Distribution and diet of otters (*Lutra lutra*) in marine areas of Loch Lomond and The Trossachs National Park, Scotland, UK

John McMahon[1] and Dominic J. McCafferty[2*]

[1] Division of Environmental & Evolutionary Biology, IBLS, University of Glasgow, G12 8QQ, Scotland, UK
[2] Department of Adult & Continuing Education, University of Glasgow, G3 6NH, Scotland, UK,
e-mail: d.mccafferty@educ.gla.ac.uk

Abstract: Loch Lomond and The Trossachs National Park was established as Scotland's first National Park in 2002 and contains marine coastal areas that provide suitable habitats for otters (*Lutra lutra*) and their prey. The aim of this study was to investigate the distribution and diet of otters in the three sea lochs bordering the National Park to provide baseline data for a local biodiversity action plan for this species. Thirty nine sites were surveyed for otter signs (spraints and tracks) between April and August 2005. Otter signs were recorded at 46% of sites with the greatest proportion of positive sites being recorded around Loch Goil (69%) compared to Loch Long (37%) and the Holy Loch (28%). There was no difference in the proportion of positive sites according to shore type or terrestrial habitat. Sites with A roads had the lowest proportion of positive sites (15.4%), compared to sites with B roads (50.0%) and sites without roads (71.4%). However, the availability of shallow water was also an important factor influencing spraint distribution. Analysis of spraints showed that the diet of otters consisted mainly of bottom dwelling fish and crab. The only significant difference between lochs was in the proportion of eelpout (*Zoarces viviparous*) and sole (*Solea solea*) present in spraints. Eelpout and sole were more common in spraints found in Loch Goil.

Keywords: European otter, *Lutra lutra*, distribution, diet, National Park.

Introduction

The European otter (*Lutra lutra*) is found in many marine habitats in Europe but it is particularly widespread in the north and west coasts of Scotland (Kruuk 1995). These coastal dwelling otters obtain much of their food from the sea but their distribution is closely associated with freshwater (Kruuk 1995, Lovett et al. 1997). Well-drained coasts with little or no freshwater on or close to the surface have few otters (Kruuk et al. 1998). When otters forage in seawater they frequently wash in freshwater pools or small streams. This activity removes salt from the fur and helps to maintain healthy fur for thermoregulation. This behaviour is essential for the exploitation of marine resources (Kruuk & Balharry 1990). A consequence of this is that the availability of freshwater sources may act as a limiting factor in determining otter numbers along some coastlines (Lovett et al. 1997).

From the 1960s onwards there has been much published information available on the diet of the European otter. Long-term investigations undertaken throughout Europe show that fish form three quarters or more of the overall diet (see review Chanin 2003a). The otter has been described as a fish specialist (Mason & Macdonald 1986), and numerous studies show that species taken are related to their availability (e.g. Breathnach & Fairley 1993, Carss et al. 1998, Ottino & Giller 2004). Otters in marine areas feed predominantly on relatively small, bottom living fish and on crabs (Kruuk & Moorhouse 1990). Prey species composition

* *Corresponding author.*

depends on season and location, and food availability may be seasonal (Heggberget 1993). Faecal remains of prey animals give rough and biased estimates of prey proportions in predator diets but the relative frequency of occurrence of prey categories gave a reasonable estimate of the rank order of prey eaten in otters (Carss & Parkinson 1996). Although spraint surveys cannot be used to estimate the population density in a particular habitat they provide a practical method of recording changes in the spatial and temporal distribution of otter populations (Kruuk et al. 1986, Chanin 2003b).

Loch Lomond and The Trossachs National Park was established as Scotland's first National Park in July 2002. The National Park extends to the low tide mark and marine coastal areas represent 20% of the 350 km park boundary (Anonymous 2005). Otters are known to occur in marine areas within this region (Green & Green 1997) and a previous study has investigated levels of organochlorine and polychlorinated biphenyls (PCBs) in spraints (Mason et al. 1992). The aim of this study was therefore to investigate the distribution and diet of otters in the three sheltered sea lochs (Loch Long, Loch Goil and the Holy Loch) that are found on the western edge of the National Park.

