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Otters and Fish Farms

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Finally, many thanks to Michael Knollseisen and Anja Roy for their help in organizing and running the workshop as well as Rosemarie Parz-Gollner for her assistance in editing this BOKU-report.
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OTTERS AND FISH FARMS: AN INTRODUCTION

Hartmut GOSSOW and Andreas KRANZ

Over the centuries, fish farmers and anglers have tended to regard the otter as vermin, a pest that deserves nothing less than extinction. However, otters have also been kept as pets, and have even been trained to hunt fish for the kitchen. Moreover, otters were regarded as a delicious meal, consumed in particular by people of high social rank.

Otter numbers apparantly decreased dramatically during the 20th century and, as the conflict lessened, the otter and the conflict were almost forgotten. Traditional ecological knowledge of the species, such as behavioural knowledge that enabled successful catching, was also lost. The main reasons for the decline of otters were thought to be habitat destruction and over-hunting. However, the recent increase in otter numbers around Europe, almost simultaneously, casts doubt on these arguments. It turns out that they are little more than slogans based upon common sense information: otters vanish from areas without food, and otters are not present where they are hunted efficiently, particularely in fragmented habitats. One of the possible forces responsible for the disappearance from large areas with food and shelter is pollution, though the causal factors are still not fully understood. However, we know at least that they exist.

Conservationists became interested in the plight of the species in the 1970's, and a decade later, as the issue was discussed wider, and numbers of otters began increasing again, problems with fish farmers began to arise again. It may turn out that otters raise more conflicting emotions than any other species in Europe. The outcome of this conflict may become an example of how people cope with a competing species at the end of the 20th century. The question is, are we more responsible and wiser than our ancestors, or are our conservation efforts and respect toward other species little more than hypocrisy, lasting just as long as our own interests are not touched. Indeed, what role, or what influence does science have in such an issue?

The Institute of Wildlife Biology and Game Management, at the University of Agricultural Sciences (Universität für Bodenkultur) in Vienna, has studied various aspects of the ecology of the Eurasian otter (*Lutra lutra*) for a number of years. In February 1996 we organised a workshop, "Otters and fish farms", in

Litschau, at which 40 people from 13 different countries attended. It was the intention to bring together biologists and fisheries professionals from several European countries to discuss the problem and to benefit from experiences elsewhere as, at least in Austria, the discussion seemed stuck in a dead end. Biologists, most of them also representing conservationists´ ideas, had the possibility to hear arguments of concerned fish farmers. In addition, fish farmers got an insight into science and the immense problems in providing sound answers to basic questions, such as how many otters live in a certain area and how much commercial fish they eat. The resulting proceedings, including a few additional contributions of people who were unable to attend the workshop, might go some way towards serving as a statement of the current state of the conflict, the state of our knowledge and areas where necessary information is not available and urgent research is still required.

FISH FARMING AND OTTER DAMAGES IN THE WALDVIERTEL REGION IN LOWER AUSTRIA - AN EXAMPLE: KINSKY´S FISH FARM ENTERPRISE HEIDENREICHSTEIN

Willibald HAFELLNER

Key words: Lutra lutra, fish farming, damage, pest control, Lower Austria

General Historical Review

Fish ponds have a long standing tradition in the Waldviertel region. They contribute considerably to the beauty of this landscape. First records abound fish ponds in the Waldviertel region go back to the 13th century. A first peak of fish farming was in the 16th and 17th century. After centuries of little importance, fish farming became again important after the Second World War, and in the last 20 years they became more important in providing casual emoluments and for recreational activities. This caused the building of many new, but usually tiny ponds; at the present, there exist about 1,400 ponds with a total area of 1,600 ha. This, together with the rivers and streams, provides a real paradise for otters.

Fish Farming in the Waldviertel Region: an Example

The fish farming enterprise of Kinsky is one of the five largest in the region with a total of 20 ponds (170 ha). The effective productive area is, however just 140 ha of water, the rest is sedimented area, covered by plants. This is in particular true for the two largest ponds (58 ha and 30 ha) which are also nature reserves. All ponds are used for carp (*Cyprinus carpio*) production, but there is also a considerable emphasis to produce other species such as zander (*Stizostedion lucioperca*), pike (*Esox lucius*), whitefish (*Coregonus* sp.), tench (*Tinca tinca*) and coarse fish, mainly perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*). Salmonids are not produced.

The average pond stocking is about 290 kg per hektar, the average harvest is about 640 kg/ha, but these values include also the stocking for the winter. Focusing just on the summer period, stocking is about 235 kg, and harvest is about 580 kg/ha. The annual increase is 350 kg/ha. Characterizing the stocking in numbers of individuals, an average of 1,200 - 1,500 K1 (= smallest carp size; <1 year; <10 cm) and an average of 380 - 420 K2 (= 1-2 year; 10-25 cm) are stocked per hectar. These stocking levels are low, compared with other fish farming areas in Central Europe, e.g. in Saxony and Bavaria, where extensive carp fish farms are by definition those with stocking under 2,500 - 3,000 K1/ha or 500 - 600 K2/ha. Stocking levels are so low here, because of the low natural productivity (cold water and little nutritive substances), but in particular because it is the aim to produce healthy and robust fish for stocking in other ponds, lakes and rivers. Indeed, 80 % are used for restocking and only 20 % are for consumption (which is a speciality of this enterprise, whereas most others in this region produce carp for consumption).

