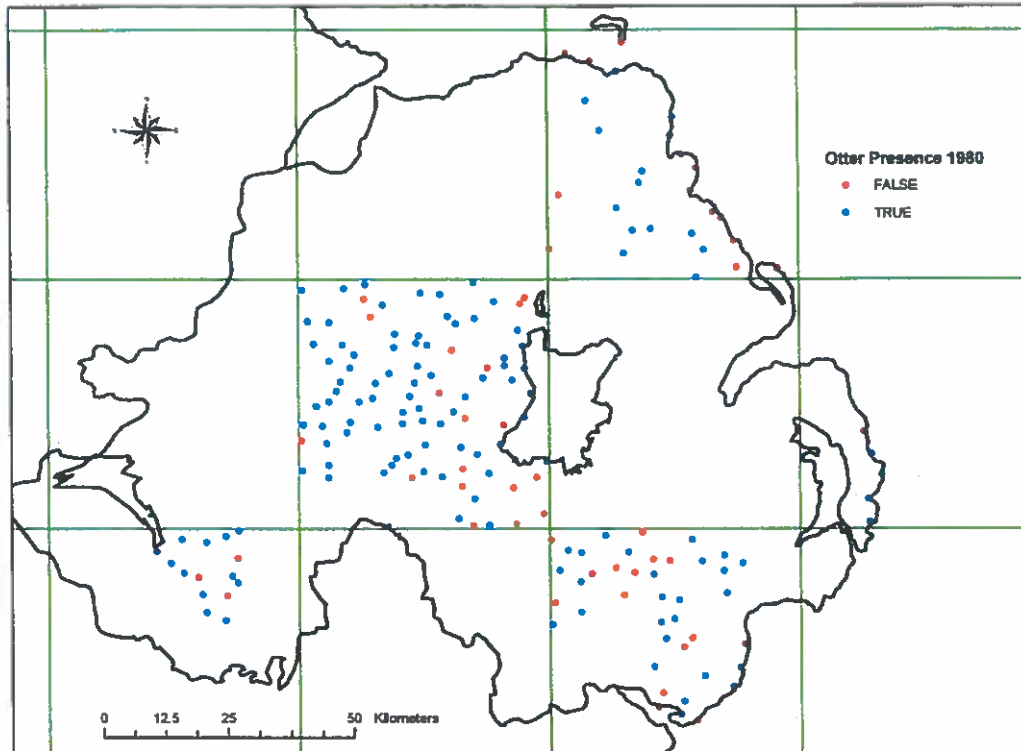


Figure 1. Distribution of sites surveyed by Chapman & Chapman (1982) showing the status of Otter occurrence at that time.

2. Background to the Current Survey

The aim of the current investigation was to reassess the distribution of Otters throughout Northern Ireland, allowing an update on the results of the Chapman data now 20 years old. In addition, the investigation aimed to obtain information on the distribution and abundance of Otters around the shores of Upper Lough Erne in County Fermanagh. Upper Lough Erne is designated as a Special Protection Area (SPA) for its breeding birds and a Special Area of Conservation (SAC) for its extensive wetland habitat and Otter population. This information will inform current Habitat and Species Biodiversity Action Plans and aid in future conservation management objectives for the Otter population both in Upper Lough Erne and throughout Northern Ireland.

The current investigation is sub-divided into three sections described below.

2.1 Project A - Assessing Otter population diversity and distribution in Upper Lough Erne.

2.1.1 Background

In comparison to the wide, open Lower Lough, Upper Lough Erne has a small scale, intricate landscape in which the main River Erne channel splits and joins, widens and narrows around a myriad of drumlin islands of varying size and shape (HMSO, 1991).

Upper Lough Erne is designated as a Special Area of Conservation (SAC) for its Otter population. However, little is known on the actual numbers of Otters using the Lough and its feeder streams.

Conservation and management plans for the Otter population on upper Lough Erne cannot take place without baseline data on population structure and dynamics. However, basic information such as overall numbers of Otters is difficult to obtain as they are rarely observed and are very difficult to trap, mark and recapture. As Otters are difficult to observe directly, indirect methods have been used to monitor their populations. In the British Isles, Otter signs, in particular their spraints, have been used to ascertain the status of Otter populations. These surveys rely on the assumption that Otter numbers and spraint numbers are correlated. Conroy and French (1987) found that there was a significant correlation between the numbers of spraints counted and the numbers of Otters seen over long stretches of coast. However, several reviews of this survey methodology have highlighted its inherent problems (Kruuk & Conroy, 1987; Macdonald and Mason, 1985; Mason & Macdonald, 1987).

The relatively recent development of microsatellite DNA profiling methodology has provided new opportunities to study genetic diversity and population structure in natural communities at considerable more detail than had previously been possible (Haig 1998). The high degree of resolution (i.e. high levels of genetic polymorphisms), coupled with their co-dominant mode of inheritance, has made microsatellite markers particularly suitable for a number of studies ranging from individual and family identification to characterisation of population structure (for review see Jarne and Lagoda 1996).

Obtaining relevant population data (e.g. estimates of population size, genetic composition, mating system, dispersal patterns) on mammals, particularly carnivores, has proved difficult in the past due to the general elusive nature of many species.

Previously, population studies have relied on traditional monitoring methods such as radio-telemetry, spotlighting, mark/recapture, and sign-surveys. The advances of molecular ecology, in particular the use of non-invasive sampling methods, has allowed the possibility of long-term studies of wild animal populations without the need for trapping, or direct observation (Taberlet & Luikart 1999, Kohn & Wayne 1997). Both hair and faeces have been proven to yield adequate amounts of DNA to identify down to species, sex, and individual level (Kohn & Wayne 1997; Scott-Mills *et al.*, 2000). Non-invasive sampling has been used on species such as bears (Kohn *et al.*, 1995; Taberlet *et al.*, 1997; Wasser *et al.*, 1997; Paetkau *et al.*, 1998), seals (Reed *et al.*, 1997), dugongs (Tikel *et al.*, 1996), primates (Woodruff, 1993; Gerloff *et al.*, 1995; Frantzen *et al.*, 1998), mountain lions (Ernest *et al.* 2000), canids (Paxinos *et al.*, 1997; Kohn *et al.*, 1999) and otters (Dallas *et al.*, 2000).

Recently, DNA profiles derived from Otter spraints have been evaluated as an alternative method for individual Otter identification (Dallas and Piertney, 1998). In a subsequent more thorough investigation Dallas *et al.*, (2003), have demonstrated that genetic data from spraints yielded similar estimates of population genetic composition to that derived from carcasses. Thus, the authors suggested that spraints can produce unbiased estimates of population genetic composition.

The current investigation aimed to: 1- carry out a survey of the Otter population on Upper Lough Erne and its feeder streams in order to determine Otter distribution and abundance using -the occurrence of spraints along the Lough shore; 2- assess the usefulness of spraints to obtain DNA material for individual, family and population based studies in the Irish Otter.

2.1.2 Methods

2.1.2.1 Surveying the shores of Upper Lough Erne for Otters

A survey of the shore of Upper Lough Erne was carried out between May and October, 2001 by selecting a number of sites around the Lough shore. These sites were selected to include areas around river mouths and other locations likely to be used by Otters such as roads and bridges that run close to the shore. A boat was used to access islands and isolated parts of the Lough.

At each site a 200m length of shore was surveyed for all signs of Otter activity including Otter runs, holts, spraints and tracks (Appendix 1). Notes were made on the position of the spraint on the shore and the substrate on which it was

found. The physical nature of each length of shore was also assessed. Features of interest included dominant shore substrate, length of shore, predominant adjacent land use, evidence of disturbance (on a scale of 0 to 5, where 5 is highly disturbed) and shore tree cover. A copy of the survey sheet used is illustrated in Appendix 2a.

2.1.2.2 Surveying the feeder rivers of Upper Lough Erne for Otters

Between May and October, 2001 a number of sites were surveyed at bridges on the major rivers flowing into Upper Lough Erne. At each site a 600m length of river was surveyed along one bank (300m upstream and downstream from the bridge). Each 600m stretch of river was examined for Otter signs. As in the survey of the Lough shore this included the presence of Otter runs, slides, holts, tracks and spraints. All spraints found were collected, labelled and returned to the lab for analysis. A note was made of the position of the spraint and the substrate on which it was found.

Physical features were noted along each section of river. These included, channel width and depth, adjacent land use, predominant flow type, channel substrate, % exposed boulder, bank height, apparent disturbance (on a scale of 0 to 5, where 5 is highly disturbed), bankside tree cover and the presence of any riparian engineering works. This follows the standard methodology used during the Otter survey of England (1991-1994) (Vincent Wildlife Trust). A copy of the survey sheet used is illustrated in Appendix 2b.

2.1.2.3 Spraint Analysis

Otter spraints were collected in the field while carrying out surveys for otter signs. During field work, each individual spraint was collected, placed in a previously coded zip-lock bag, sealed, and placed in a cool box with ice. On return to the laboratory the bags were stored at minus 70°C until required for analysis. From this frozen collection, 29 spraints were selected for DNA extraction which was carried out using the Qiagen Stool Extraction Kit following manufacturer's recommendations. These spraints were chosen on the basis of approximate 'age' (i.e. fresh condition), ability to remove an area for extraction, and spraint content. Following extraction, DNA was spun down for 10 minutes and placed in an incubator at 37°C to concentrate the DNA. Samples were subsequently resuspended to 25µl in double-distilled water and 1µl of each extraction were run out on 0.8% 0.5XTBE agarose gels in order to check for DNA quality and concentration. DNA extracted from blood

tissue from a number of Otters specimens, kindly provided by Dr Dallas (University of Aberdeen), were used as positive controls.

Microsatellite testing was carried out using three microsatellite primer sets developed specifically for the Eurasian otter (*Lutra lutra*) (Dallas & Piertney 1998, Table 1). PCR reactions were carried out in 12µl reaction volume comprised of 1X Promega Taq polymerase buffer, 1.5 mM MgCl₂, 100µM dNTP, 10 pM of each microsatellite primer, 2µl extracted DNA, and 0.5 U of Promega Taq DNA polymerase. PCR cycling conditions consisted of one cycle at 94°C for 3 min followed by 30 cycles of 94°C for 1min, optimum annealing temperature (Table 1) for 1 min, and 72°C for 1 min. The Otter DNA samples provided by Dr. Dallas (above) were used as positive controls for PCR amplification. Resulting PCR products were visualised on an Ethidium Bromide stained 2.5% 1X TBE agarose gels.

Table 1. Details of microsatellite primer sets used in the present study.

Microsatellite	Primer sequence	Repeats	Tm (°C)
Lut 717-F	5'-TGTTGCCTTCAGAGTCCTGTG-3'	(GATA) ₁₂	60
Lut 717-R	5'-GTCAGGCATTGTAACATATTCTCAG-3'		60
Lut 818-F	5'-AAGGATGTGAAACAGCATTG-3'	(GATA) ₁₁	53
Lut 818-R	5'-CCATTTTATACACATAAATCGGAT-3'		54
Lut 833-F	5'-CAAATATCCTTTGGACAGTCAG-3'	(GATA) ₁₅	57
Lut 833-R	5'-GAAGTTATCTAATTTGGCAGTGG-3'		57

2.1.3 Results

2.1.3.1 Otter Distribution on Upper Lough Erne and Feeder Streams

A total of 86 sites were surveyed around the Lough shore and islands of Upper Lough Erne (Figure 2). In addition, 31 sites were surveyed on rivers feeding into Upper Lough Erne. These rivers were the Colebrooke, Finn / Lackey, Swanlinbar and Woodford. Otters were widely distributed throughout Upper Lough Erne and its islands (Figures 3a & 3b). Otters were found to occur at **70.9%** of sites surveyed around the Lough shore. In addition, signs of current Otter activity were recorded at **70.9%** of sites surveyed on the rivers feeding into Upper Lough Erne (Table 2).

Table 2. Percentage Occurrence of Otters on Upper Lough Erne and its feeder streams.

Location	No. of Sites Otters Absent	No. of Sites Otters Present	Total No. of Sites	Overall % occurrence
Colebrooke	6	14	20	
Finn/Lackey	1	5	6	
Swanlinbar	0	1	1	
Woodford	2	2	4	
Total Rivers	9	22	31	71%
Upper Lough Erne	25	61	86	71%

The shore along the majority of Upper Lough Erne and its islands is fairly uniform in character. For the most part, it consists of a border of approximately 25m in width along the shore dominated by short grass and boulders. This area is often grazed by livestock. Behind this there is usually a tall thick hedgerow composed of a mixture of Hawthorn, Blackthorn and mature tree species such as Ash.

Otter spraints were regularly found on prominent sites along the Lough shore. Spraint sites were often located on a small promontory of land, at a field boundary, on an overhanging tree branch or on a large boulder. Interestingly, Badger latrines and Pine Marten scats were also frequently found at these sites, perhaps indicating the occurrence of territorial cues for a variety of mammals.

Otter spraints on Upper Lough Erne were frequently impossible to collect as they consisted of black, tarry liquid or anal jelly with very few fish bones. This also hampered collection of sufficient spraint material for DNA analysis. One possible explanation for the runny nature of the spraints is the potentially rich diet Otters enjoy on Upper Lough Erne. A constant diet of large, fleshy fish would lead to few bones and little solid structure to Otter spraints. Alternatively, given the large area of Upper Lough Erne and the high percentage occurrence of Otters evidenced by the current investigation, it is possible that Otters spraint more frequently than would be expected in riverine habitats.

Spraint sites were dominated by a covering of the green algae *Prasiola* spp. that thrives in the nitrate-enriched environment (Photo 4). Identification of this algae was carried out in conjunction with Dr Fabio Rindi, a phycologist based in University

College Galway. A number of different species of *Prasiola* have been identified from spraint sites. *Prasiola* are typically reported as very nitrophilous organisms, often occurring in sites covered by animal faeces. However, the evidence for this is essentially observational and there have only been a few studies to date of this type of association in the field for nesting sites of penguins or other sea birds. This is the first time that the algae has been positively associated with Otters or any other wild mammal.