Materials and methods

Sign survey

A total of 39 sites were surveyed for otter signs (spraints and tracks) between April and August 2005. Nineteen of these sites were along the shores of Loch Long, 13 sites on Loch Goil and the remaining seven sites were on the Holy Loch (figure 1). The criteria for site choice was based on the assumption that otters using marine habitats also require access to freshwater and therefore sampling locations were taken to be the entry point of all streams to the sea. In a small number of areas this was not possible and peninsular areas were surveyed as it was viewed that they were suitable sprainting areas. Each site was surveyed on two separate occasions to account for any missed signs in the first survey.

Keeping with standard IUCN monitoring guidelines (Chanin 2003b) 600 m lengths of waterway/coastline were selected. However, in this instance a minimum of four sites were surveyed every 10 km instead of one site at intervals of 5-8 km to provide greater detail on otter distribution. Where possible 300 m were surveyed to the right of freshwater streams entering a loch and a further 300 m were surveyed to the left of the freshwater streams. In certain locations this technique proved impossible and 600 m were surveyed to whichever side of the stream we had access. A boat was used to gain access to areas which could not be easily reached on foot.

Diet analysis

All spraints from each survey site were placed in the same plastic bag and treated as one sample. Due to this method of collecting, 142 spraints were collected but analysed as 39 samples. The plastic bags were sealed and stored at –20 ºC for subsequent analysis (McCafferty 2005). A binocular microscope (x10-20) was used to identify the remains. The bones were identified using standard keys (Harkonen 1986, Conroy et al. 1993) and a reference collection of otoliths (University of Glasgow Otolith Chart).

Statistical analysis

Two of the Holy Loch sites showed positive signs of otter presence but this proved too few for accurate statistical analysis. As the Holy Loch is essentially an inlet of Loch Long, the Holy Loch data were combined with the Loch Long data for the purpose of more accurate statistical analysis. Chi-square tests were computed using Minitab (Version 13.3 for Windows) to test for differences in the proportion of positive otter sites according to location and habitat type and to examine differences in the frequency of prey species recorded in spraints.