Otter Damages

It is not the otter damage alone, which brings the economic disaster to local fish farmers, but the generally bad economic situation which is caused by the new concurrence of the Czech Republic after the velvet revolution in 1989 (cheap carp), and the fact that Austria joined the European Community. However, in order to understand fish farmers, their arguments and feelings, I would like to describe the harvest of a pond in a narrative way:

A large, 58 ha pond of the Waldvietel is going to be harvested. It is already the second day of harvest, a sunny but rather cold day in autumn. On the first day, the more sensitive fish, whitefish and zander, were harvested. The second day is `carp day´. The carp looks healthy and nice and is well grown. More than 20 men are ready, everybody knows his duty, it is a good team. The fish are taken out with nets and are sorted and stored in different barrels on a lorry. But as the work proceeds, jokes are more and more rare. The last net was only half full. The boss of the team starts calculating, he expected at least another five to six tons of fish. In this harvesting period, there were no fish diseases recorded, no problems with the water quality, no dead fish. Only the otter was permanent present during the year, and today already 10 carp, injured or half eaten by otters, were found in the net. They looked very unpleasant. The faces of the fishermen get longer and longer, at the end of the day about three tons of carp are missing. The general mood has reach its low point. There is no other plausible explanation, but the otter.

In concrete figures, otter damages increased quickly in the fish ponds of Kinsky. Before 1991, damages were so small that they were ignored. Since 1991 two, respectively three small ponds showed losses caused by the otter, and since 1992 also one large pond. The losses were up to 25 % of the stock, the annual loss from the harvest was 3.5 tons or 150,000 ATS (12,000 USD). The extent of even such high otter damages could be tolerated as long as compensation payments would outweight the loss.

The year 1995 was, however, a real disaster. The damage caused by the otters endangered the future of the fish farming enterprise. During the draining of ponds in spring 1995, which was done in order to translocate carp from one pond to another, it became already clear that fish to the value of 26,000 ATS (2,080 USD) are missing. The main problem, however, was the bad condition of carp after being disturbed by otters, as indicated by the permanent presence of otters all over the winter. The bad quality of fish asked for additional manipulation and sorting in order to provide only excellent fish for the customers. Until autumn, when the harvest took place, many of these poor looking carp had died and the total financial loss due to otter was calculated to be 660,000 ATS (52,800 USD) for all Kinsky´s fish ponds. Another serious disadvantage was, that many customers could not be served. As a result they shifted to the concurrence.

From our point of view, there are too many otters in this ideal, but mainly man-made habitat. Fish farmers have predicted this increase of otters, but conservationists believed that these were only exaggerations. The situation now asks for a drastic reduction of otters, five or ten otters would not be enough, because in 1993 alone, 13 otters were killed on the roads in the Waldviertel region without having any effect on the level of otter damages.

It is not the intention to ask for killing otters which would not be acceptable for conservationists, but we ask for live catching and translocating of otters from this area.

OTTERS VERSUS PRIVATISATION IN THE CZECH REPUBLIC

Ales TOMAN

Key words: Lutra lutra, velvet revolution, fish pond, conservation, Czech Republic

Right after the revolution in 1989, nobody expected that the political changes in the Czech Republic would have a major effect upon nature conservation problems. The experiences of the years following 1989 proved quickly the opposite. The privatisation of land, forest and especially fish ponds raise conflicts with nature protection interests. Before the revolution of 1989, fish farms belonged to the state fisheries and co-operative farms. They tolerated fish losses caused by otters, it was part of the natural fish mortality. Nowadays, fish farmers and anglers are not willing to accept losses caused by fish eaters such as grey herons (*Ardea cinera*), cormorants (*Palacrocorax carbo*) and otters (*Lutra lutra*). The damage caused by otters and the resulting claims, however, have to be considered differntialy according to the three main otter habitats in the Czech Republic.

The mountain habitat is characterized by small and medium sized oligotrofic streams. It can be found in the Sumava and the Novohradské hory mountains in southern Bohemia and in the Beskydy mountains in northeast Moravia. These streams are used by the Czech Anglers Union. They can be scored into breeding streams, where angling is forbidden and streams for angling. The main fish species, both in terms of biomass and economic importance, are brown trout (*Salmo trutta m. fario*) and grayling (*Thymallus thymallus*). Due to the low abundance of prey, the otter density is low. Snow surveys revealed the presence of 35 otters in an area of one tousand square kilometres in the Sumava mountains in 1991 - 1992. Fisheries complain about disastrous damages on trout populations in breeding streams. However, to data there does not exist any reliable information about damage caused by otters. The disappearance of trout may have also other causes than the regular presence of otters. Proved damage was found so far only in hatcheries and other water bodies with artificial high stocking levels of trout. In the first case it will be necessary and possible to solve the problem by fencing. The second case - unnatural high stocking levels - askes for a change in the attitude in people. It is not the otter which cause problems, but the activity of human beings.