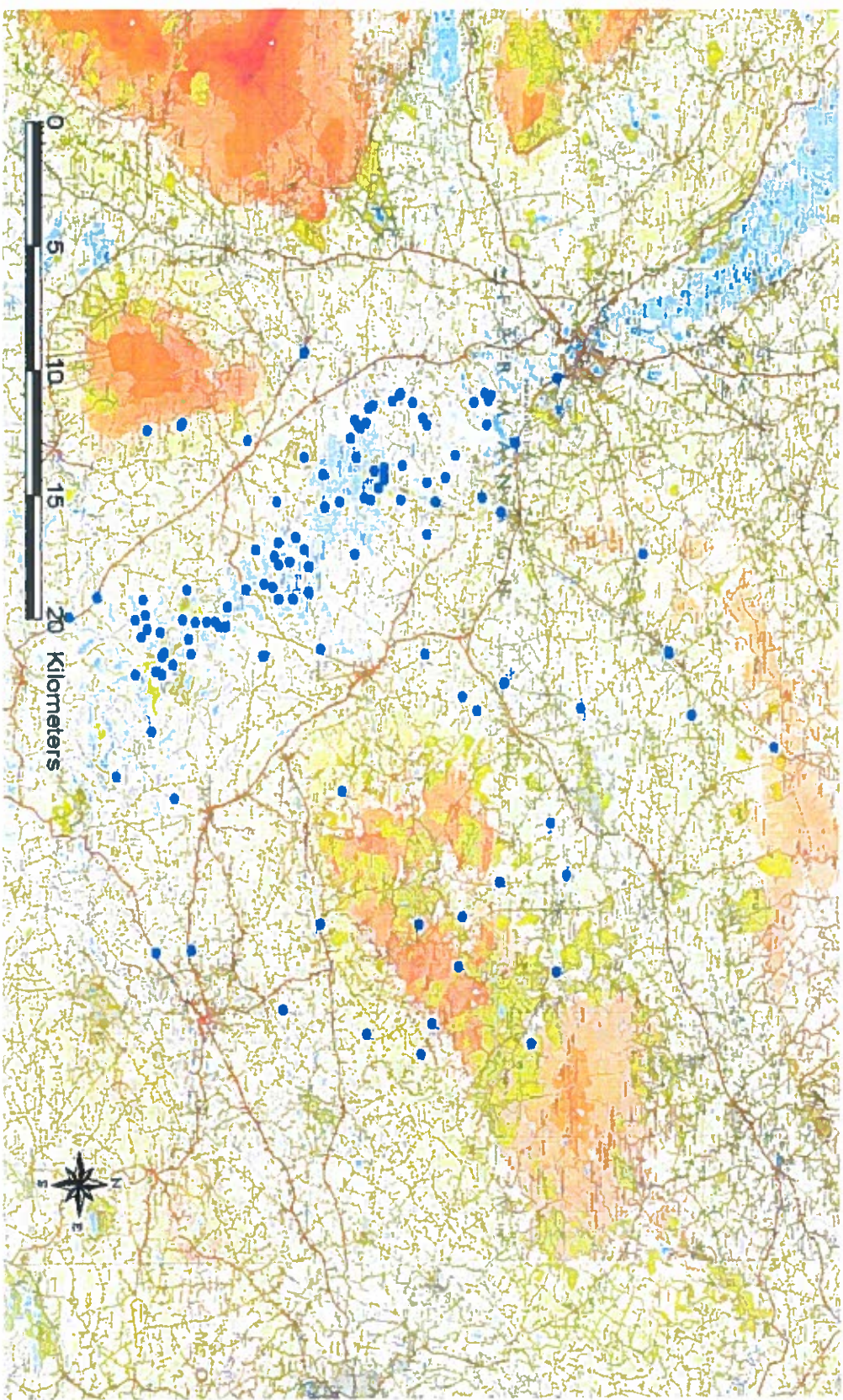


Figure 2. Distribution of sites surveyed for signs of Otter activity on Upper Lough Erne and its feeder rivers.

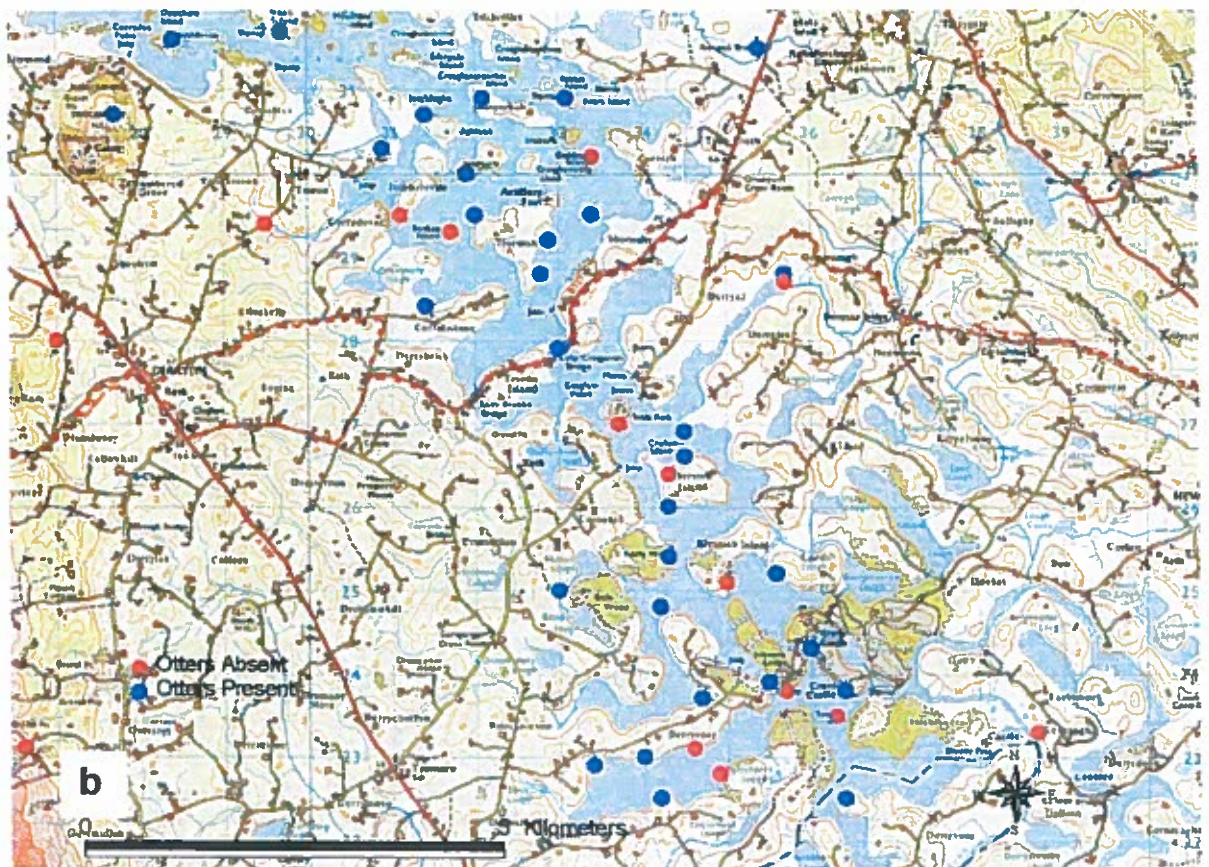


Figure 3a & 3b. Distribution of sites surveyed for the evidence of Otter activity in the northern half and southern half of Upper Lough Erne respectively.

2.1.3.2 Genetic Analysis of Otter Spraints

Despite careful choice of spraints for genetic analysis based on individual spraint age/condition, the resulting DNA from all 29 spraints were found to be extremely degraded and thus unsuitable for genetic screening. Spraint age/condition is reported to have considerable effect both on DNA quality and yield (Dallas, pers. com.). To test for this problem, a feasibility experiment for DNA extraction was carried (four replicates) from a spraint known to be less than 24 hours 'old' in comparison to the 29 samples collected during the field survey. The result to this test (illustrated in Figure 4) suggests that even very fresh spraints (<24h) are already showing signs of degradation. Thus, the usefulness of spraint material would appear to be limited. Considering what has been found in similar investigations, however, these results are not entirely unexpected. For instance, although Dallas *et al.* (2003) have clearly demonstrated the usefulness of spraints for population genetic studies of Otters, they have also emphasised the quite low success rate for actual individual extraction. Indeed, from a total of 426 spraints examined, the authors were only able to obtain suitable DNA material from 85 (i.e. only a 20% success rate). Thus, although potentially useful, a much larger sample size (i.e. number of spraints) than that used in the present study (N = 29) will be required in order to obtain meaningful population data.

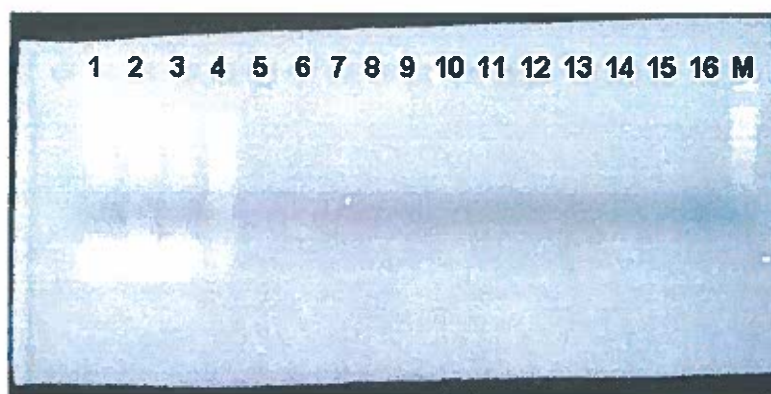


Figure 4. Image of an Ethidium Bromide stained agarose gel illustrating the poor quality of DNA (i.e. smeared DNA in lanes 1 to 4 – four replicates) extracted from a very fresh spraint (<24h) and the almost complete degradation of DNA (i.e. only very faint smeared DNA visible in some lanes) from the remaining 12 spraints (i.e. from the original 29 chosen spraints). Despite several attempts, it was not feasible to obtain enough good quality DNA for subsequent genetic screening. 'M' stands for the molecular size marker.

Since the results of the spraints material were less than satisfactory, we have decided to explore potential alternative source for DNA material. As part of parallel projects currently being carried out within our research group, a protocol for DNA extraction suitable for genetic analyses from hair follicle from mammal species (e.g. Irish hare) has been successfully implemented. Using this protocol, attempts were made to extract DNA from Otter hair follicles from one individual found dead (road kill) during the field survey. The result of this preliminary test (illustrated in Figure 5) is extremely positive as clearly evidenced by the PCR amplification of DNA fragments of expected size. Thus, it is possible that hair follicles will provide an alternative reliable source for DNA for future essential genetic work in the Irish Otter.

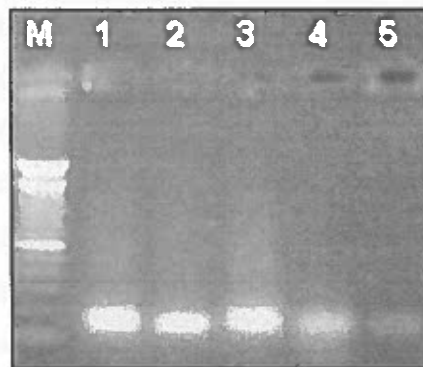


Figure 5. Image of an Ethidium Bromide stained agarose gel illustrating PCR products for one Otter microsatellite (SSOOSL311) tested during this study. In this particular case, DNA from blood from three Otter control individuals (1 – 3), and from muscle tissue (4) and hair follicles (5) from the road killed are displayed. Notice the PCR product of expected size amplified across all specimens/tissues screened. 'M' – Marker size lane (100 base pair ladder).

One of the major difficulties associated with the use of microsatellite DNA marker is related with the often need to develop species specific markers. The developmental procedure can be expensive and time consuming, and as such it has somewhat slowed the application of these useful and powerful genetic markers. This is not the situation for the Eurasian Otter for which a large number of microsatellite markers are readily available (Dallas and Piertney, 1998). The benefits of employing microsatellite DNA profiling for the investigation of Otter population genetic structure and dynamics have been well illustrated in a number of studies. For instance, Dallas *et al.* (1999) have examined the relationship between genetic diversity and geographical

fragmentation/isolation in Scottish Otter populations. They have found that isolated populations exhibited a reduced level of genetic diversity while fragmented populations contained levels of genetic similar to the high levels observed in large continuous populations. In the latter case, the authors suggested that gene flow appear to be the main factor maintaining microsatellite diversity among populations.

More recently, Blundell *et al.* (2002) investigated potential patterns of sex-biased dispersal and gene flow in coastal river Otters (*Lontra canadensis*) using microsatellites developed for the Eurasian Otters (Dallas and Piertney 1998). They found that gender differences in sociality and spatial relationships resulted in distinct dispersal distances. Males were found to exhibit much greater gene flow among close populations mostly due to breeding dispersal. Both sexes, however, showed a low probability of natal dispersal. The authors suggest that natural recolonisation of coastal river Otters following local extinction could be a slow process because of low dispersal among females. They also recommend that because of significant isolation by distance for male otters and reduce gene flow for females, translocations should be undertaken with caution to help to maintain genetic diversity in this particular species.

These studies clearly confirm both the usefulness and potential of microsatellite DNA markers. Little is still known on many aspects of the Eurasian Otter population structure and dynamics. Thus, it is clear that such markers will prove invaluable to obtain fundamental information required for any conservation/management of this important species in Ireland. The problems encountered in the present investigation, could be easily overcome by means of a well planned sampling scheme involving trapping (similar to that currently carried out for badgers) to obtain reliable tissue for DNA extraction (e.g. blood, hair follicles). If appropriate non-destructive biopsy material is available, microsatellite genetic screening could be carried relatively quickly and efficiently.

2.1.3.3 Estimates of Abundance

Otter territories are linear (Fairley, 2001). However, the size of an Otter territory is strongly affected by food availability (Durbin, 1996). In addition, there may be intra-sexual spacing and males generally have larger ranges than females (Durbin, 1996). Females often have overlapping territories, while male territories rarely overlap (Fairley, 2001). Therefore, it is often difficult to determine the number of Otters inhabiting a

stretch of water. However, in studies of Otters in Shetland and in mainland Scotland, an average of one Otter was found for every 15km of stream with slightly less than one Otter per 1km of coast (Kruuk, 1995 quoted by Fairley, 2001).

In the absence of hard data on Otter numbers derived from genetic analysis of spraints, it is almost impossible to put any meaningful figure on the number of individuals inhabiting Upper Lough Erne. However, given that Upper Lough Erne has approximately 200km of shoreline bounded by the Special Protection Area (SPA) including islands, densities obtained from the Shetland / Scotland studies may be used to produce a very rough estimate of Otter numbers.

If we estimate that a single Otter may occupy a shore length of between 5km and 10km on Upper Lough Erne, we obtain an upper and lower population estimate of between 20 and 40 Otters under optimal conditions. When we apply a percentage occurrence of 70.9% to these figures we get a revised population estimate of between 14 and 28 Otters on Upper Lough Erne. However, this figure should be treated with extreme caution since we know nothing about the size of Otter territories on Upper Lough Erne and this estimate does not include feeder rivers and adjacent small lakes. Further, more detailed studies encompassing both genetic and ecological investigations are required to assess numbers of Otters using the Lough accurately.

2.2 Project B - Reassessing Otter distribution in Northern Ireland.

2.2.1 Background

A total of 329 sites were surveyed in Northern Ireland during the Otter survey of Ireland carried out in 1980-1981 (Chapman & Chapman, 1982). 258 sites were found to have signs of Otter activity, while 71 sites were classed as being 'negative' - giving an overall percentage occurrence of 78%. Two main areas in Northern Ireland were surveyed. These were the north-eastern region and the north-central region (Figure 6). However, large areas of Counties Antrim, Down, Fermanagh and Londonderry were missed as they fell outside the alternatively selected 50km squares (Figure 6).