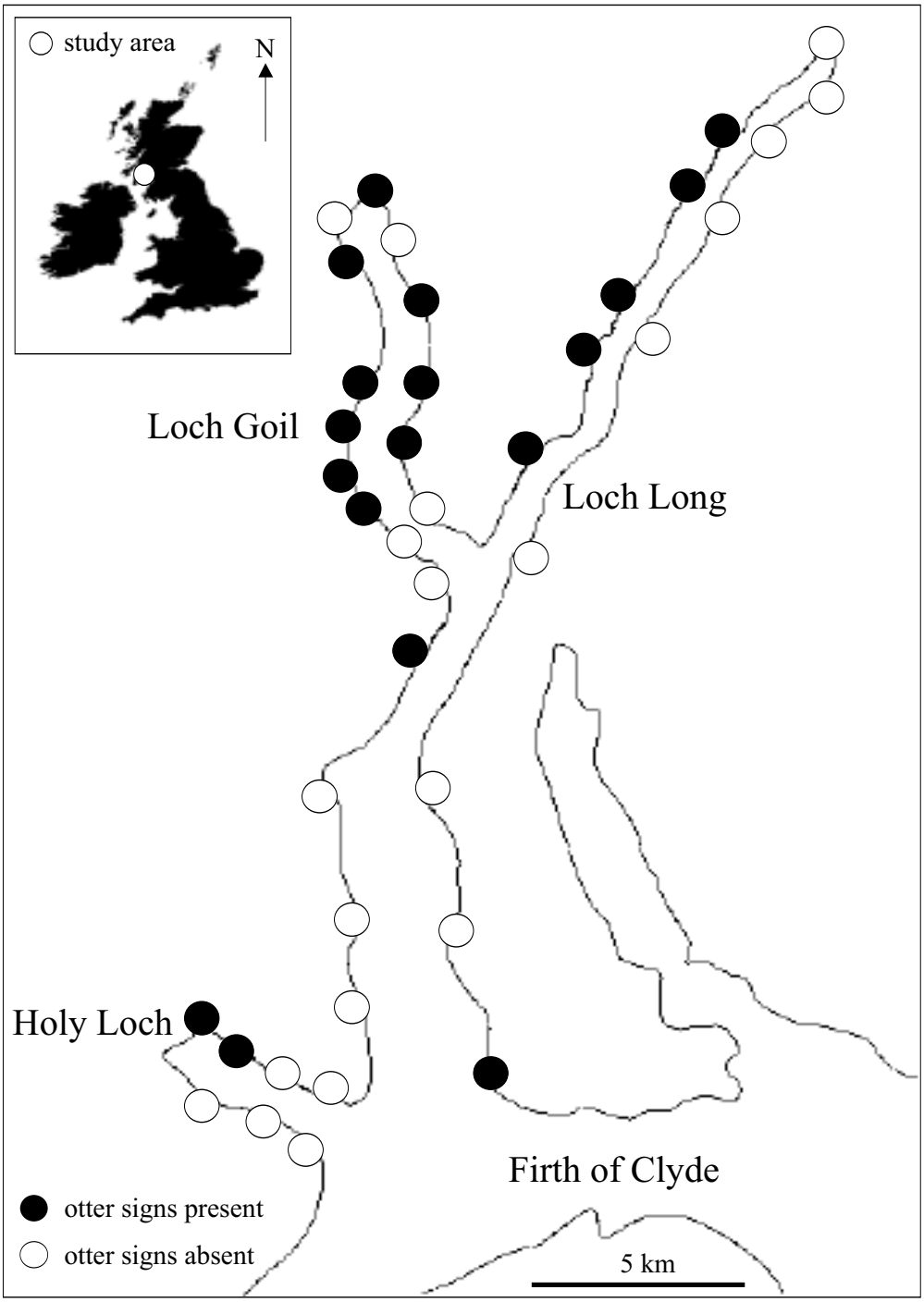

Figure 1. Map of 39 survey sites where otter signs were present or absent in Loch Long, Loch Goil and the Holy Loch. Inset shows the geographical location of Loch Lomond and The Trossachs National Park, Scotland, UK.

Results

Otter signs

Signs of otter presence were recorded at each of the three sea lochs and at 46% of sites (figure 1). A significant difference was found in the proportion of sites positive for otters at Loch Goil and the combination of Loch Long and the Holy Loch (c2=4.18, df=1, P=0.04), with a greater proportion of positive sites being recorded in the Loch Goil area. At Loch Goil 69% of sites were positive compared to 37% at Loch Long and 28% at the Holy Loch.

Shore types and terrestrial habitats

The shore type at the different sites was grouped into three categories: boulders, stones, and sand/silt. Terrestrial habitats were divided into woodland, grassland and park/garden. No significant difference was found between the frequency of occurrence of otter signs and the expected frequency based on the distribution, either of each shore type (χ^2=1.08, df=2, *P*=0.58) or terrestrial habitat (χ^2=4.48, df=2, *P*=0.11).

Proximity to roads

From the 39 sites surveyed, 13 were next to A roads (major road), twelve on B roads (minor road) and 14 had no roads. There was a significant association between presence and absence of otter signs and road type (χ^2=8.62, df=2, *P*=0.01). Sites with A roads had the lowest proportion of positive sites (15.4%), compared to sites with B roads (50.0%) and sites without roads (71.4%).