The second type of otter habitat is the fish pond area in pans of southern Bohemia around the towns Trebon and Cesky Budeovice. There, many large ponds of tens and hundreds of hectares are managed by large and professional fish farming companies. In spite of the fact that this habitat holds the highest otter density of the Czech Republic, otters are not considered to be a serious problem. In contrast the grey heron and the cormorant are seen as a problem These two species have several breeding colonies of several hundred pairs in this area and the resulting damage is much more visible than that of the elusive otter. However, in winter, when ice restricts access to food, otters concentrate in some cases on ponds which are kept open artificially by man. Then, the damage is more visible, fish farmers visit these holes every day to keep them open and they find blood and food remains. Finally and most recently, there are increasing complains about secondary damages caused by otters stressing over-wintering carp (*Cyprinus carpio*).

The habitat with the most serious conflict is found in the Czech-Moravian highlands. This habitat represents the largest part of the otter distribution in the Czech Republic. Most streams and small rivers are chanalysed in different degrees of intensity and many of them are heavily polluted. However, many small ponds, used for carp production, provide a rich food base and convenient shelter for otters. Besides a few larger fish companies which manage several dozen of ponds, many ponds belong to private people, each of them owning only one or a few. The situation is quite similar to that in neighbouring Austria. These private people complain about losses of up to 100 % of the stock in one year. And they complain also about secondary losses. However, up to present, the role of otters for indirect fish losses in winter is unclear. There exist several other reasons (water accidity, water temperature, oxygen level, noise) which can cause lethal stress to over-wintering carp. The identification of a certain reason is frequently difficult and asks for a permanent control of the ponds. This is rather rare in private people who run the ponds as a little enterprise with as little effort as possible and also often with little experience.

OTTERS (*LUTRA LUTRA*) AND FISH FARMING IN SCOTLAND

Jim CONROY and Rosemary GREEN

Key words: Lutra lutra, Salmo trutta, Salmo salar, angling, fisheries, trout damage, Scotland

Introduction

For several centuries there has been in Britain a conflict between man and otter (*Lutra lutra*). As long ago as the mediaeval ages, large estates and ecclesiastical houses kept ponds stocked with fish, while in some areas, e.g. Yorkshire, fish traps were set on many rivers to catch salmon (*Salmo salar*) (Howes 1976). Otters were known to enter these ponds and take the fish, and as a result the piscivorous otter was seen as a direct competitor for the fish. The result was a campaign to eradicate this voracious menace (Howes 1976). At this time, men, who could kill otters very well were in much demand. Such was the problem that in 1566, the otter in England was proscribed by law under the `Acte for the Preservation of Grayne´. This legislation enabled church wardens to place bounties on otters, and fishermen in many parts of the country were instructed to keep dogs to hunt otters on the rivers. Failure to do this could result in a substantial fine.

In the UK, the otter is currently listed in the Red Data Book of British Mammals (Morris 1993), is protected under the Wildlife and Countryside (1981) Act and is listed on Schedule 2 of the Conservation Regulations (1994). It can only be removed from an area, or killed, if a license for the purpose is issued by the appropriate Government Department - in Scotland the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD).

SOAEFD consults with Scottish Natural Heritage (SNH), the country´s statutory conservation agency over license applications. There has been a presumption against issuing a license to a fish farm if deterrent and protective measures are not in place. Licenses are issued to live-trap and remove otters from the vicinity in the first instance. (Policy was that live-trapping was the only permitted option. In 1996, however, when live-trapping was unsuccessful in removing an otter which was killing poultry, the Department granted a license to kill.)

To date, no licenses have been issued in regard to predation on natural fisheries and stocked river beats or lochs. The Act states that licenses may be applied for in respect of `serious damage´. It is unfortunate that after more than 15 years there is no working definition of `serious damage´, no procedure for independent assessment of the scale of loss and no system for verification of the cause of damage. Few such licenses have been issued (SOAEFD records list 4). There is little evidence of illegal killing of otters.

Today, the potential for conflict between otters, man and fisheries remains. In this paper we describe the current situation in Scotland and recent observations on otters at commercial fisheries. In Scotland, no compensation is currently paid for damage caused by otters at fish farms.

Fisheries Interests in Scotland

There are three main fisheries interests in Scotland:
- Sports angling - salmon/trout and coarse fishing
- Marine fisheries
- Fish farming - marine and freshwater

Sports Angling

Salmon and Trout Fisheries. Scotland is renowned throughout the world for its salmon / trout fisheries, with thousands of anglers regularly fishing in Scottish rivers and lochs. Such fishing makes a significant contribution to the economy of the country. For example, using the 1988-1989 data for ten of the most important fishing areas in Scotland, Mackay Consultants (1989) estimated that salmon fishing was worth £50.4 million to the Scottish economy, and was responsible for the equivalent of 514 full-time jobs. Crisp in Bayfield & Conroy (1995) estimated the fisheries in Loch Lomond were valued at £1 - £2 millions , while fisheries on the River Spey were valued at £6 million in 1988 (NERPB 1995). Estimates for 1995 put the value of Scottish salmon fisheries at £350 million (Mclay & Gordon-Rogers 1997), with the salmon and trout catch for River Tweed catchment valued at £13.6 million to the local economy and supporting 520 full time job equivalents.