The aim of the current investigation was to reassess the distribution of Otters in Northern Ireland by resurveying a large sample of the original survey sites. In addition, the investigation aimed to expand information on Otter distribution in Northern Ireland by extending the survey to areas previously missed in 1980-1981. This information would allow an update on the current Otter distribution, now 20 years old, help to

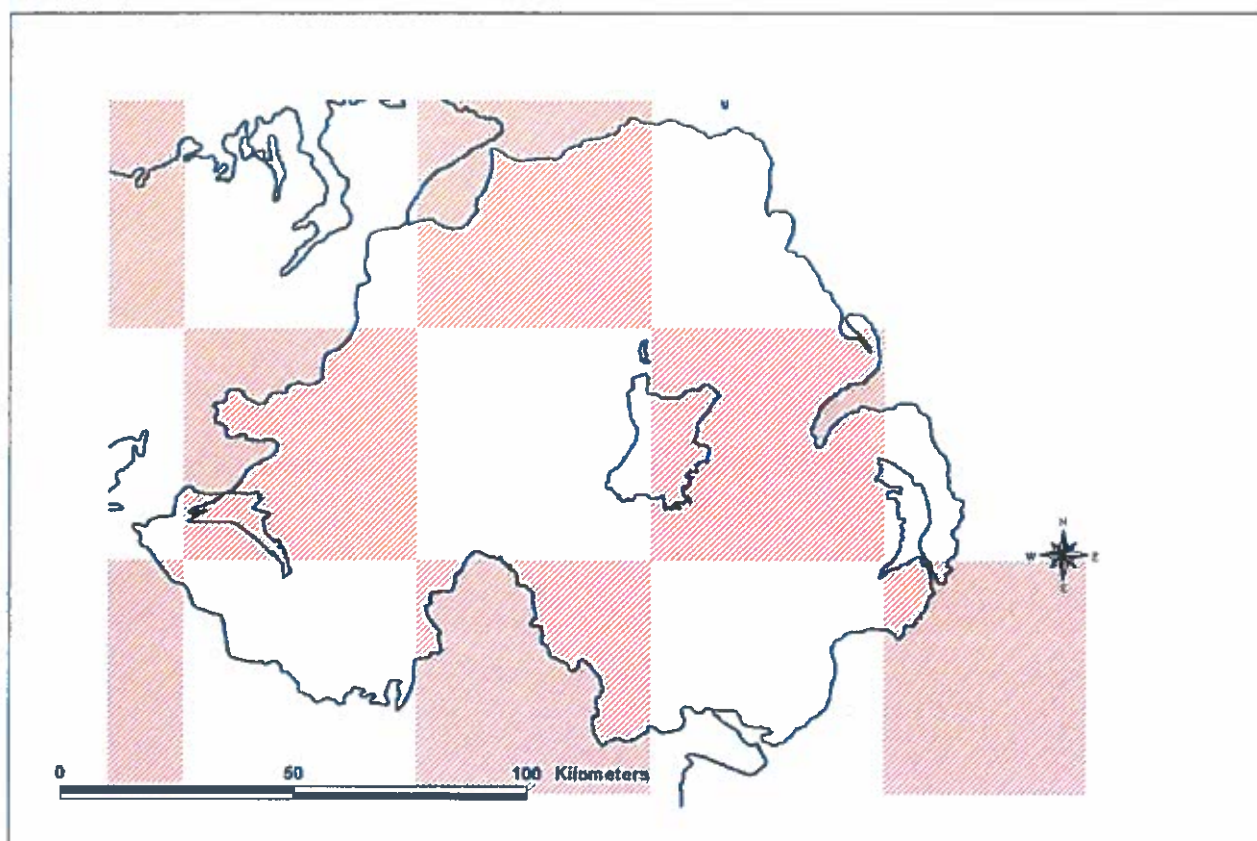


Figure 6. Alternate 50km squares (in white) surveyed in Northern Ireland by Chapman & Chapman (1982).

inform current Biodiversity Action Plans and assist in the conservation management of the Otter in Northern Ireland.

2.2.2 Methods

2.2.2.1 Resurvey

When the data from the original survey were analysed it was noted that some of the sites had been over-surveyed. This was either due to extended survey lengths, sites being revisited or different locations being surveyed during revisits. Therefore, a decision was made to exclude some sites from the analysis due to the inconsistencies in the original survey methodology. This makes the repeatability of the survey and subsequent comparisons of data difficult.

A sample of 131 of the 258 sites originally found to have signs of Otter activity were re-surveyed. In addition, a sample of 50 'negative' sites were also re-surveyed. Due both to an extremely wet summer and the restrictions imposed during an outbreak of Foot and Mouth disease in 2001, the original survey period was extended into 2002. Survey methodology was identical to that used during the original survey. At each site a 600m length of river / shoreline was surveyed for all signs of Otter activity including Otter runs, holts, spraints and tracks. At each site, the search was terminated when signs of Otters were found. The occurrence of spraints and tracks was accepted as proof of Otter presence. Well-worn trackways, rolling spots, fish remains, reported sightings, etc., were noted on record sheets but not considered to provide satisfactory evidence of Otter presence (Chapman & Chapman, 1982). Habitat data and other site details were recorded on the standard survey sheet used by Chapman & Chapman (1982) (Appendix 2b). All spraints found were collected, labelled and frozen.

2.2.2.2 New Survey

It was estimated that a further 450 sites would need to be surveyed to complete the coverage of Northern Ireland. This figure was based on an average of 6 to 7 sites per 10km square. Sites were selected from as broad a geographical range and as representative a selection of Northern Ireland land classification groups (Cooper *et al.*, 1996) as possible. A total of 441 new sites were surveyed for the occurrence of Otters between May and July, 2002.

2.2.3 Results

2.2.3.1 Resurvey - Reassessment of Otter Occurrence at sites previously surveyed in 1980-1981.

Results from the resurvey suggest an overall decline of 9.9% in Otter occurrence since the original survey in 1980-1981 (Figure 7, Table 3). This decline is statistically significant ($\text{Chi}^2=4.07$, $p<0.05$, $d.f=1$).

When the data were analysed with respect to broad habitats (Figure 8, Table 4a) and the Northern Ireland Land Classification groups (Figure 9, Table 4b) where the original survey results represent a baseline of 100% occurrence (Cooper *et al.*, 1997), it was apparent that the decline in Otter abundance has occurred throughout the habitat range. The decline was slightly greater along the sea-coast and estuaries (Figure 8, Table 4a) but in general follows a downward trend from upland to lowland. The greatest percentage decline has occurred in high uplands and mountains, with drumlin farmland and lakelands and marginal uplands showing the least change in Otter occurrence since 1980-1981 (Figure 9, Table 4b).

Similarly, there has been a general decline in Otter occurrence throughout the range of catchments in Northern Ireland (Figure 10 & 11). However, the greatest decline has occurred in rivers in the Mourne and South Armagh with the least decline in the Foyle and Roe systems and in the Lagan, Belfast Lough and East Down catchment (Figure 11, Table 5).

Table 3. Number of resurveyed sites with +ve and without -ve signs of current Otter activity showing the percentage change from 1980-1981 to 2001-2002.

	n	+ve	-ve	% Occurrence
Number of sites 1980/1981	181	131	50	72.4%
Number of sites 2001/2002	181	113	68	62.5%
% Decline				9.9%

Table 4a. The number of resurveyed positive sites with signs of current Otter activity in 2002 within broad habitat types.

	n	No. Positive Sites 1980-1981	No. Sites Positive 2002	% Occurrence Otters 2002	% Change Since 1980-1981
Running Water / Canal	142	108	92	64.8%	-11.3
Sea Coast / Estuary	23	10	9	39.1%	-4.3
Lake / Tarn / Reservoir	16	13	12	75.0%	-6.3

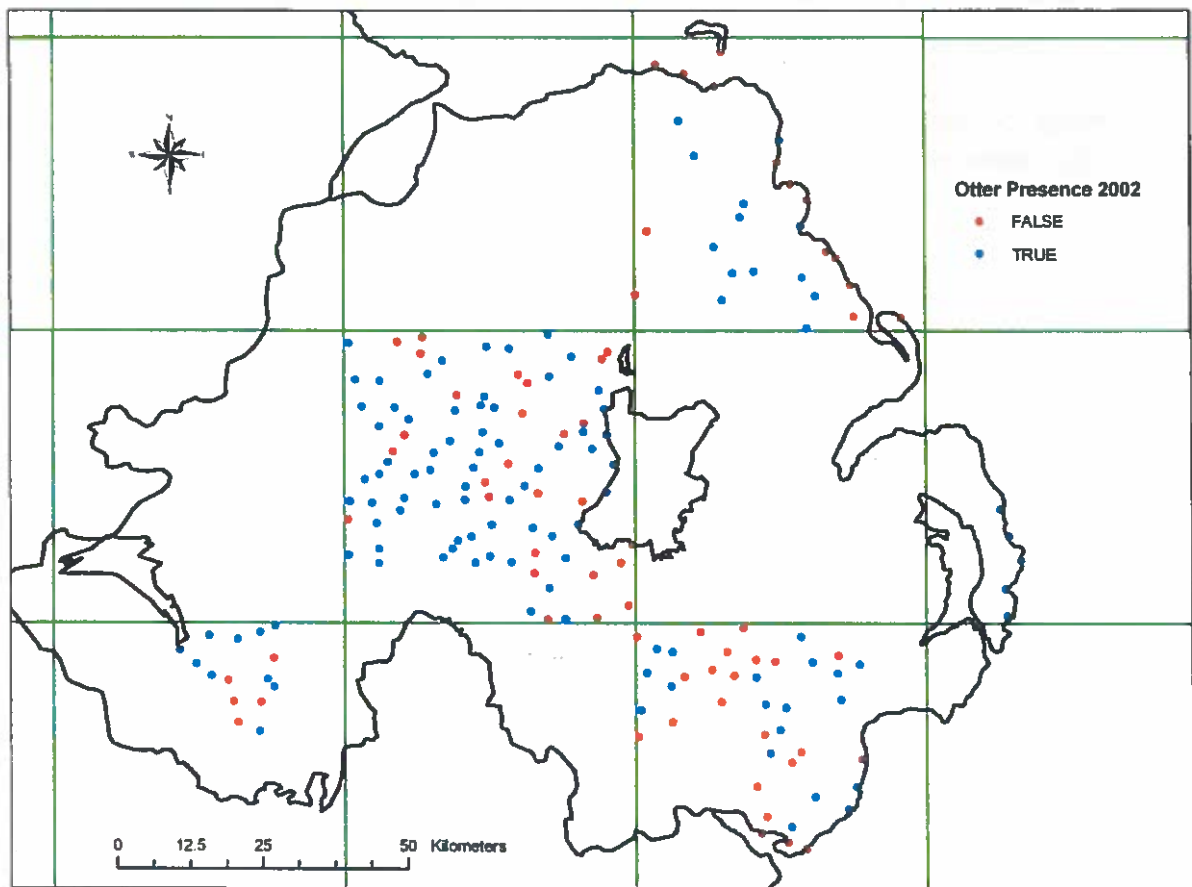


Figure 7. Distribution of resurveyed positive sites showing the current status of Otter occurrence.

Table 4b. The number of resurveyed positive sites with signs of current Otter activity in 2002 within broad land class groupings (Cooper *et al.*, 1997).

	n	No. Positive Sites 1980-1981	No. Sites Positive 2002	% Occurrence Otters 2002	% Change Since 1980-1981
Drumlin Farmland & Lakelands	39	28	26	66.7	-5.1
Marginal Lowland	34	28	24	70.6	-11.8
Central Lowlands	27	19	16	59.3	-11.1
Marginal Uplands	25	12	11	44.0	-4.0
Settled Uplands	36	31	26	72.2	-13.9
High Uplands & Mountains	20	13	10	50.0	-15.0

Table 5. The number of resurveyed positive sites with signs of current Otter activity in 2002 within each catchment .

	n	No. Positive Sites 1980-1981	No. Sites Still Positive 2002	% Occurrence Otters 2002	% Change Since 1980-1981
Erne	15	12	10	66.7	-13.3
Foyle & Roe	29	26	25	86.2	-3.4
Lagan, Belfast Lough & East Down	14	10	10	71.4	0.0
Lough Neagh	89	65	56	62.9	-10.1
Mourne & South Armagh	15	8	5	33.3	-20.0
NE Antrim Coast & Glens Rivers	19	10	7	36.8	-15.8

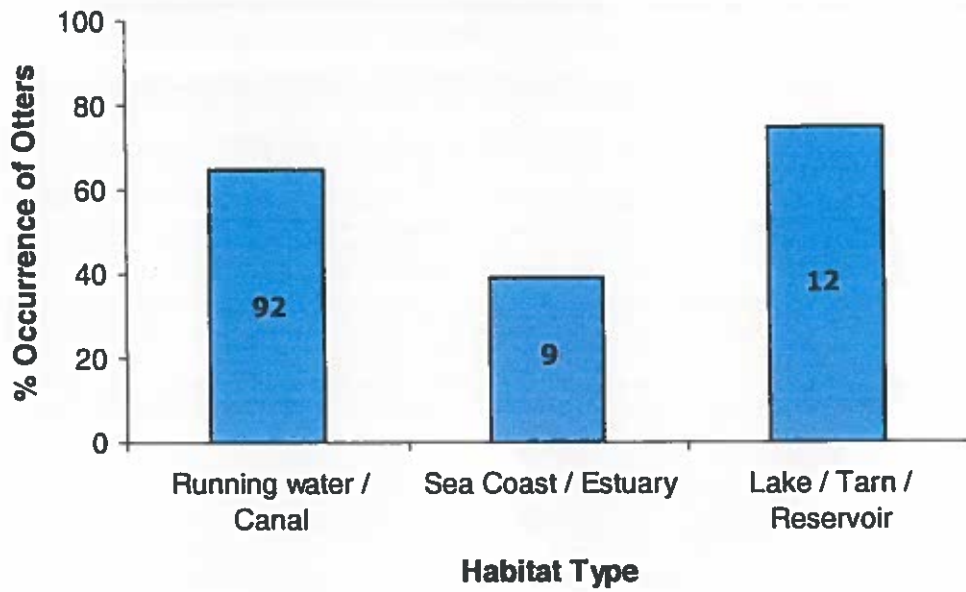


Figure 8. The percentage occurrence of Otters within broad habitat types at re-surveyed positive sites.