Diet composition

Prey species identified in spraints included eelpout (*Zoarces viviparous*), wrasse (Labridae), butterfish (*Pholis gunnellus*), goby (*Gobius* spp.), eel (*Anguilla anguilla*), rockling (Gadidae), sole (*Solea solea*), dab (*Limanda limanda*), salmonid species (*Salmo* spp.), Yarrell's blenny (*Chirolophis ascanii*), bullrout (*Myoxocephalus scorpius*), stickleback (*Gasterosteus aculeatus*), seasnail (*Liparis* spp.), and shore-crab (*Cancer maenas*). Bird and mammal remains were also found but not identified further.

Differences in diet between lochs

The only significant differences in diet found between lochs involved eelpout and sole. Eelpout (χ^2=4.32, df=1, *P*=0.037) and sole (χ^2=4.62, df=1, *P*=0.031) were more common in Loch Goil than in Loch Long (figure 2). For the remaining species no significant differences were found between lochs (*P*>0.06 in all cases).

Discussion

Distribution

Signs of otters were recorded at each of the sea lochs within the National Park and spraints were found at 46% of sites. The proportion of positive sites was considerably lower than the overall figure reported for Scotland (88%) in the last published otter survey (Green & Green 1997). However, examination of the data for this region shows that otter signs were only recorded in around 50% of sites in the Clyde sea lochs and Clyde Estuary (see distribution map in McCafferty 2005). There was however a difference in the proportion of positive sites between different sea lochs, with Loch Goil having the greatest proportion of positive signs. Although this only indicates a difference in the occurrence of spraints between sites and not otter density, it may suggest that otters are showing some preference for different sea lochs, at least in sprainting activity. A number of reasons may account for this. Firstly, Loch Goil is free from major roads and it was shown that road type influenced the proportion of positive sites. Indeed Loch Long with the lowest proportion of positive sites has an A road running the length of

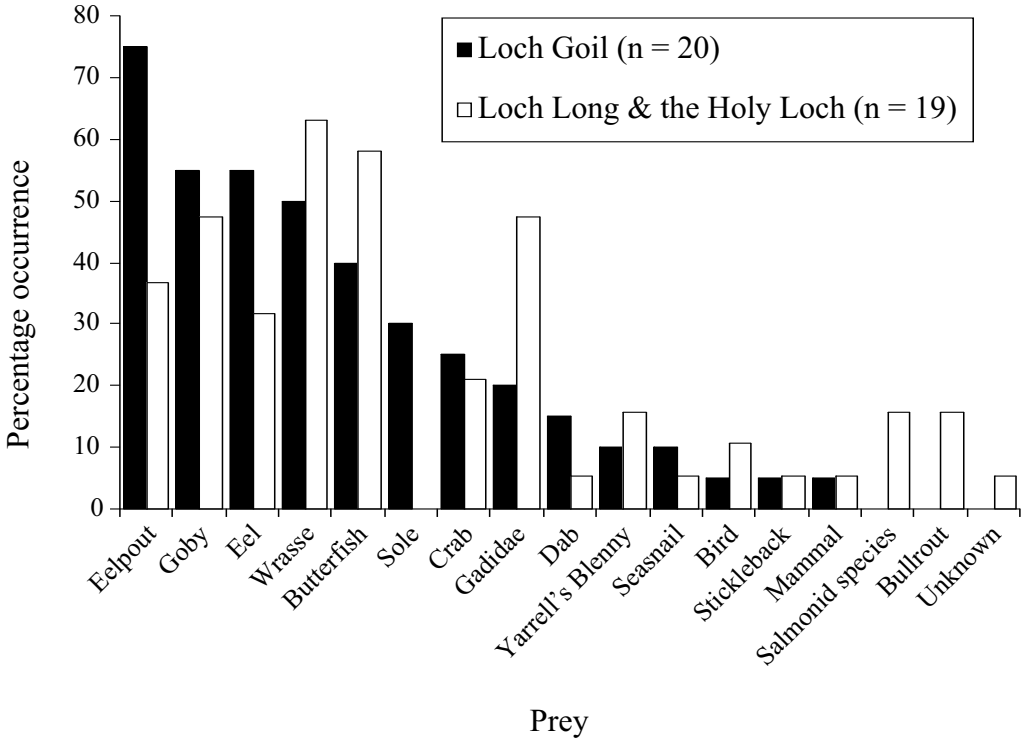

Figure 2. The percentage occurrence of prey species in spraints from Loch Goil and Loch Long & the Holy Loch.