Sports angling is therefore an important resource to the national and local economies, and anything which is likely to affect this in a serious way would be viewed with alarm. The Report of the Scottish Salmon Strategy Task Force

((Mclay & Gordon-Rogers 1997) states `Otters are capable of inflicting significant damage on salmon populations,... In view of this, it is important to keep the impact of otters upon salmon under review.´ The authors produced little evidence for this view, which was contested during the consultation procedure.

Otters are known to eat salmonids (see Chanin 1985; Mason & Macdonald 1986; Carss 1995 for summary of diet). Many tales are told of large fish lying on river banks with a single bite from its back. Such kills are attributed to otters and they have, especially in the past, been seen as a major predator on game fish. The picture is not as simple as it seems, however. In general otters feed on the smaller salmonids. For example Wise, Linn & Kennedy (1981) recorded that 74 % of the salmonid remains identified in otter faeces measured less than 12 cms. Carss, Kruuk & Conroy (1990) undertook a detailed study of otter predation on salmon, using faecal analysis, radio nuclides and radio tracking, and concluded that although large salmon are killed by otters, these tend to be males and occur in the winter, usually after spawning, and that the effects of otters on salmon populations and on fishing returns is small.

During studies of otters along the rivers of north-east Scotland, one of us (JWHC) regularly talked with anglers, fishing ghillies and game keepers. None of them saw the otter as a serious threat to the fishing. In fact many were pleased to have otters in the rivers, especially when they realised that the animals were also feeding on eels. Mackay Consultants (1989) in their survey of salmon fishers asked what measures could be taken to improve the fishing. None of the respondents mentioned the otter as a problem, there were, however, calls for a cull of seals.

Apart from the Scottish Salmon Strategy Task Force, there is little concern for the effects of the otter predation on salmonid fisheries on the major rivers in Scotland. There is, however, concern on some commercial, highly managed fisheries, such as small lochs, stocked with specimen fish, or `put and take´ fisheries. Complaints arise particularly after otters recolonise an area, paralleling fears over the introduction of American minx (*Mustela vison*) or the expansion of inland cormorant (*Phalacrocorax carbo*). We therefore conclude that the impact of otters on sports angling is quite small.

Coarse Fisheries. While coarse fisheries is relatively scare in Scotland, it is a major leisure pursuit in England. Coarse fishery users and proprietors are much more vociferous about predation because in this sport every fish, regardless of species or size, is considered important. In Scotland, complaints have arisen from the manager of a loch stocked with large carp (*Cyprinus carpio*). Each fish is valuable, so fish removed from the loch and left to die represent greater loss than most salmonid predation.

Neither the scale of otter predation on coarse fishing nor the economic implications have, however, been assessed, and it is not possible to determine its likely impact on the sport, but in Scotland, we suggest that overall it is minimal.

Marine Fisheries

Otters living in the sea feed largely on small, non-commercial demersal fish, which are caught in shallow water close inshore (see Kruuk 1995 for details). There is, therefore, no conflict between commercial marine fisheries and otters.

Fish Farming

Fish farming in Scotland occurs in both freshwater and marine habitats. The former can be in lochs, rivers or in specially designed fish tanks near freshwater. Marine fish farms tend to be in sheltered bays or sea lochs, are largely sited close inshore and in relatively shallow water. In recent years, there has been a trend to use large rafts of fish cages, anchored in deeper water, and situated much further offshore. These farms are unlikely to attract otters, and are not discussed here.

Two species of fish dominate fish farming in Scotland; rainbow trout (*Oncorhynchus mykiss*) and Atlantic salmon. Each year, the Scottish Office produces an annual review of fish production from Scottish farms (Table 1). Unless, otherwise acknowledged, the figures produced for production, employment etc. are taken from the 1995 survey (Scottish Office 1996).

Most rainbow trout fish farms are associated with freshwater (93 %). Production has more than doubled (108 %) over the past decade. The bulk of the fish are used for human consumption, although a proportion goes to restocking rivers or to sustain small-scale angling interests, usually at the farm.

Table 1: Fish production and employment statistics for Scottish fish farms in 1995 (from Scottish Office 1996)

Species of Fish	Number of Companies	Number of Sites	Numbers Employed F/T	Numbers Employed P/T	Fish Production (Tonnes)
Rainbow trout	55	69	132	64	4,683
Atlantic salmon	108	268	1,104	251	70,060

Key: F/T Full time employment; P/T Part time employment

Salmon fish farming is by far the more important, employing nearly seven times that of the trout fishery, production is about 15 times greater, and has increased ten-fold from 6,921 tonnes in 1985 to 70,060 tonnes in 1995. The bulk of this production is for human consumption. Both these fisheries contribute greatly to the economy, with sites very often situated in socially-deprived parts of Scotland, e.g. the Highlands and Islands. Some trout farms produce brown trout for re-stocking and production of ova for sale.