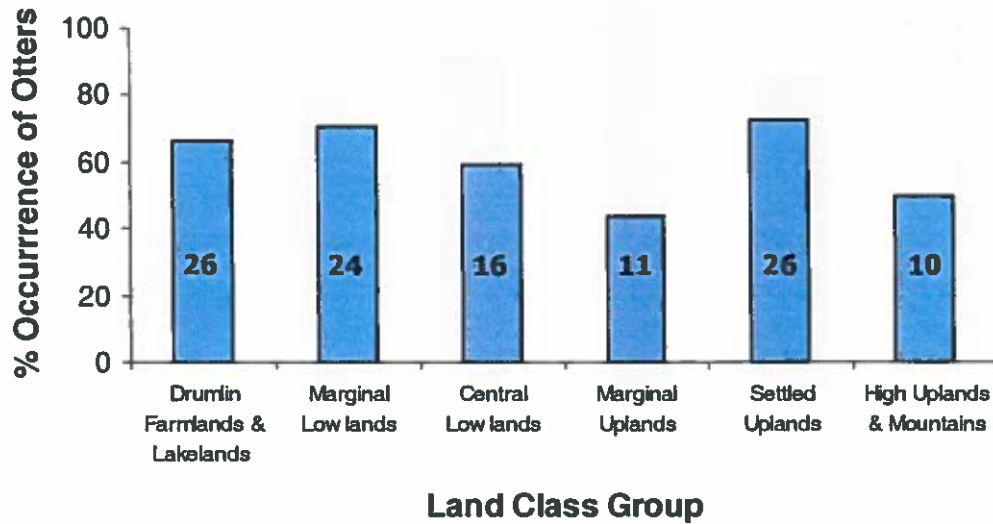


Figure 9. Percentage occurrence of Otters within different land class groups at re-surveyed positive sites.

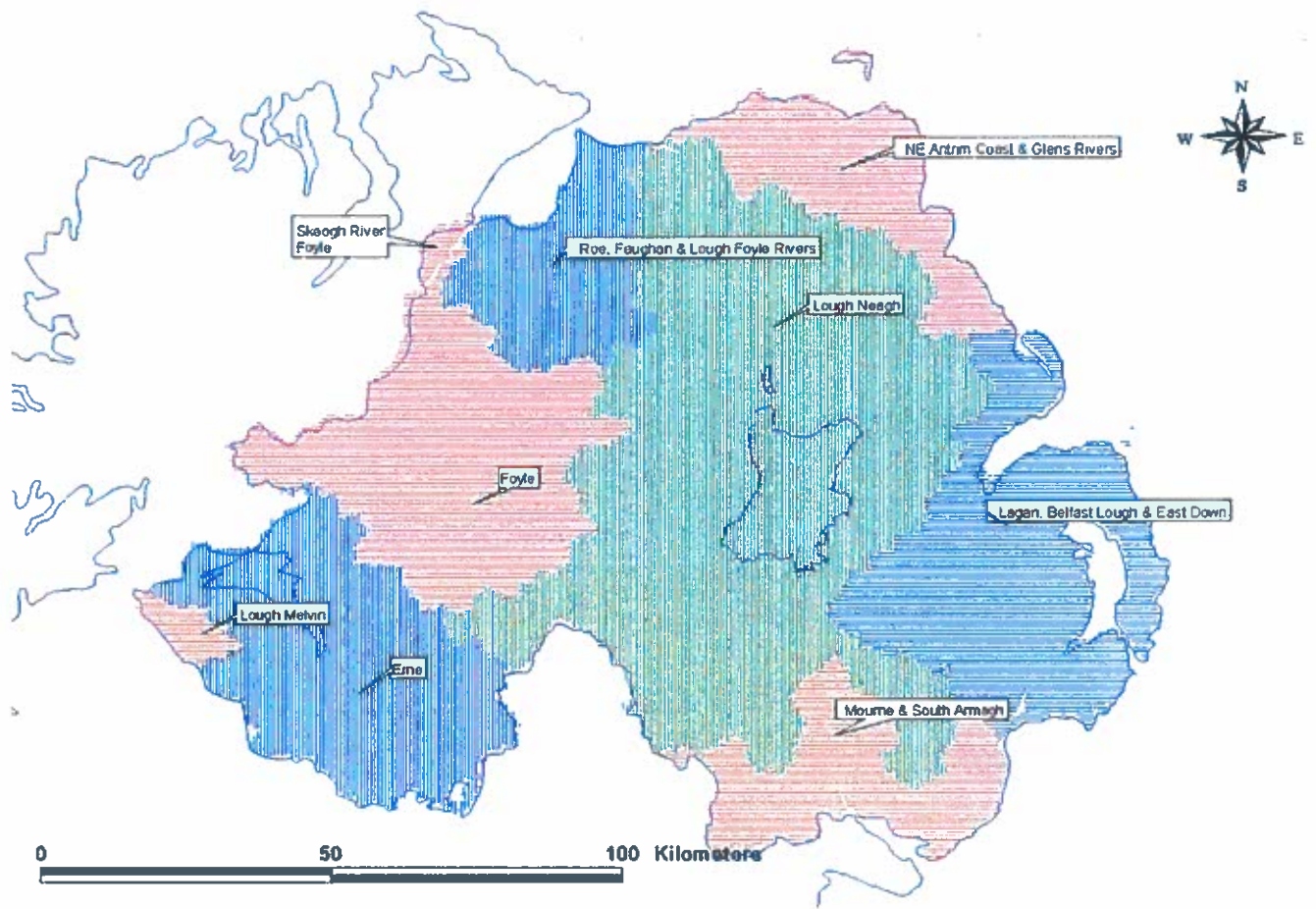


Figure 10. Map of Northern Ireland showing the distribution of river catchments.

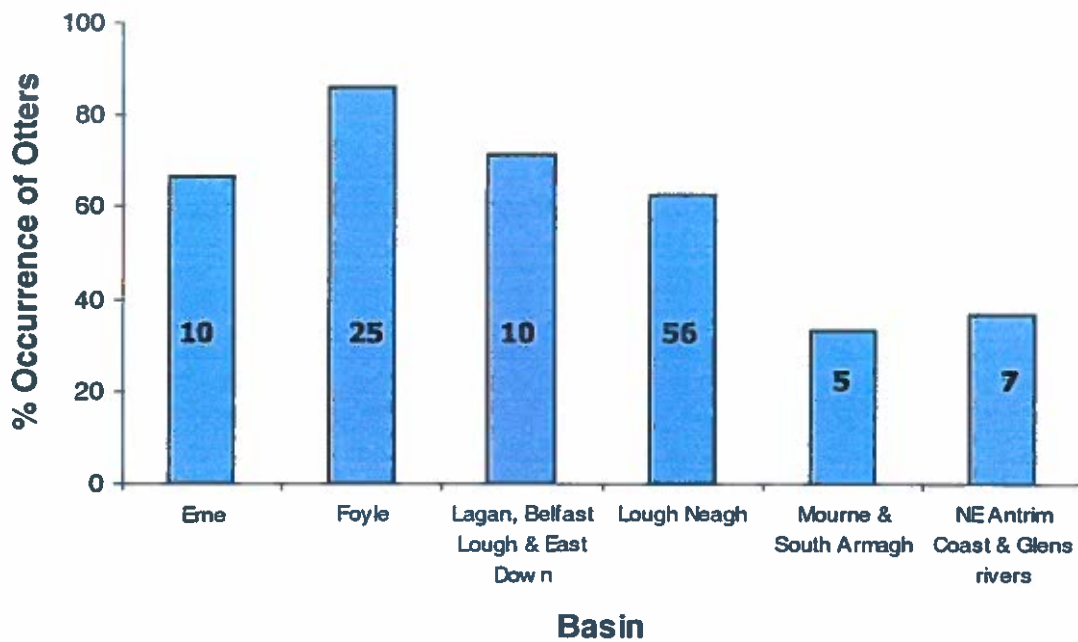


Figure 11. Percentage occurrence of Otters within different river catchments at re-surveyed positive sites.

2.2.3.2 New Survey - Assessment of Otter Occurrence at previously unsurveyed sites throughout Northern Ireland.

A total of 441 sites were surveyed in addition to those covered by Chapman & Chapman (1982). These sites were widely distributed throughout Northern Ireland but concentrated in those areas not covered during the original survey (Figure 12). Positive signs of Otter activity were found at 65% of sites surveyed (Figure 12). When these data were analysed with respect to broad habitat types, the highest percentage occurrence of Otters was found around lakes (Figure 13, Table 6a) while sites along the sea coast and estuaries were found to have the lowest percentage occurrence of Otters (Figure 13, Table 6a). Similar results were obtained when the data were analysed with respect to the Northern Ireland land classification groups (Figure 14, Table 6b) (Cooper *et al.*, 1997). Lakelands have the highest percentage occurrence of Otters (Figure 14, Table 6b) while sites surveyed in mountainous areas have the lowest percentage occurrence of Otters in Northern Ireland (Figure 14, Table 6b). The percentage occurrence of Otters varied considerably with respect to catchment. With the exception of the Lough Melvin catchment, the rivers associated with Lough Foyle had the highest percentage occurrence of Otters. The lowest percentage occurrence was found along the north east coast and Glens of Antrim rivers (Figure 15, Table 7).

Otter occurrence also varied with respect to river width (Figure 16). The highest percentage occurrence of Otters was found in larger rivers with a significantly lower incidence Otters in streams less than 2m wide (Figure 16).

Table 6a. The number of new sites found to have signs of current Otter activity within broad habitat types in 2002.

	Otters Present	Otters Absent	% Occurrence Otters
Running Water / Canal	240	132	65%
Sea Coast / Estuary	7	12	37%
Lake / Tarn / Reservoir	40	10	80%

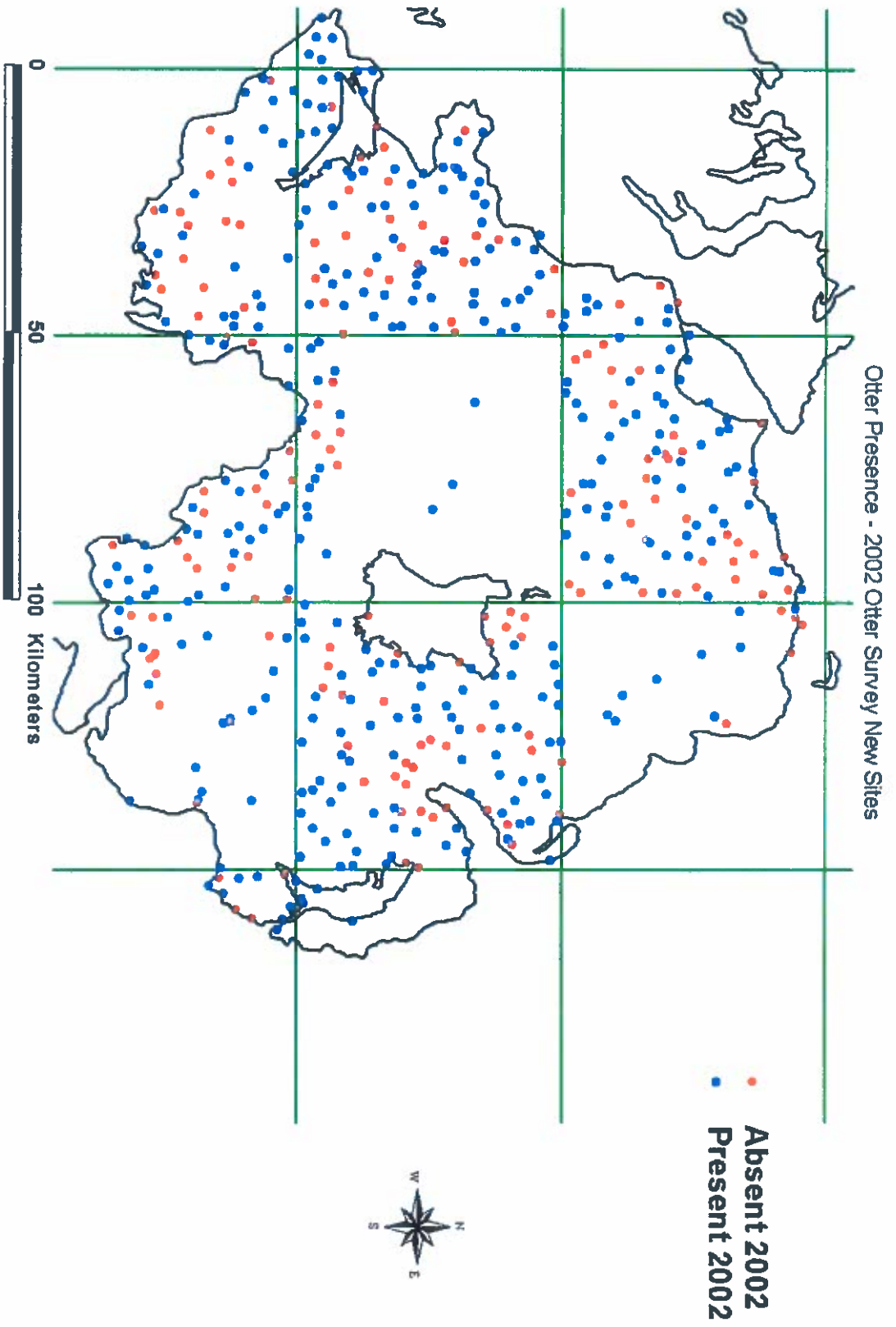


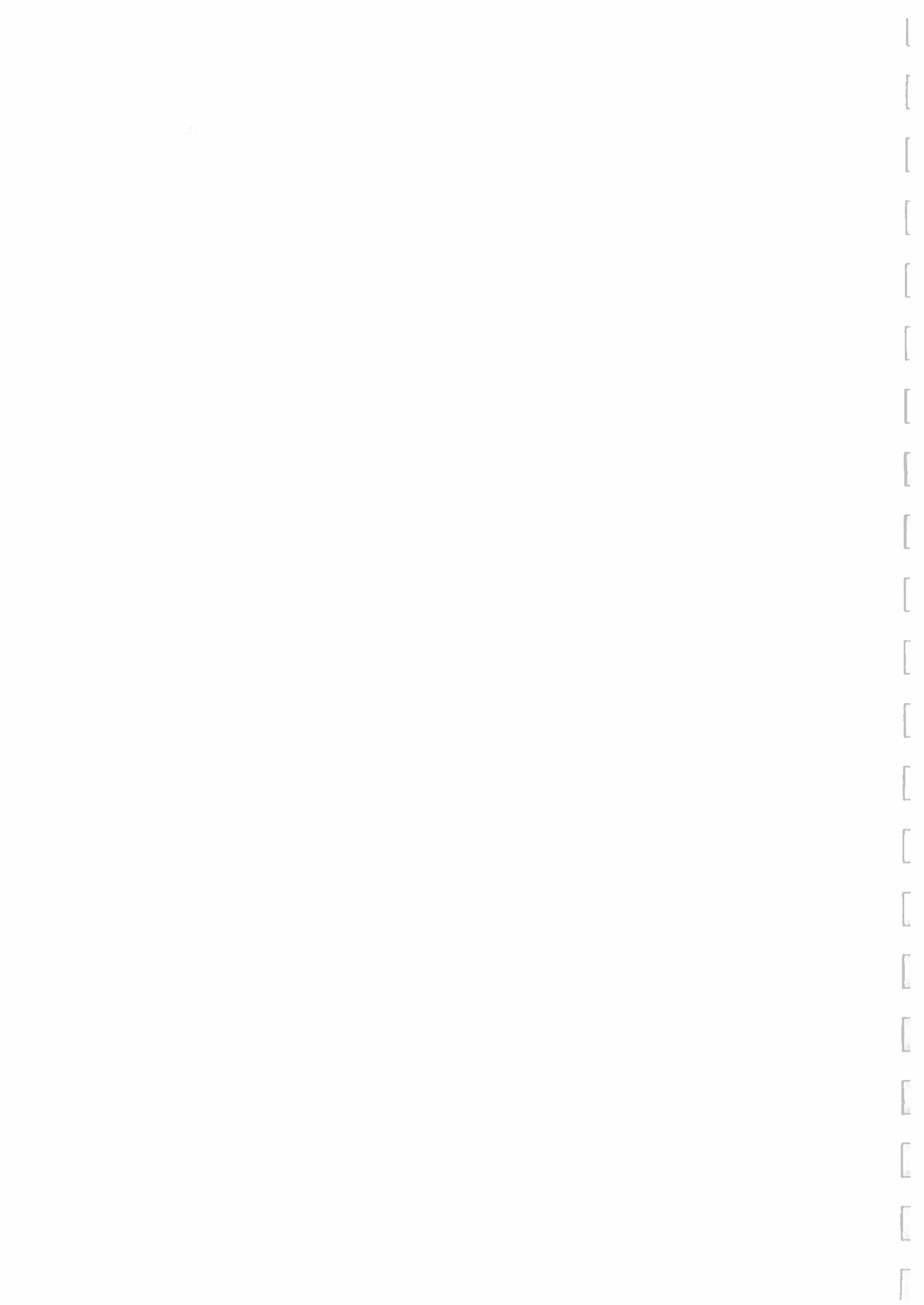
Figure 12. Distribution of additional sites surveyed in 2002 only for signs of Otter activity throughout Northern Ireland.