its east shore. It is thought that disturbance does not have a strong influence on otter behaviour (Chanin 2003a), however road access may influence otters either as a result of increased road mortality (Philcox et al. 1999) or an increase in number of people in the area may influence either the sprainting behaviour of animals or their habitat use. A second factor that may account for differences between sea lochs is that the edges of Loch Goil are shallower than the edges of Loch Long (Hydrography of Navy 1976). Otters forage in shallow water for demersal prey (Nolet et al. 1993), so lochs with large areas of shallow water are likely to contain more available prey. Finally, Mason et al. (1992) found that otter spraints from Loch Long and Loch Goil contained relatively high levels of polychlorinated biphenyls (PCBs), (both sites >20 mg kg^{-1} lipid) while spraints from the Holy Loch had a lower PCB content (<5 mg kg^{-1} lipid). Although the study by Mason et al. (1992) was conducted over a nine month period and sample sizes were small, there is no evidence to suggest that the distribution of otter signs in the three sea lochs in this study was related to pollution.

In this study there was no preference for any particular shore type or terrestrial habitat and it seems that the otters used whatever habitat was available. Although this may be true with regard to spraint distribution in this survey, it may not necessarily hold for rest or holt sites. The most important aspect of habitat for otters in marine areas appears to be access to freshwater (Kruuk et al. 1998) and in each of the sea lochs there are a large number of streams suitable for otters to maintain good condition of their fur.

Diet

The sampling regime used to study the diet of

otters in this study differed from that used in many other studies in that individual spraints collected in the field were pooled together to form one sample from each survey site. Although the sample size of 39 appears to be small, the total number of spraints collected was 142. Data are however limited to the diet during the summer months. Eelpout, wrasse, goby, butterfish and eel were the most common prey species (>40%) found in spraints while birds, salmonid species, bullrout, seasnail, stickleback and mammals (<10%) were the least common prey species in spraints. The diet at the study site followed the pattern of other Scottish west coast studies with otters feeding on butterfish gadoids, eels, goby and wrasse (Mason & Macdonald 1980, Watt 1995, McCluskie 1998).

Eelpout were more frequent in spraints from Loch Goil. Eelpout is a common inshore fish, reaching the southern limit of its range to the south of the British Isles. On northern British coasts it is found fairly commonly on the shore between tidemarks (Wheeler 1969). The occurrence of eelpout in spraints from Loch Goil is interesting because McCluskie (1998) did not record eelpout in a similar west coast study and Kruuk (1995) stated that eelpout were a far commoner component of the diet in Shetland but were not as common in the West of Scotland. Eelpout have been regularly recorded in the Clyde estuary (Henderson & Hamilton 1986) but further detailed information on their distribution is required to determine if eelpout is more abundant in Loch Goil than in the other lochs. Eelpout are abundant in shallow waters frequenting 5.5-27.5 m and rarely moving deeper than 40 m (Wheeler 1969). The water-depth near most of the positive sites in Loch Goil is less than 20 m whereas the depths near positive sites along Loch Long are greater than 25 m (Hydrography of Navy 1976). This may account for a higher proportion of eelpout in Loch Goil samples. Sole occurred in samples from Loch Goil and not other lochs. As the shore types at Loch Goil are quite similar to those of the other two lochs it can only be speculated that the shallower depths in Loch Goil may influence either sole abundance or their availability to otters.