The only salmon farms likely to have problems with otters are smolt farms, although they are usually heavily protected because of the value of the enterprise. It is the only type of farming to have produced significant complaints about otters.

Other Fisheries

In the past, there was also commercial eel (*Anguilla anguilla*) fisheries in Scotland. This was never a major industry, lasting for only a few years at any one location. The eels were caught in specially designed fyke nets, which until they were modified by the addition of guard grids were dangerous to otters - the animals enter the nets after the eels, become caught and drown (Jefferies *et al.* 1988).

Otters and Fish Farms

In 1990, a Code of Practice for Salmon Farming and Predatory Wildlife was published by the Scottish Salmon Growers Association (SSGA) in conjunction with the Nature Conservancy Council (NCC) and five concerned wildlife organisations - the Marine Conservation Society (MCS), World Wide Fund for Nature (WWF), Royal Society for the Protection of Birds (RSPB), the Sea Mammal

Research Unit (SMRU) and the Vincent Wildlife Trust (VWT). Adherence to this code, which incorporate advice on the deployment of anti-predator nets, should eliminate any possibility of otter damage (Anon 1990).

Marine Fish Farms

Along many of the coasts where fish farms are most commonly situated, otters are also numerous. For example, the Highlands and Islands of Scotland has the densest distribution of otters in the U.K. (Green & Green 1996), while Shetland could contain as much as 11 % of the UK otter population (Conroy & Kruuk 1995; Harris *et al.* 1995). There is therefore the potential for conflict between commercial fisheries and otters.

Otters are regularly seen around fish farms and can even be seen feeding on the walkways between the cages. Talks with fish farmers in both Shetland and on the west coast of Scotland confirm that while otters can take the occasional fish from the cages, this loss is not seen as being of economic importance when compared with natural mortality within the cages. It is not thought worthwhile to take additional measures to make cages otter-proof, or to make efforts to remove or kill the offending animals. In a review on the environmental impacts of salmon farming in Scotland, Ross (1997) also commented that otters are not regarded as a problem at marine salmon farms. Between 1989 and 1990, a study of the interactions between otters and marine fish farms found no adverse impacts in either direction (Green *et al.* unpublished).

The reason why otters tend to be seen around fish cages is because food intended for the salmon passes through the net and attracts wild fish. It is upon these that the otters prey. Even when the animals are seen eating on the walkways, they are usually eating large wild fish, which if the fish cages were not present would have been taken ashore. Observations on otters in marine habitats show that salmonids form a very small part of their diet (Herfst 1984; Watson 1978; Watt 1991, 1995).

Freshwater Fish Farms

In freshwater habitats, the problems can be more serious, and there are proven records of otters entering fish ponds and over a period of time removing large numbers of fish. In fact it was largely because of this behaviour that the species was proscribed by law in 1566.

There are three problems reported from freshwater fish farms whether farming salmon smolts, rainbow or brown trout. These are:

- The volume of fish eaten. This, however, is easily overestimated, and may include other losses, which are ascribed to otters.
- If a predator enters a pool, fish are said to panic and crowd together resulting in asphyxiation, especially when conditions are warm. This is commonly quoted by fish farmers, but has not been independently verified. Fish farmers to whom one of us (RG) has spoken described watching otters catch eels in their farms without causing panic. It is also argued that fish which are disturbed by a predator, eat less and grow more slowly.
- Damage to large, high value fish, such as stock fish. If heavily stocked and crowded in small pools, an otter getting in may grab and damage several fish before managing to secure one.

Farms with earth ponds or fattening cages in lochs, which include most smolt farms, are the prime area of concern. Freshwater loch cages can be adequately protected, using curtain and top nets as advised for marine cages. Farmers may, however, find the cost of the extra work involved with curtain nets uneconomic for the scale of otter damage.

The weak points for farms with earth ponds are the water intakes and outlets. If piping water in and out of the farm is not possible, a series of screens and regular maintenance can help reduce the problem. Protection by electric fencing can extend to the whole farm, or can be used for specific ponds with the most high value stock. The use of electric fencing requires a commitment to regular maintenance. It is easier to install when the farm is being built rather than after problems arise. The most effective solution to prevent otters getting into the farm is by including an otter proof boundary at the time of construction. Dissuading otters once the farm has become part of the animalís home range is difficult. However, as with otters visiting the walkways of marine cages, an otter in a fish farm is not necessarily preying on farmed fish. A male otter radio-tracked in Perthshire, for example, had two fish farms within its home range and visited them both whenever he was in their vicinity, but on no occasion did he linger and fish there (Green *et al.* 1984). We would like to see otter protection made a necessary condition of planing consent for all new fish farms.