Table 6b. The number of new sites found to have signs of current Otter activity within each land class grouping (Cooper *et al.*, 1997) in 2002.

	Otters Present	Otters Absent	% Occurrence Otters
Drumlin Farmland	51	26	66
Lakelands	23	8	74
Marginal Lowland	33	13	72
Central Lowlands	41	26	61
Marginal Uplands	64	32	67
Settled Uplands	28	22	56
High Uplands	43	20	68
Mountains	4	7	36
Total	287	154	65%

Table 7. The number of new sites found to have signs of current Otter activity within each catchment in 2002.

	Otters Present	Otters Absent	% Occurrence Otters
Erne	47	29	62
Foyle	49	17	74
Lagan, Belfast Lough & East Down	44	24	65
Lough Melvin	7	0	100
Lough Neagh	89	47	65
Mourne & South Armagh	15	10	60
NE Antrim Coast & Glens Rivers	4	10	29
Roe, Faughan & Lough Foyle Rivers	32	17	65
Total	287	154	65%



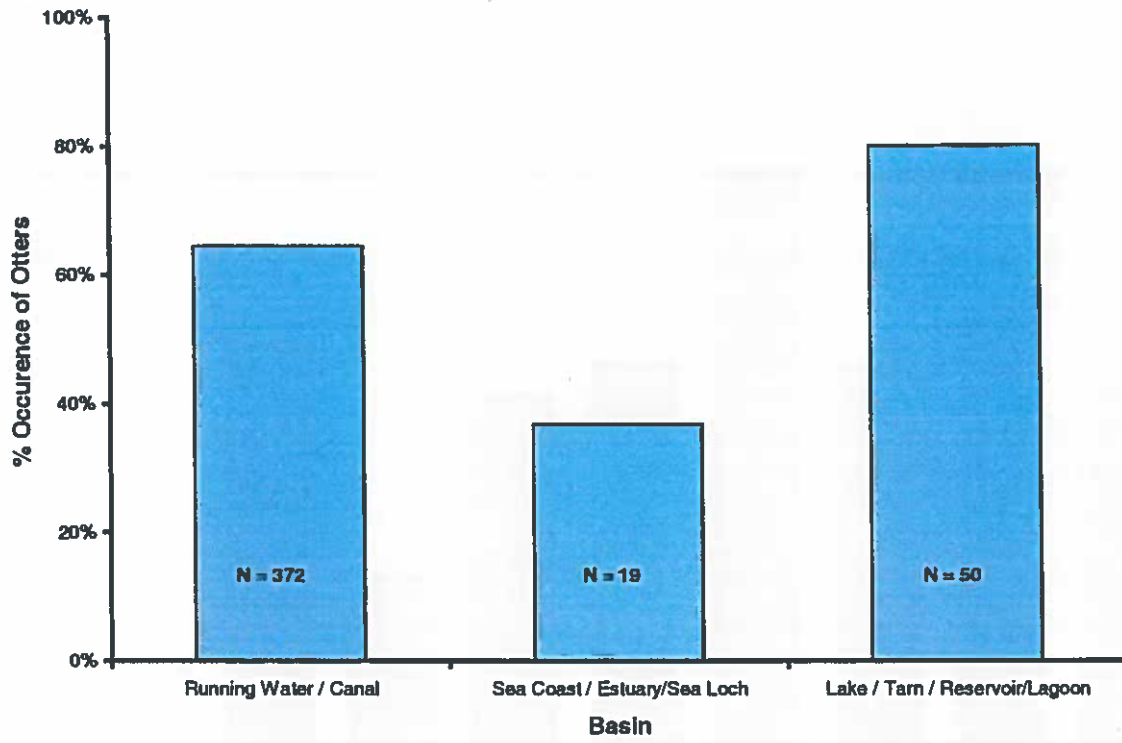


Figure 13. Percentage occurrence of Otters within broad habitat types at new survey sites.

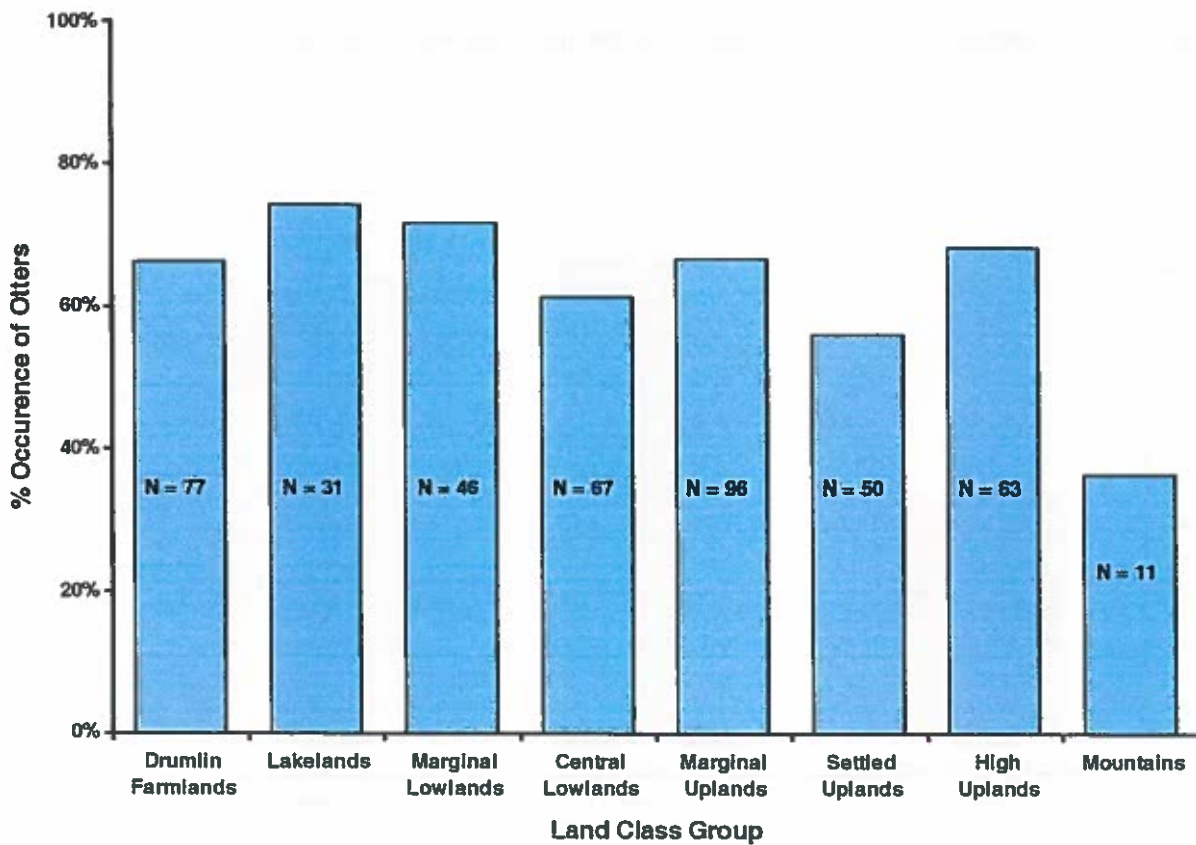


Figure 14. Percentage occurrence of Otters within different land class groups at new survey sites.

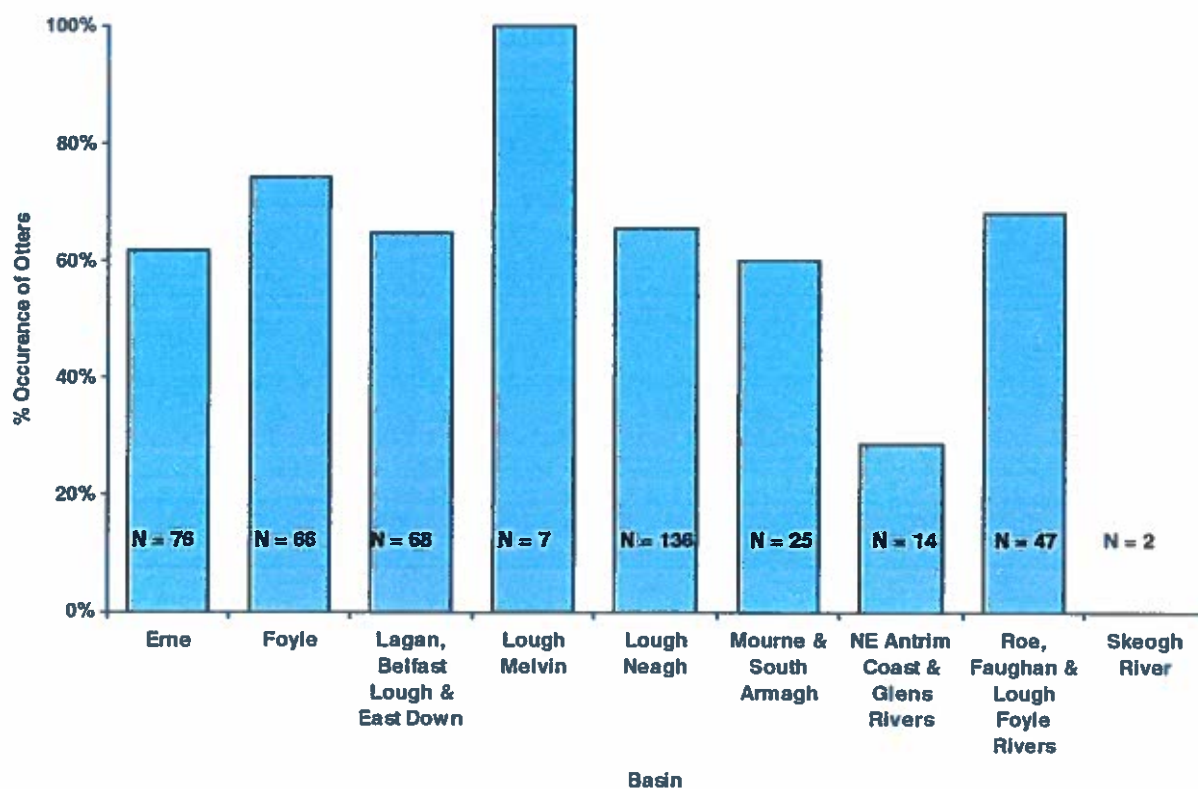


Figure 15. Percentage occurrence of Otters within different catchments at new survey sites.

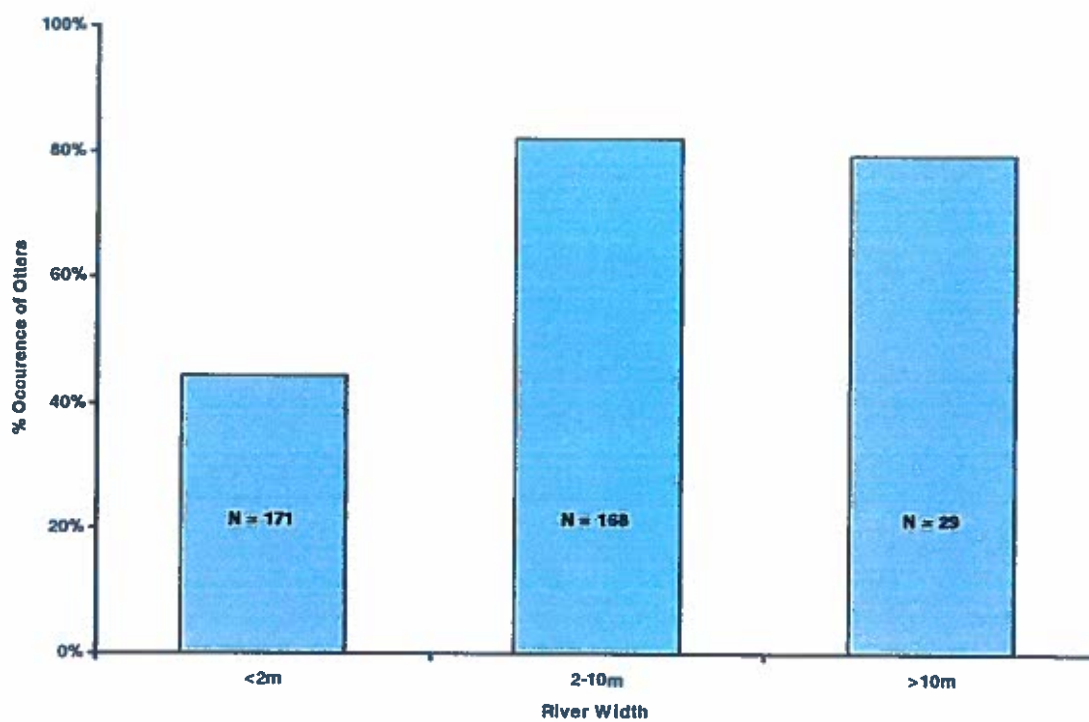


Figure 16. Percentage occurrence of Otters on rivers of differing widths at new survey sites.