Conclusions

Shore type and terrestrial habitat had no effect on the distribution of otter signs but proximity to major roads and availability of shallow water did appear to influence the occurrence of spraints. The diet of otters broadly agreed with previous studies, showing that otters selected bottom dwelling fish. The differences in diet between lochs were possibly due to habitat-depth preferences for otters and their prey. Further research is required to establish how prey abundance in marine habitats may influence otter distribution within different areas of the National Park.

Acknowledgements: We would like to thank T. Murray of Lochgoilhead for access to field sites by boat. This study was completed by J. McMahon as part of an MRes in Ecology and Environmental Biology at the Institute of Biomedical and Life Sciences, University of Glasgow. We also thank two anonymous referees for their helpful comments on the manuscript.

References

Anonymous 2005. State of the Park Report 2005. Loch Lomond & The Trossachs Park Authority, Balloch, UK.

Breathnach, S. & J.S. Fairley 1993. The diet of otters *Lutra lutra* in the Clare river system. Biology and Environment 93B:151-158.

Carss, D.N. & S.G. Parkinson 1996. Errors associated with otter *Lutra lutra* faecal analysis: I. Assessing general diet from spraints. Journal of Zoology (London) 238: 301-317.

Carss, D.N., K.C. Nelson, P.J. Bacon & H. Kruuk 1998. Otter (*Lutra lutra* L.) prey selection in relation to fish abundance and community structure in two different freshwater habitats. In: N. Dunstone & M. Gorman (eds.). Behaviour and ecology of riparian mammals: 191-214. Symposia of the Zoological Society of London 71. Cambridge University Press, Cambridge, UK.

Chanin, P. 2003a. Ecology of the European otter. Conserving Natura 2000 Rivers Ecology Series No. 10. English Nature, Peterborough, UK.

Chanin, P. 2003b. Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers. Monitoring Series No.10, English Nature, Peterborough, UK.

Conroy, J.W.H., J. Watt, J.B. Webb & A. Jones 1993. A guide to the identification of prey remains in otter spraint. The Mammal Society, London, UK.

Green, R. & J. Green 1997. Otter survey of Scotland 1991-1994. Vincent Wildlife Trust, London, UK.

Harkonen, T.J. 1986. Guide to the otoliths of the boney fishes of the North East Atlantic. Danbiu, Hellerup, Denmark.

Henderson, A.R. & J.D. Hamilton 1986. The status of fish populations in the Clyde estuary. Proceedings of the Royal Society of Edinburgh 90B: 157-170.

Heggberget, T.M. 1993. Marine-feeding otters (*Lutra lutra*) in Norway: seasonal variation in prey and reproductive timing. Journal of the Marine Biological Association of the United Kingdom 73: 297-312.

Hydrography of Navy 1976. Marine chart 2131, Firth of Clyde and Loch Fyne, Scotland West Coast. Hydrographic office, Taunton, UK.

Kruuk, H. 1995. Wild otters predation and populations. Oxford University Press, Oxford, UK.

Kruuk, H. & D. Balharry 1990. Effects of seawater on thermal insulation of the otter *Lutra lutra*. Journal of Zoology (London) 185: 205-212.

Kruuk, H., D.N. Carss, J.W.H. Conroy & M.J. Gaywood 1998. Habitat use and conservation of otters (*Lutra lutra*) in Britain. In: N. Dunstone & M.L. Gorman (eds.). Behaviour and ecology of Riparian mammals: 119-133. Symposia of the Zoological Society of London 71. Cambridge University Press, Cambridge, UK.

Kruuk, H., J.W.H. Conroy, U. Glimmerveen & E. Ouwerkerk 1986. The use of spraints to survey populations of otters (*Lutra lutra*). Biological Conservation 35: 187-194.

Kruuk, H. & A. Moorhouse 1990. Seasonal and spatial differences in food selection by otters in Shetland. Journal of Zoology (London) 221: 621-623.

Lovett, L., H. Kruuk & X. Lambin 1997. Factors influencing the use of freshwater pools by otters, *Lutra lutra*, in a marine environment. Journal of Zoology (London) 243: 825-831.