Most trout farms in Scotland show some evidence of otter activity, but, even with a lack of deterrents, comparatively few farms report significant damage. Since 1990, complaints from the fish farming community to the Vincent Wildlife Trust average around three a year, with a maximum of five. Some farms report regular problems, while other have never had any. Much of what is reported is short-term, an outbreak of persistent predation often stops as suddenly as it started, often being the result of visits from sick or injured animals surviving on the most easily accessible prey. Such animals either die or recover. Sixteen percent of all injured otters sent to the VWT´s otter rehabilitation centre were caught at fish farms, and four cases of predation, on which advice was sought ended when a dead animal was found. The other circumstance which may produce a noticeable outbreak of predation is a period of prolonged bad weather preventing a female with small cubs from utilising her usual feeding area.

Removal of the otters is not recommended, because in many areas, where the species is now common, the vacated range will become occupied quite quickly by another animal, and the problem may arise once again.

Ornamental Ponds

In addition to commercial fish farms, otters also predate ornamental ponds, often taking fish. The scale of this problem is far from clear; the vociferous response from people who have experienced such predation may over emphasis the problem.

Impact of Fisheries on Otters

While there is no serious conflict between man and otters, commercial fisheries have been responsible for the deaths of many otters in the UK, with in areas where populations are small and fragmented the possibility of serious implications for the continuing survival of the species there.

Between 1975 and 1993 Jefferies *et al.* (1993) recorded 137 otters drowning as a result of commercial fisheries - 69 in fyke nets, 66 in creels and two in nets. The authors believe that these figures are very much an underestimate, suggesting that, between 1975 and 1992, as many as 230 otters have drowned in creels laid in the waters around Skye, South Uist, Orkney and Shetland.

Deaths in fyke nets have been reduced greatly by the use of guard grids over the mouth, these allow eels, but not otters, to enter the nets (Jefferies *et al.* 1988). While most of these deaths are reported in areas where otters are relatively common, and are likely to have little effect on the population, e.g. in Shetland 15 animals drowned in nine years, this is less than 1 % of the Island's population. However, in some areas, where otters are rare, or small populations are fragmented, the death of a single animal can have serious implications for the subsequent survival of these populations (Jefferies 1985, 1990).

Discussion

Fishing interests in Scotland include commercial sports fishing, coarse fishing, commercial sea fishing and fish farming. All are important to the local communities, both in income generated and employment. In many cases important angling areas and fish farm sites are located in area where otters are common, e.g. Shetland and the Highlands and Islands of Scotland (Conroy & Kruuk 1995; Green & Green 1996).

While the potential for conflict between fishery interests and otters exist, these are largely minimal. Either:

- the damage done is so small that efforts to reduce or eliminate the problem are considered not to be economic - marine fish farms;
- simple methods such as electric fences are usually sufficient to eliminate the problem - freshwater fish farms;
- the majority of the fish taken by the otters are not of the quality or the size which are of interest to anglers - sports fishing. This is not the case with coarse fishing or carp stocked ponds.

Electric fencing requires some maintenance and can create problems. It is not cheap to install, and really effective exclusion measures may on the end cost more than the scale of damage warrants.

To date no serious claims for compensation have been made for damage by otters to any fisheries interest in Scotland. Some, however, has been mooted in England at trout farms and cap ponds. Rather fisheries managers in general see no real problems with otters. This, of course, is somewhat different from the situation in some other countries where the animals are perceived as causing problems with the commercial fisheries. For example in the fish pond areas of Austria and the

Czech Republic (Bodner 1994). The situation, however, could change in Britain, if the otter population continues to recover, and there are increases in otter incursions into fish farms and ornamental ponds.

One serious problem with the whole question of otter predation at fish farms has been the lack of good scientific evidence showing the scale of the problem. There is a need for a comprehensive research programme to address this. Also, the statutory agencies responsible for the issuing of licenses should ensure that there is a degree of verification about the request. For example, in 1990 a salmon farmer on the Outer Isles was granted a license in respect of damage which, when investigated by the VWT was shown to be seal related. The license was revoked, but it is exemplifies the problem of a licensing system which does not require independent verification of the perpetrator or the scale of the damage.

References

Anon. 1990: Salmon Farming and Predatory Wildlife: a Code of Practice. SSGA, MCS., RSPB, SMRU, VWT, NCC. Perth.

Bayfield, N.G. and Conroy, J.W.H. 1995. Ecological Assessment of Loch Lomond Water Management Proposals. Institute of Terrestrial Ecology, Banchory.

Bodner, M. 1994. The European otter *Lutra lutra* L. In Austria - a review of recent research and conservation activities. In: Seminar on the Conservation of the European Otter (*Lutra lutra*). Leeuwarden, the Netherlands, 7-11 June 1994. Pp98-104. Council of Europe, Strasbourg.

Carss, D.N. 1995. Foraging behaviour and feeding ecology of the otter *Lutra lutra*: a selective review. Hystrix (n.s.), 7, 179-194.

Carss, D.N., Kruuk, H. and Conroy, J.W.H. 1990: Predation on adult Atlantic salmon, *Salmo salar*, by otters, *Lutra lutra*, within the River Dee system, Aberdeenshire. Journal of Fish Biology, 37, 935-944.

Chanin, P.R.F. 1985. The Natural history of Otters. Croom Helm, London.