2.2.3.3 Overall Results

A total of 742 sites were surveyed for the occurrence of Otter activity (Figure 17). This represents a comprehensive coverage of Northern Ireland and provides a baseline on which future monitoring programmes can be established. The complete dataset was analysed with respect to various environmental parameters. There was no significant relationship found between Otters occurrence and disturbance. In addition, there was no significant relationship between bankside cover and the occurrence of Otters.

The obvious presence of pollution at each site was assessed visually on the day of survey. Signs of obvious pollution included the presence of sewage fungus or visible effluent. 14% of sites surveyed in Northern Ireland were judged as being obviously polluted. There was a significant relationship between pollution and the occurrence of Otters. Otter occurrence was found to be higher at unpolluted (69%) as compared to polluted (57%) sites ($\text{Chi}^2 = 5.72$, d.f. = 1, $p < 0.01$) (Table 8).

Table 8. The percentage occurrence of Otters at polluted and non-polluted sites.

	No Pollution	Pollution
No Otters	197	44
Otters Present	442	59
% Occurrence	69	57

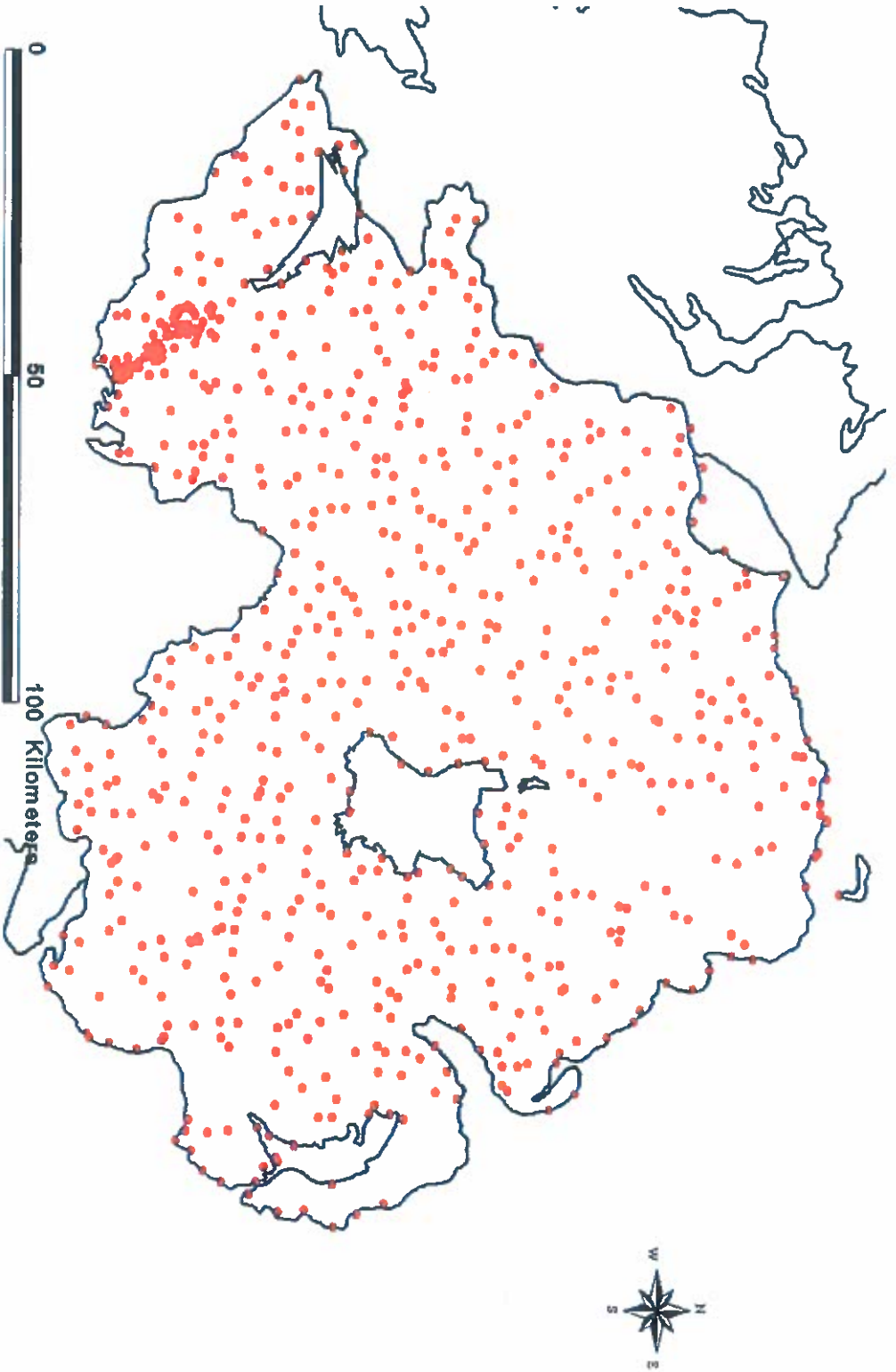


Figure 17. Distribution of all sites surveyed for positive signs of Otter activity throughout Northern Ireland 2001 - 2002.

2.2.4 Otter Diet

2.2.4.1 Background

Spraints Collected During the Distribution Survey

A total of 304 spraints were collected between 2001 and 2002 during the investigation into Otter distribution in Northern Ireland. Fresh spraints were placed individually in specimen tubes in the field. Each spraint was oven-dried at 60°C after collection, dried again for a further 48 hours before analysis to drive off possible moisture absorbed during storage and weighed to the nearest 0.01g. The hard parts were separated by overnight immersion in a solution of the denture cleaner Steradent, gently washed through a sieve of 0.5mm mesh and dried on paper at room temperature. Hard parts were identified under a binocular microscope ($\times 8 - \times 40$) against a reference collection of fish bones and using the key of Conroy *et al.* (1993).

Each spraint was crumbled and food categories present were determined using the methods described by Ward *et al.* (1986). The approximate percentage of the hard parts was judged subjectively by eye. For those sites in which more than one spraint was collected, the data were pooled in proportion to the weight in each spraint, so as to give equal bias to all sites.

Data from a group of samples, recorded as presence or absence of food categories, are most readily expressed in two ways: as percentage occurrence i.e. the number of samples n in which a category c occurred - n_c - divided by the total number of samples examined $\times 100$; or as percentage frequency: n_c divided by $\sum n_c$ for all categories $\times 100$.

Percentage occurrence follows a binomial distribution and is independent of other categories. It can be used to compare occurrence in different sub-groups of samples. However, percentage frequencies are better at illustrating Otter diet as a whole since percentage occurrences do not sum to 100%. Percentage frequency has been shown to give a reasonably true picture of Otter ingesta (Erlinge, 1968).

Variation in Otter Diet: Long-term change

A total of 83 spraints collected during the original 1980's Otter survey were obtained from the Vincent Wildlife Trust. Only a sub-sample of spraints had been collected during this survey and these had been preserved as described above and retained in glass specimen tubes. Details of the location of the sample sites and date of survey had been recorded for each spraint. In order to compare Otter diet over the 20-year period each of the 83 sites was revisited at the same time of year between July and September 2003 and a fresh spraint collected if present. These spraints were also labelled and preserved as described above.

2.2.4.2 Results

Spraints Collected During the Distribution Survey

A total of 304 spraints from the 2001/2002 survey were examined. A total of 284 spraints contained identifiable material. Given the difficulties in the identification of hard parts from Otter spraints collected from the coast, all spraints collected <3km from the coast were omitted from the analysis. This left a total of 212 valid spraint samples. There was a total of 25 spraints containing 'other'. These were composed of insect (2 Family *Dytiscidae*, 1 *Dytiscus* identified to genus, 1 dragonfly larva (Odonata), 1 stonefly larva (Plecoptera), 1 terrestrial beetle); bird (3 rail Family *Ralliformes*, 2 duck/goose Family *Anseriformes*, 7 unidentified); mammal (4 lagomorph, 1 rat, 4 unidentified). In 8 samples *Cyprinidae* were identified from pharyngeal teeth. These were found to consist of 2 roach and 6 minnow.

The percentage frequency of prey categories at all sites is presented in Table 9 and Figure 20. Pooled data indicate that over 50% of analysed Otter spraint is composed of 3 prey items – sticklebacks, salmonids and cyprinids (Table 9, Figure 20). However, stickleback constitutes the largest proportion of analysed spraint in Northern Ireland with salmonids representing the second largest prey category (Table 9, Figure 20). Other important prey categories include frog, eel and stone loach (Table 9, Figure 20). Crayfish, Perch and Pike occur less frequently in analysed Otter spraints in Northern Ireland (Table 9, Figure 20).

Table 9. Percentage frequency of prey categories found in Otter spraints collected at sites surveyed throughout Northern Ireland in 2001/2002 (n=212).

Prey Category	% frequency
Salmonid	17.45
Stickleback	21.23
Cyprinid	12.26
Eel	8.96
Perch	2.36
Pike	2.83
Stone Loach	6.84
Unidentified Fish	7.08
Frog	10.85
Crayfish	4.24
Other	5.89

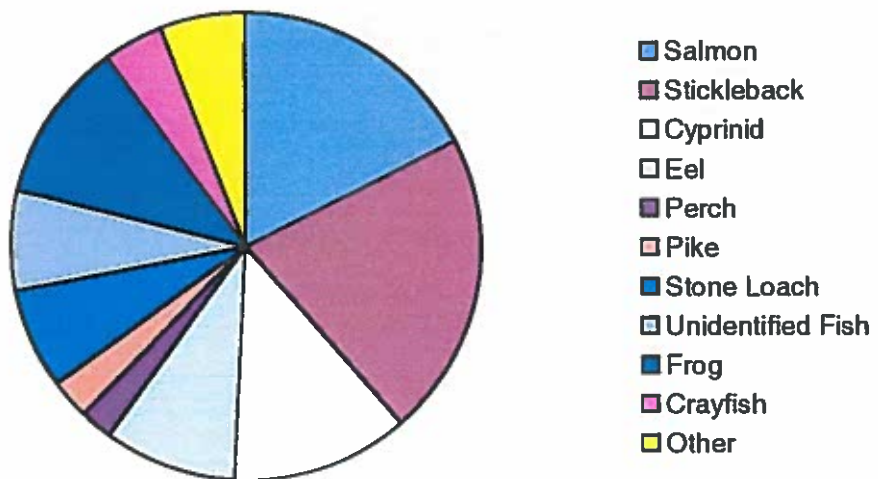


Figure 20. % Frequency of prey categories found in spraints collected in 2001/2002 in Northern Ireland. (n=212)

Variation in Otter Diet: Long-term change

Comparisons of spraints collected from the same sites in 1980/81 and 2003 indicate that spraints are composed of a similar assemblage of prey categories (Table 10, Figure 21). The % frequency of the majority of main prey categories does not change over the 20 year period. Salmonids and sticklebacks account for over 45% of the Otter diet in both the 1980's and today. However, there was a significantly higher percentage frequency of cyprinids, eels and stone loach in Otter spraints collected in the 1980s. In addition, there is significantly more frog in current spraints compared to those collected 20 years ago.

When the % weight of prey categories is calculated it is apparent that there has been a decline in the % weight of both salmonids and sticklebacks over the 20 year period (Table 10). In addition, corresponding to the changes noted in the % frequency data, the % weight of eel has also declined while that of frog and 'other prey' has increased (Table 10).

Table 10. Percentage frequency of prey categories found in Otter spraints collected from the same sites surveyed for Otter presence in 1980/1 and 2003 (n=71).

Prey Item	Chapman's Survey 1980/81		Current Survey 2003	
	% frequency	% weight	% frequency	% weight
Salmon	37.7	39.8	39.1	31.5
Stickleback	9.1	13.1	8.0	6.9
Cyprinid	8.2	8.4	7.4	10.3
Eel	16.5	17.6	9.3	9.9
Perch	1.4	0.4	0.7	0.6
Pike	2.9	1.9	0	0
Stone Loach	5.1	2.9	1.5	1.9
Unidentified Fish	10.3	4.4	12.9	2.5
Frog	6.0	8.9	10.2	17.8
Other	2.8	2.6	10.2	18.6

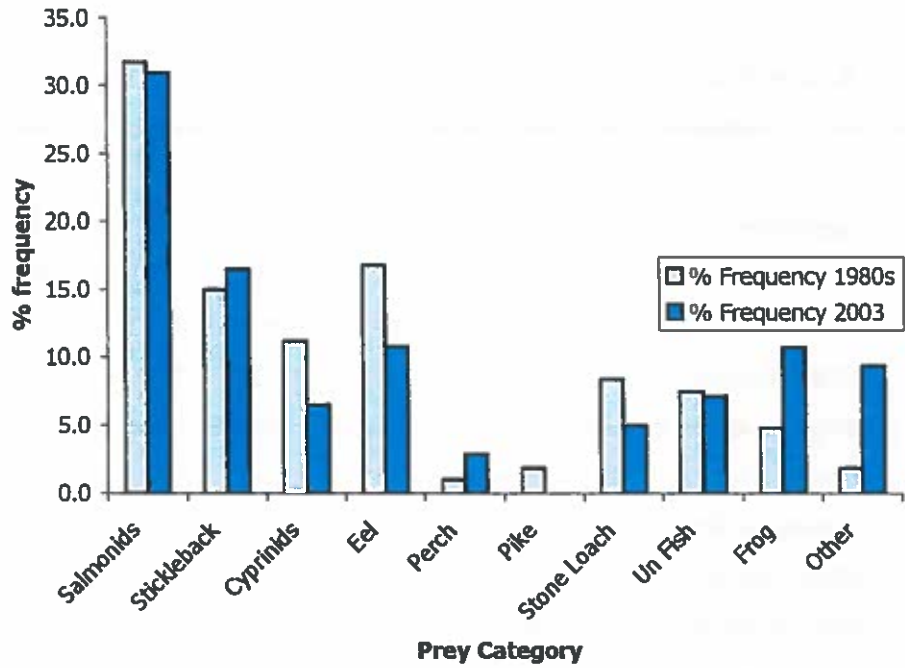


Figure 21. A comparison of the % frequency of prey items found in Otter spraints collected from the same sites surveyed in Northern Ireland in 1980/81 and 2003. (n=71)

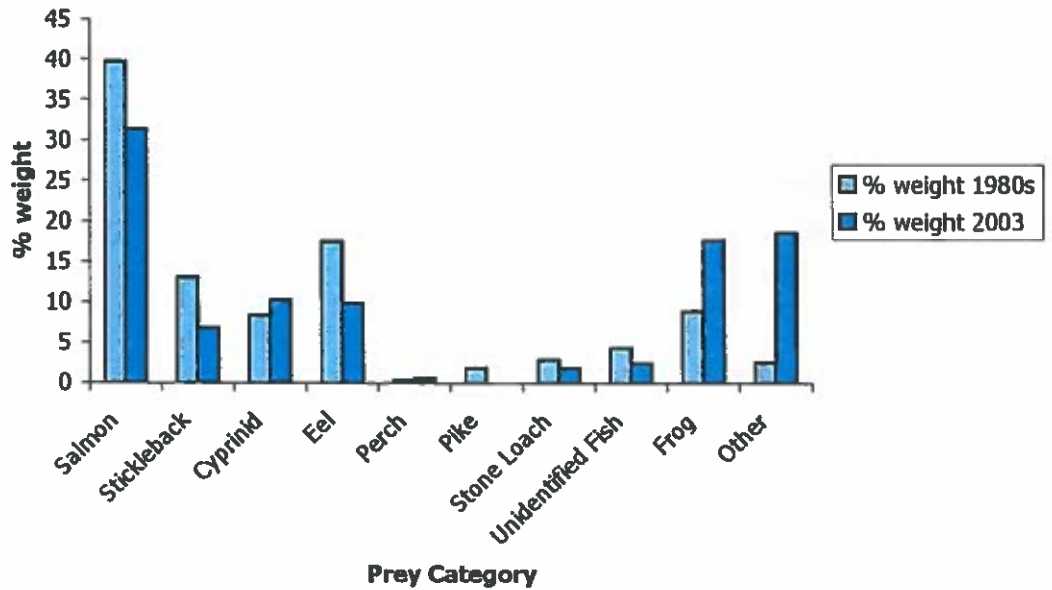


Figure 22. A comparison of the % weight of prey categories found in Otter spraints collected from the same sites surveyed in Northern Ireland in 1980/81 and 2003.