McCafferty, D.J. 2005. Dietary response of otters (*Lutra lutra*) to introduced prey in Loch Lomond, Scotland. Journal of Zoology (London) 266: 255-260.

McCafferty, D.J. 2005. Ecology and conservation of otters (*Lutra lutra*) in Loch Lomond and The Trossachs National Park. Glasgow Naturalist 24:29-35.

McCluskie, A.E. 1998. Temperature-mediated shifts in the foraging behaviour of the Eurasian otter, *Lutra lutra* L. PhD thesis. University of Glasgow, Glasgow, UK.

Mason, C.F. & S.M. Macdonald 1980. The winter diet of otters (*Lutra lutra*) on a Scottish sea loch. Journal of Zoology (London) 192: 558-561.

Mason, C.F. & S.M. Macdonald 1986. Otters: ecology and conservation. Cambridge University Press, Cambridge, UK.

Mason, C.F., S.M. Macdonald, H.C. Bland & J. Ratford 1992. Organochlorine pesticide and PCB contents in otter (*Lutra lutra*) scats from western Scotland. Water Air and Soil Pollution 64: 617-626.

Nolet, B.A., D.E.A. Wansink & H. Kruuk 1993. Diving of otters (*Lutra lutra*) in a marine habitat: use of depths by a single prey loader. Journal of Animal Ecology 62: 22-32.

Ottino, P. & P. Giller 2004. Distribution, density, diet and habitat use of the otter in relation to land use in the Araglin valley, southern Ireland. Proceedings of the Royal Irish Academy 104B: 1-17.

Philcox, C.K., A.L. Grogan & D.W. Macdonald 1999. Patterns of otter *Lutra lutra* mortality in Britain. Journal of Applied Ecology 36: 748-762.

Watt, J. 1995. Seasonal and area-related variations in the diet of otters *Lutra lutra* on Mull. Journal of Zoology (London) 237: 179-194.

Wheeler, A. 1969. The fishes of the British Isles and North-West Europe. Macmillan, London, UK.

Samenvatting

De verspreiding en voedselkeuze van otters (*Lutra lutra)* langs de kusten van Loch Lomond en The Trossachs National Park, Schotland, Groot-Brittannië

Loch Lomond and The Trossachs National Park, het eerste nationale park van Schotland, werd in 2002 opgericht. Langs de kusten van het park bevindt zich geschikt habitat voor otters (*Lutra lutra*) en hun prooidieren. Dit artikel presenteert een onderzoek naar de verspreiding en voedselkeuze van otters in drie 'lochs' (zeearmen) grenzend aan het nationale park. De gegevens dienen als basis voor een soortenbeschermingsplan voor de otters in dit gebied. Tussen april en

augustus 2005 werd op 39 lokaties gezocht naar ottersporen (spraints en pootafdrukken). Op 46% van de lokaties werden ottersporen aangetroffen. Op 69% van de lokaties rond Loch Goil werden sporen gevonden, rond Loch Long (37%) en Holy Loch (28%) was dit minder. Er was geen verschil in aanwezigheid van ottersporen tussen verschillende oevertypen of landhabitats. Op lokaties met hoofdwegen werden minder (15,4%) ottersporen aangetroffen dan op lokaties met secundaire wegen (50,0%) of zonder wegen (71,4%). De verspreiding van otterspraints werd daarnaast in belangrijke mate beinvloed door de beschikbaarheid van ondiepe wateren. Uit analyse van spraints bleek dat voornamelijk bodembewonende vissoorten en krabben waren gegeten. Het enige significante verschil tussen de drie lochs uittte zich in het aandeel puitaal (*Zoarces viviparous*) en tong (*Solea solea*) in de spraints. Puitaal en tong kwamen meer voor in spraints afkomstig van Loch Goil.

Received: 4 November 2005
Accepted: 11 January 2006