Conroy, J.W.H. and Kruuk, H. 1995. Changes in otter numbers in Shetland between 1988 and 1993. Oryx, 29, 197-204.

Green, J. and Green, R. 1996. Otter Survey of Scotland 1991-1994. The Vincent Wildlife Trust, London.

Green, J. , Green, R. and Jefferies, D.J. 1984. A radio-tracking survey of *Lutra lutra* on a Perthshire river system. Lutra, 27, 85-145.

Harris, S., Morris, P.A., Wray, S. and Yalden, D. 1995. A Review of British Mammals: Population Estimates and Conservation Status of British Mammals and other Cetaceans. JNCC, Peterborough.

HERFST, M. 1984. Habitat an d food of the otter *Lutra lutra* in Shetland. Lutra, 27, 57-70.

Howes, C.A. 1976. The decline of the otter in South Yorkshire and adjacent areas. Naturalist, 101, 3-12.

Jefferies, D.J. 1985. An otter casualty from Breydon Water, Norfolk. Otters; journal of the Otter Trust, 1984, 1, No. 8, 23-24.

Jefferies, D.J. 1990. Further records of fyke net and creel deaths in British otters (*Lutra lutra*) with a discussion on the use of guards. Otters; journal of the Otter Trust, 1989, 2, No. 3, 13-20.

Jeffereies, D.J., Green, J. and Green, R. 1994: Otter mortalities due to commercial fishing 1975-1992. In: Proceedings of the National Otter Conference. (ed. P.A Morris). pp. 25-29. Mammal Society, Bristol.

Jefferies, D.J., Crisps, S.J., Gorod, L.A., Harrison, B., Johnstone, J.S., Potter, E.C.E. and Weir, V. 1988. The Effects of Otter Guards on the Fishing Efficiency of Eel Fyke Nets. The Vincent Wildlife Trust, London.

Kruuk, H. 1995. Wild Otters, Predation and Populations. Oxford University Press, Oxford.

Mackay Consultants 1989. Economic Importance of Salmon Fishing and Netting in Scotland. Mackay Consultants, Inverness.

Mason, C.F. and Macdonald, S.M. 1986. Otters: Ecology and Conservation. Cambridge University Press, Cambridge.

Mclay, A. and Gordon-Rogers, K. 1997. Report of the Scottish Salmon Strategy Task Force. The Scottish Office, Edinburgh.

Morris, P.A. 1993. A Red Data Book for British Mammals. The Mammal Society, London.

NERPB 1995. River Spey Catchment Review 1995. NERPB, Aberdeen.

Ross, A. 1997. Leaping in the Dark; a review of the environmental impacts of marine salmon farming in Scotland and proposals for change. Scottish Countryside and Wildlife Link, Perth.

Scottish Office 1996. Scottish Fish Farms Annual Production Survey, 1995. Scottish Office, Edinburgh.

Watson, H. 1978. Coastal Otters in Shetland. The Vincent Wildlife Trust, London.

Watt, J. 1991: Prey Selection by Coastal Otters (*Lutra lutra* L.). Ph.D. Thesis, University of Aberdeen, Aberdeen.

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

Wise, M.H., Linn, I. and Kennedy, C.R. 1981. A comparison of the feeding biology of mink *Mustela vison* and otter *Lutra lutra*. Journal of Zoology, London, 195, 181-213.

OTTERS AS PREDATORS AT ORNAMENTAL PONDS

Rosemary GREEN

Key words: Lutra lutra, ornamental fish ponds, damage, Great Britain

Otter predation at commercial fish ponds and fish farms has a long history, but predation of goldfish (*Carasius auratus*) in garden ponds is not so well known. A well publicised episode of predation in gardens in Lincolnshire in May and June 1995 brought to light similar incidents throughout the UK.

Hagworthingham is a picturesque village in the Lincolnshire Woods, on the watershed between the River Bain and the River Lymn. It is situated on the springline, which facilitates the creation of ornamental ponds in almost every garden. Gardening is a competitive enterprise in this village with a population of mainly middle-aged and retired people. The ponds varied from a tiny pool of 1.5m x 0.6m raised on a plinth, in courtyard entirely surounded by the house on two sides and a wall on the others, accessible only by a small gate, to a pond 150m x 50m and over 4m deep. The fish species taken by the predator included goldfish (*C. auratus*), koi, mirror and other ornamental carp varieties (*Cyprinus carpio* .), roach (*Rutilus rutilus*), rudd (*Scardinius erythropthalmus*), eels (*Anguilla anguilla*), stickle-backs (*Gasterosteus aculeatus*) and grass carp (*Ctenopharyngodon idella*). The loss of carp varieties caused most distress as these were not only costly, but regarded as pets. Owners had watched them grow for several years, some to weights in excess of 4 kilos, only to find them killed, and often not even eaten, which caused such outrage at the predation.