3. Conclusions

The Otter was once common throughout Britain. However, the population crashed in the late 1950s due to a combination of poisoning from agricultural pesticides, hunting and devastation of riparian habitat (Macdonald & Mason, 2003). In most of Britain, conservation initiatives have focused on the rehabilitation of riparian habitat and water quality for Otters. This has included schemes to lure Otters back to areas such as the Thames where Otters have recently been recorded after an absence of 30 years (London Radio Service, 1999) and to Wicken Fen, Cambridgeshire where they were absent for 60 years (National Trust). This initiative and many others are part of the National Otter Biodiversity Action Plan launched in 2002. The Action Plan aims to restore breeding Otters by 2010 to every watercourse and coastal area where they have been recorded since 1960. Results from surveys carried out in England, Wales and Scotland over the past 30 years suggest that the Otter population in mainland Britain is recovering (Table 9).

Table 9. Results from National Otter Surveys: 1977-79, 1984-86 and 1991 (IUCN published data).

	No. of river stretches surveyed	% Otter Occurrence 1977-79	% Otter Occurrence 1984-86	% Otter Occurrence 1991	% Increase 1977-79 to 1991
England	2,940	6	10	23	304
Wales	1,008	21	39	52	156
Scotland	2,650	57	65	83	46

However, results from the current investigation in Northern Ireland contrast with the positive trend in the rest of the UK and suggest a small but significant decline in Otter abundance over the past 20 years. Current results suggest that this decline has not been restricted to particular habitats or catchments but has been across the board. However, the most notable declines occurred in the high uplands and mountains and in areas east of Lough Neagh. Upland areas represent the margins of Otter distribution and one would predict that if a general decline in numbers were to occur, then it would occur most markedly in the sub-optimal habitats first.

Lakelands represent current Otter strongholds in Northern Ireland with fewer Otters occurring around coastal regions, particularly in north-east Antrim. This is surprising given the length of available habitat present in this area and may be a consequence of the limited and often harsh intertidal environment along these shores (Appendix 3).

Otters are indicators of a healthy river system where water is relatively unpolluted and there are good fish stocks and bankside vegetation. In the current investigation, significantly fewer Otters were recorded on small rivers with the highest occurrence on rivers of moderate width. This may reflect reduced water quality and / or fish stocks on small rivers and streams that may be more vulnerable to eutrophication, drainage and clearance of bankside vegetation.

If Otters are to increase in numbers from their current strongholds then healthy rivers and wetlands are essential. Obvious signs of pollution were noted at 14% of sites surveyed in Northern Ireland with a higher percentage of Otters found at unpolluted sites. With the exception of the Lough Melvin catchment, the rivers associated with Lough Foyle have the highest percentage occurrence of Otters. This may be indicative of either the healthy state of rivers in this catchment, the high relative density of available wetland habitat present or the greater abundance of optimal prey (Appendix 3).

There were difficulties repeating the original survey due to the fact that some of the sites appeared to be over-surveyed in the 1980's. This was either due to extended survey lengths, sites being revisited or different locations being surveyed during revisits. This makes any subsequent comparisons of data difficult. In addition, the majority of resurveyed sites were visited in the summer of 2001 that was particularly wet. This may have had an impact on the detection of positive signs of Otters, since spraints will be less persistent than during a dry summer with fewer flood events. However, during the current investigation a total of 742 sites were surveyed for the occurrence of Otter activity representing a comprehensive coverage of Northern Ireland and providing a sound baseline on which future monitoring programmes can be effectively established. The data suggest a reduction in Otter density not in the overall range of the species. Abundance has been affected in marginal areas more than in optimal Otter habitat. Therefore, a reduction in density is due to some widespread factor such as water quality or food availability, since more local impacts such as disturbance or forestation may be discounted. Changes in agricultural practice and the widespread use of nitrates are the most likely causes for

deterioration in water quality throughout Northern Ireland. Water quality will impact Otters in a variety of ways, but primarily via its effects on resident fish populations and hence Otter diet.

It is often difficult to assess the diet of Otters and other piscivores and quite often investigations into diet have had to rely on the examination of undigested remains in faeces (Feltham & Marquiss, 1989). There are many inaccuracies in using undigested hard parts to assess Otter diet since the amount of remains will vary with prey species, with the size of the individual item and the amount of it consumed (Ward, Smal & Fairley, 1986). Smaller, bonier fish such as stickleback may thus be over represented in the diet as compared to larger fleshier fish such as salmonids or cyprinid species.

Results from analysis of spraints collected from sites throughout Northern Ireland suggest that Otter diet is composed predominantly of fish with species such as salmonids, sticklebacks and cyprinids comprising over 50% of Otter diet. The dominant prey category is stickleback which is surprising since, in comparisons with other published analyses of Otter spraints from Ireland, they are normally recorded at much lower percentage frequencies (Table 10). Non-fish prey include frogs, crayfish, mammals, birds and smaller items (insects, molluscs and invertebrates) with frogs making a significant contribution to the diet.

A 20-year comparison of spraints collected from the same sites indicates differences in the percentage weight of some Otter prey categories. Changes in the percentage weight of salmonids, sticklebacks and eels may reflect smaller individuals of these prey categories now being consumed by Otters compared to the 1980s. In addition, an increase in the percentage weight of non-fish prey categories such as frogs, mammals, birds and insects may reflect larger amounts of these prey categories in the diet of Otters today as compared to 20 years ago. However, further research is needed to fully investigate Otter diet in Northern Ireland and the processes that might effect this.

Table 10. The % frequency of sticklebacks in published analyses of spraints from freshwater sites in Ireland (tabulated by J. Fairley).

Location	Month	Years	no. spraints analysed	% frequency
Connemara (West of Ireland) (Tangney & Fairley, 1994)	Jul – Sep	1993	192	0
Munster (Blackwater river) (Southern Ireland) (O'Sullivan, 1994)	May – Sept	1984	303	1.6
Lough Leane, Killarney (South-west Ireland) (Fairley & Murdock, 1989)	June	1987	171	0
Clare river (West of Ireland) (Mc Fadden & Fairley, 1984)	July	1981	131	5.2
Clare river (West of Ireland) (Breathnach & Fairley, 1993)	All year	1991	1709	9.3
River Inny – Mullingar (Midlands) (Kyne, Smal & Fairley, 1989)	April – July	1984-5	283	0
River Gore (Midlands)	May – July	1984-5	380	0
Lough Ennell (Midlands)	May – July		35	0
Roundstone bog Connemara (West of Ireland) (Kyne, Kyne & Fairley, 1990)	June - July		180	0
Selected rivers in Northern Ireland (O'Neill, 1995)	Throughout the year	1995	1702	19.6
Sites throughout Northern Ireland (current investigation)	May - August	2001- 2002	212	21.23

References

- Bas, N., Jenkins, D., & Rothery, P. (1984) Ecology of otters in northern Scotland. V. The distribution of otter (*Lutra lutra*) faeces in relation to bankside vegetation on the River Dee in summer 1981. *Journal of Applied Ecology*, 21, 507-513.
- Breathnach, S. & Fairley, J.S. (1993). The diet of Otters *Lutra lutra* (L.) in the Clare River system. *Biology and Environment* 93B: 151-158.
- Chapman, P.J. & Chapman, L.L. (1982). Otter Survey of Ireland 1980-81. The Vincent Wildlife Trust.
- Conroy, J.W.H. & French, D.D. (1987) The use of spraints to monitor populations of otters (*Lutra lutra* L.). *Symposia of the Zoological Society of London*, 58, 247-262.
- Conroy, J.W.H, Watt, J., Webb, J.B. & Jones, A. (1993). A guide to the identification of prey remains in otter spraint. The Mammal Society, London.
- Copp, G.H. & Roche, K. (2003) Range and diet of Eurasian Otters *Lutra lutra* (L.) in the catchment of the River Lee (south-east England) since re-introduction.
- Crawford, A., Jones, A., and McNulty, J. (1979) Otter survey of Wales 1977-78. Society for the Promotion of Nature Conservation: Lincoln.
- Dallas J.F., Carss D.N., Marshall F., Koepfli K., Kruuk H., Piertney S.B., & Bacon P.J. (2000). Sex identification of the Eurasian otter *Lutra lutra* by PCR typing of spraints. *Conservation Genetics* 1: 181-183.
- Dallas J.F. & Piertney S.B. (1998). Microsatellite primers for the Eurasian otter. *Molecular Ecology* 7: 1247-1263.
- Erlinge, S. (1968b). Food studies on captive otters *Lutra lutra* L. *Oikos* 19, 259-270.
- Ernest H.B., Penedo M.C.T., May B.P., Syvanen M., and Boyce W.M. (2000). Molecular tracking of mountain lions in the Yosemite Valley region in California: genetic analysis using microsatellites and faecal DNA. *Molecular Ecology* 9: 433-411.
- Fairley, J. (2001) A Basket of Weasels. Privately Published, Belfast.
- Fairley, J.S. (1972) Food of otters (*Lutra lutra*) from Co. Galway, Ireland, and notes on other aspects of their biology. *Journal of the Zoological Society of London*, 166, 469-474.
- Feltham, M.J. & Marquiss, M. (1989). The use of first vertebrae in separating and estimating the size of trout *Salmo trutta* and salmon *Salmo salar* in bone remains. *Journal of Zoology*, London. 219, 113-122.
- Frantzen M.A.J., Silk J.B., Ferguson J.W.H., Wayne R.K., & Kohn M.H. (1998). Empirical evaluation of preservation methods for faecal DNA. *Molecular Ecology* 7: 1423-1428.
- Fairley, J.S. & Murdoch, B. (1989). Summer food of Otters in the lakes of Killarney. *Irish Naturalists' Journal* 23: 38-41.
- Gerloff U., Schlötter C., Rassmann K., Rambold I., Hohmann G., Fruth. & Tautz D.

- (1995). Amplification of hypervariable simple sequence repeats (microsatellites) from excremental DNA of wild living bonobos (*Pan paniscus*). *Molecular Ecology* 4: 515-518.
- Gormally, M.J., McFadden, Y.M.T., & Fairley, J.S. (1983) Notes on otter sprainting sites. *Irish Naturalists' Journal*, 21, 22-24.
- Green, J., and Green, R. (1980) Otter survey of Scotland 1977-79. The Vincent Wildlife Trust: London.
- Green, J. Green, R. & Jeffries, D.J. (1984). A radio-tracking survey of Otters *Lutra lutra* L. on a Perthshire river system. *Lutra* 27: 85-145.
- Gutleb, A.C. & Kranz, A. (1998) Estimation of polychlorinated biphenyl (PCB) levels in livers of the otter (*Lutra lutra*) from concentrations in scats and fish. *Water, Air and Soil Pollution*, 106, 481-491.
- Hilder, R.C., Mason, C.F., & Bakaj, M.E. (1982). Chlorinated Hydrocarbon Pesticides and Polychlorinated Biphenyls in Freshwater Fishes in the United Kingdom, 1980-1981. The Vincent Wildlife Trust.
- Jeffries, D.J. (1989) The changing otter population of Britain 1700-1989. *Biological Journal of the Linnean Society*, 38, 61-69.
- Jenkins, D. & Burrows, G.O. (1980) Ecology of otters in northern Scotland. III. The use of faeces as indicators of otter (*Lutra lutra*) density and distribution. *Journal of Applied Ecology*, 49, 755-774.
- Kohn M., Knauer F., Stoffella A., Schroder W., & Pääbo S. (1995). Conservation genetics of the European brown bear – a study using excremental PCR of nuclear and mitochondrial sequences. *Molecular Ecology* 4: 95-103.
- Kohn M.H. & Wayne M.K. (1997). Facts from faeces revisited. *Trends in Ecology & Evolution* 12: 223-227.
- Kruuk, H. (1996) *Wild Otters: Predation and Populations*. Oxford University Press, Oxford.
- Kruuk, H. & Conroy, J.W.H. (1987) Surveying otter, *Lutra lutra*, populations: A discussion of problems with spraints. *Biological Conservation*, 41, 179-183.
- Kruuk, H., Conroy, J.W.H., Glimmerveen, U., & Ouwkerk, E.J. (1986) The use of spraints to survey populations of otters, *Lutra lutra*. *Biological Conservation*, 35, 187-194.
- Kyne, M.J., Kyne, M.J., & Fairley, J.S. (1990) A summer survey of otter signs on Roundstone Bog, south Connemara. *Irish Naturalists' Journal*, 23, 273-276.
- Kyne, M.J., Smal, C.M. & Fairley, J.S. (1989). The food of Otters *Lutra lutra* in the Irish midlands and a comparison with that of mink *Mustela vison* in the same region. *Proceedings of the Royal Irish Academy* 89B:33-46.
- Lenton, E.J., Chanin, P.R.F., and Jeffries, D.J. (1980) Otter survey of England 1977-79. Nature Conservancy Council: London.
- Lunnon, R. & Reynolds, J. (1991). Report on the National otter Survey of Ireland 1990-1991. Department of Zoology, Trinity College, Dublin.

- Mason, C.F. (1993) Regional trends in PCB and pesticide contamination in northern Britain as determined in otter (*Lutra lutra*) scats. *Chemosphere*, 26, 941-944.
- Mason, C.F. & MacDonald, S.M. (1986) Levels of cadmium, mercury and lead in otter and mink faeces from the U. K. *Science of the Total Environment*, 53, 139-146.
- Mason, C.F. & MacDonald, S.M. (1987a) Acidification and otter, *Lutra lutra*, distribution on a British river. *Mammalia*, 51, 81-88.
- Mason, C.F. & MacDonald, S.M. (1987b) The use of spraints for surveying otter, *Lutra lutra*, populations: An evaluation. *Biological Conservation*, 41, 167-177.
- Mason, C.F. & MacDonald, S.M. (1989) Acidification and otter, *Lutra lutra*, distribution in Scotland, U. K. *Water, Air and Soil Pollution*, 43, 365-374.
- Mason, C.F., MacDonald, S.M., & Aspden, V.J. (1982). *Metals in Freshwater Fishes in the United Kingdom, 1980-1981*. The Vincent Wildlife Trust.
- Murphy, K.P. & Fairley, J.S. (1985) Food of otters, *Lutra lutra*, on the south shore of Galway Bay. *Proceedings of the Royal Irish Academy B*, 85, 47-55.
- Mc Fadden, Y.M.T. & Fairley, J.S. (1984). Food of Otters *Lutra lutra* (L.) in an Irish limestone river system with special reference to the crayfish *Austropotamobius pallipes* (Lereboullet). *Journal of Life Sciences of the Royal Dublin Society* 5: 65-76.
- O'Neill, E.M. (1995) Resource use by otters, *Lutra lutra*, in Riparian habitats. Unpublished Phd thesis, University of Ulster.
- O'Sullivan, W.M. (1994). Summer diet of Otters on part of the Blackwater catchment. *Irish Naturalists' Journal* 24: 349-354.
- Paetkau D., Waits L.P., Clarkson P.L., Craighead L., Vyse E., Ward R., & Strobeck C. (1998). Variation in genetic diversity across the range of North American brown bears. *Conservation Biology* 12: 418-429.
- Reed J.Z., Tollit D.J., Thompson P.M., & Amos W. (1997). Molecular scatology: the use of molecular genetic analysis to assign species, sex, and individual identity to seal faeces. *Molecular Ecology* 6: 225-234.
- Scott-Mills L., Citta J.J., Lair K.P., Schwartz M.K. & Tallmon D.A. (2000). Estimating animal abundance using non-invasive DNA sampling: promise and pitfalls. *Ecological Applications* 10(1): 283-294.
- Taberlet P & Luikart G. (1999). Non-invasive genetic sampling and individual identification. *Biological journal of the Linnean Society* 68: 41-55.
- Taberlet P., Camarra J.J., Griffin S., Uhrès E., Hanotte O., Waits L.P., Dubious-Paganon C., Burke T., & Bouvet J. (1997). Noninvasive genetic tracking of the endangered Pyrenean brown bear population. *Molecular Ecology* 6: 869-876.
- Tagney, D.E. & Fairley, J.S. (1994). Otter signs and diet in Connemara National Park and its environs. *Irish Naturalists' Journal* 24: 434-440.
- Tikel D., Blair D., & Marsh H.D. (1996). Marine mammal faeces as a source of DNA. *Molecular Ecology* 5: 456-457.

Ward, D.P, Smal, C.M. & Fairley, J.S. (1986). The food of Mink *Mustela vison* in the Irish midlands. *Proceedings of the Royal Irish Academy*. 86.

Wayre, P. (1979) *The private life of the otter*. Book Club Associates, London.

Wasser S.K., Houston C.S., Koehler G.M., Cadd G.G. & Fain S.R. (1997). Techniques for application of faecal DNA methods to field studies of Ursids. *Molecular Ecology* 6: 1091-1097.

Woodruff D.S. (1993). Non-invasive genotyping of primates. *Primates* 34: 333-346.

Appendix 1.

Signs of Otter Activity

- A** **Otter tracks are often found on sand bars along a river or stream.**
- B** **Otters use prominent rocks along rivers and lakes as sprainting sites. Spraints found on these rocks are signs that Otters are using the area. Where Otters have been regularly sprainting in one area there will be a build up of green algae *Prasiola* spp.**
- C** **Partially eaten Crayfish along a river are signs that Otter are feeding in the area.**
- D** **An Otter run and slide leading down a river bank is an indication that Otters are active in an area.**
- E** **View of an entrance to an Otter holt.**



Appendix 2a. Survey sheet used to assess Otter activity along a section of coast or lake.

Otter Survey 2002 – Loughs & Coastal areas

10km square reference		County	Armagh	Down	Fermanagh		
1km square reference		Lough /Coast	Antrim	Londonderry	Tyrone		
Grid reference of site		Site name					
Date	/	/ 2002	Conditions	Dry	Sunny	Wet	Cloudy

Habitat type	Adjacent land use	Water Use
Sea loch	Grassland – upland – perm/temp	Abstraction
Estuary		Boating – powered
Lowland lake / broad	Woodland – broadleaved – conifer	– sailing
Upland Loch / tarn		– man powered
Reservoir	Peat bog	Angling
Running water	Arable	Shooting
Bog /marsh	Saltmarsh	Keeped
Canal	Heath	Current
	Urban / industrial / road	Static
	Park / garden	Tidal

Width (m)	Depth (m)	Shore type (%)	Substrate (%)	
< 1	< 0.5	Rocky	Bedrock	
1 - 2	0.5 - 1	Sandy	Boulders	
2 - 5	1 - 2	Sheltered	Cobbles	
5 - 10	> 2	Exposed	Gravel	
10 - 20	Exposed Boulder (%)	Seaweed cover	L	Sand
20 - 40			M	Silt
> 40			H	

Vegetation (%)		Bank surveyed	Bank slope (°)	Bank height (m)
Banks	Trees		0 – 30	< 1
	Shrubs		30 – 60	1 – 2
	Tall herbs		60 – 90	2 – 3
Channel	Emergent			> 3
	Floating attach	Tree species		Weed control
	Floating free	Alder	Cherry	Mechanical
	Submerged	Hawthorn	Holly	Chemical
Tree extent		Sycamore	Elder	None
Isolated		Horse chestnut	Conifer	Bank treatment
Regular		Beech	Blackthorn	Maintained
Clumps		Oak	Gorse	Wild
Semi-continuous		Willow		
Continuous		Ash		

Associated features	Other features	Pollution		
Channel shading	Piers	Present	Absent	
Overhanging boughs	Moorings	Agricultural	Domestic	Industrial
Roots	Slipways			
Fallen trees	Fishing stands			
Debris	Islands			
Other	Other			

Survey distance (m)							Other animals				
Survey direction		N				E	Animal	Obs	Tracks	Faeces	Other
		S				W	Fox				
Disturbance factor 0 = no disturbance		0 1 2 3 4 5					Badger				
							Mink				
Photographs						Heron					
Number	Description					Swan					
	Spraint site					Moorhen					
	Lough / coast view - facing					Coot					
						Ducks					
						Fish					

Otter signs – spraint sites and tracks									
Location(s)									
No. of sites									
Spraints (number) and condition		Site				Remains in spraint			
		Old				Fish bones		Crayfish	
		Recent				Scales		<i>Gammarus</i>	
		New				Other bones			
Tracks	Yes		No						
Runs /glides	Yes		No						
Holt	Yes		No						

Sketch map of the site

- Gate
- Park car P
- Spraint *
- Tracks Δ
- Glide //
- Grass G
- Arable A
- Forest F
- House Hse
- Industry I
- Urban U
- Bog B

Appendix 2b. Survey sheet used to assess Otter activity along a section of river.

Otter Survey 2002 - Rivers

10km square reference		County	Armagh Down Fermanagh Antrim Londonderry Tyrone
1km square reference		River	
Grid reference of site		Site name	
Date	/ / 2002	Conditions	Dry Sunny Wet Cloudy

Habitat type		Adjacent land use		Water Use	
Sea loch		Grassland – upland – perm/temp		Abstraction	
Estuary				Boating – powered	
Lowland lake / broad		Woodland – broadleaved – conifer		– sailing	
Upland Loch / tarn				– man powered	
Reservoir		Peat bog		Bank angling	
Running water		Arable		Shooting	
Bog /marsh		Saltmarsh		Keeped	
Canal		Heath			
		Urban / industrial / road			
		Park / garden			

Width (m)		Depth (m)		Current		Substrate (%)	
< 1		< 0.5		Rapid		Bedrock	
1 - 2		0.5 - 1		Fast		Boulders	
2 - 5		1 - 2		Slow		Cobbles	
5 - 10		> 2		Sluggish		Gravel	
10 - 20		Exposed Boulder (%)		Static		Sand	
20 - 40				Tidal		Silt	
> 40							

Vegetation (%)		RB	LB	Bank surveyed	Bank slope (°)		Bank height (m)	
Banks	Trees				0 - 30		< 1	
	Shrubs				30 - 60		1 - 2	
	Tall herbs				60 - 90		2 - 3	
Channel	Emergent						> 3	
	Floating attach			Tree species			Weed control	
	Floating free			Alder		Cherry		Mechanical
	Submerged			Hawthorn		Holly		Chemical
Tree extent				Sycamore		Elder		None
Isolated				Horse chestnut		Conifer		Bank treatment
Regular				Beech		Blackthorn		Canalised
Clumps				Oak		Gorse		Resectioned
Semi-continuous				Willow				Maintained
Continuous				Ash				Wild

Associated features		Other features		Pollution			
Channel shading		Weirs		Present		Absent	
Overhanging boughs		Waterfalls		Agricultural		Domestic	Industrial
Roots		Channel bars					
Fallen trees		Side bars					
Debris		Islands					
Other		Other					

Survey distance (m)						Other animals					
Survey direction	U/S					Animal	Obs	Tracks	Faeces	Other	
	D/S					Fox					
	both					Badger					
Disturbance factor 0 = no disturbance	0	1	2	3	4	5	Mink				
							Heron				
Photographs							Dipper				
Number	Description					Moorhen					
	Spraint site					Coot					
	River view - facing					Ducks					
						Kingfisher					
						Fish					
						Other					

Otter signs – spraint sites and tracks										
Location(s)										
No. of sites										
Spraints (number) and condition	Site						Remains in spraint			
	Old						Fish bones		Crayfish	
	Recent						Scales		<i>Gammarus</i>	
	New						Other bones			
Tracks	Yes		No							
Runs /glides	Yes		No							
Holt	Yes		No							

Sketch map of the site

Gate	☒
Park car	P
Spraint	*
Tracks	△
Glide	//
Grass	G
Arable	A
Forest	F
House	Hse
Industry	I
Urban	U
Bog	B

Appendix 3. Conservation objectives for Otters Upper Lough Erne SAC.

Feature 4 (SAC) – Otter *Lutra lutra* (Status B)

Attribute	Measure	Target	Notes
Otter Population Numbers	Estimate numbers of Otters using Upper Lough Erne and its feeder streams.	Maintain and if possible increase Otter population	Assess Otter density/population through ecological or genetic techniques.
Presence of otters along Lough shore.	<p>Presence of one or more positive signs of Otter activity at a statistically representative number of sites around the shore and islands of Upper Lough Erne.</p> <p>Positive identification of fresh otter spraint or footprints.</p> <p>Presence of tracks, paths, lying-up sites or feeding signs also noted.</p>	Maintain number of positive sites for Otter around Upper Lough Erne.	<p>Current survey sets baseline for Otter presence.</p> <p>Signs of otters (spraint or footprints) to be found at least once per reporting cycle. Repeat surveys to be carried out at same time of year to ensure comparability of results.</p> <p>Use data from other surveys or Ulster Museum, if available</p>
	Sightings of otters.		
	Positive identification of holt(s).	Searches for holts carried out adjacent to sprainting sites.	

Attribute	Measure	Target	Notes
<p>Presence of otters on feeder rivers.</p>	<p>Presence of one or more positive signs of Otter activity on each of the feeder rivers / streams entering Upper Lough Erne. Surveys to be carried out at bridges / fords for ease of access. Positive identification of fresh otter spraint or footprints. Presence of tracks, paths, lying-up sites or feeding signs also noted.</p>	<p>Maintain number of positive sites for Otter on each of the feeder rivers/stream entering Upper Lough Erne.</p>	<p>Signs of otters (spraint or footprints) to be found at least once per reporting cycle. Repeat surveys to be carried out at same time of year to ensure comparability of results.</p>
	<p>Sightings of otters.</p>		
	<p>Positive identification of holt(s).</p>	<p>Searches for holts carried out adjacent to sprainting sites.</p>	
<p>Bankside/Waterside cover</p>	<p>Presence of cover: Mature trees, woodland, scrub, other tall bankside vegetation, reed and sedge beds.</p>	<p>Maintain lakeside / riparian buffer strips. No overall permanent decrease in lakeside / riparian vegetation.</p>	<p>Some change acceptable as long as it is appropriately mitigated. Where there is significant absence of vegetative cover along the lough shore / river margins, it may be appropriate to create bankside / loughshore cover by planting with native species at suitable locations.</p>
<p>Water quality</p>	<p>EP water quality scale</p>	<p>Water quality should be at least category A or B, according to EP guidelines, with no pollution incidents. Regular monitoring of water quality in Upper Lough Erne and feeder rivers. Extending sampling regime to cover feeder rivers / streams not already covered.</p>	<p>Refer to Environment Protection for data</p>
<p>Food Sources</p>	<p>Assessment of fish stocks and other food sources</p>	<p>Maintain fish stocks appropriate to the nutrient</p>	<p>Refer to appropriate Agency for</p>

Attribute	Measure	Target	Notes
	(e.g amphibians) in both Upper Lough Erne and feeder streams	status of the river/lough, with no significant decline in fish biomass or species diversity.	<p>sample data if available (This information may need to be inferred from the water quality category).</p> <p>Initiate Otter diet analysis from collected spraints to determine key food / prey items in Upper Lough Erne and feeder rivers.</p> <p>Liaise with DARD to determine stocking levels in Upper Lough Erne and feeder rivers. Look to historical data to identify any declines / increases in species abundance.</p> <p>If necessary, initiate regular monitoring of species composition by electrofishing surveys at appropriate locations.</p>
Disturbance Accidental deaths	Extent of public access to river / Lough shore Deaths due to road accidents	No significant Increase in disturbance to Otters No significant loss of Otters due to road kills	<p>If necessary,</p> <ol style="list-style-type: none"> 1. promote public awareness in the area 2. initiate appropriate mitigation at known black spots. 3. Collect and send all casualties for post mortem investigation. 4. Advise DoE Roads Service of the needs of Otters on roads around / crossing the Lough shore / feeder rivers.

Attribute	Measure	Target	Notes
Flow rate	Mean annual flow rate	Maintain annual flow rates	Refer to data from Rivers Agency if available
Site integrity	Total area	No reduction or fragmentation of area	

Absence of cover:
 Significant absence of vegetative cover along the lough shore / river margins.

Creation of bankside / loughshore cover by planting with native species at appropriate locations.

Appendix 4. Ranked relative density of available wetland habitat in different catchments in Northern Ireland.

Catchment	Relative Wetland Habitat Density Index
Lough Melvin	1.00
Erne	0.92
NE Antrim Coast & Glens Rivers	0.92
Roe	0.75
Skeogh River	0.73
Foyle	0.69
Mourne & South Armagh	0.67
Lough Neagh	0.65
Lagan	0.64