Otter signs were present in the village gardens, but in rather small numbers (n = 4 sprains only 1 of which was less than a week old, + 1 set of tracks, found on 2 visits). Spraints found in the gardens or the adjoining Nature Reseve did not contain carp scales and none of the spraints found had the remains of any large fish. However as large fish were left partly eaten and descaled in the gardens this may not be significant. Three of the villagers have seen otters in their gardens and others have been visited by predators large enough to dislodge substantial underwater planting baskets. Water lilies and more exotic water plants are expensive; the average cost of planting a modest garden pond was estimated by one gardener to be about £ 250, so the damage to plants was also a cause of grievance.

Otters had been almost completely absent from this part of eastern England for twenty years when a small restocking programme was carried out in 1994 in which eight otters were released on the River Lymn and the Steeping River to the east of Hagworthingham. In the early part of 1995 the remnant otter population on the River Bain expanded rapidly in size and range and mink also moved onto the River Lymn in large enough numbers to cause problems at pheasant rearing pens. Given the unusual abundance of predators in the area and the paucity of evidence on the ground it is not possible to be certain whether the restocked otters, which were blamed, were responsible for all, or indeed, any of the predation. This incident caused such high feeling because predation in gardens on this scale was new and because the village was composed of a mixture of former town dwellers, who were unused to any wildlife at close quaters, and rural people who were used to protecting their stock against predation.

In the same year similar reports of predation in garden ponds were received from the outskirts of Scarborough in North Yorkshire. Again ponds in gardens close to the becks were cleared of goldfish and ornamental varieties of carp and again mink were present as well as otters. In this incident many spraints were found in the gardens and householders had seen otters in their gardens. While some of them regretted the loss of fish, most were pleased to know that they were visited by otters and happy to be able to watch them from their windows; (G. Woodroffe, pers.comm.).

As North Yorkshire had also had a restocking programme from 1990 to 1993 and a more recent increase of the wild population it might be argued that such predation is a result of otters returning to an area after an absence and exploiting every available food source. However in 1995-6 otters taking fish from garden ponds have been reported from Pertshire (H.Livermore, pers. comm.) and Galloway (T. Kenyon, pers. comm.) in Scotland, where otters have always been abundant. These incidents involved predation of golden orfe (*Idus idus*) 35cm in length, goldfish and brown trout (*Salmo trutta fario*). Before 1995 we knew of otters visiting large ornamental lakes in parkland and had radio tracked otters through riverside gardens in Scotland, even having an altercation with a resident cat. However only once, in 1983, had we heard of otters taking goldfish from a garden pond on the banks of the River Lyon in Perthshire. In 1996 otters are also recorded taking fish from garden ponds in parts of Wales where they have recently increased in numbers, but have never been absent; (G. Liles, pers. comm.).

None of these rivers and streams involved in these reports have low fish densities or severe pollution problems, indeed some of them are noted fishing rivers. Food shortage is not forcing otters to visit garden ponds and in any case the predation is usually first noticed when uneaten fish are found.

It is not yet clear if this is genuinely new behaviour by otters or whether otters have been ranging through gardens regularly in the past. It may be that it has only just been noticed by the growing population of affluent and leisured gardeners in rural and suburban areas who have the time and money to build and stock garden ponds. As otters increase in numbers all over the UK more reports of this behaviour may be expected.

OTTERS *(MUSTELIDAE, CARNIVORA)* AND THEIR ROLE IN RICEFIELDS AND FISH PONDS OF WEST JAVA, INDONESIA

Roland MELISCH and Irwansyah Reza LUBIS

Summary
In West Java, several crustacean species cause irrigation problems and crop loss in rice cultivation areas and ponds. Two otter species (*Aonyx cinerea* and *Lutrogale perspicillata*) were found to occur on Java. Faeces' analysis revealed that pest crabs form a high percentage of otters' prey in ricefields and fisheries. Devices to prevent otters from raiding fish ponds are presented. The Indonesian Minister of Forestry gave a commitment for full protection of all four otter species in Indonesia.

Key words: Aonyx cinerea, Lutrogale perspicillata, Java, Indonesia, Southeast Asia, fishery, aquaculture, rice, pest control

Introduction
Crustaceans have repeatedly been reported to be destructive towards rice plants (Balss 1956, Iqbal 1994) and dams in the irrigated ricefield agriculture (Jordan 1957, Lim *et al.* 1971, Iqbal 1994). Similar reports have been published on the detrimental activities of crustaceans in mangrove reforestation schemes (Chan 1988) and in brackish-water pond aquaculture (Scharff & Tweedie 1942, Ferguson 1951, Schuster 1952). Otters are reported to predate on these destructive freshwater crabs in ricefields in Southeast Asia (Wayre 1974, Boonkird & Kanchanasaka 1988, Iqbal 1994). However, otters are also regarded as pests in freshwater and brackish-water fish ponds in the region (Bartels 1934, Rukyani *et al.* 1992). Indonesia has four otter species, all considered endangered (Foster-Turley *et al.* 1990, Groombridge 1993). The aims of the West Javan Otter Project were to reveal the role of otters in ricefields and fisheries within a model project, and to suggest a concept of integrative management suitable for both purposes: food production and conservation.

Methods
Eighteen characteristic wetland areas of West Java were chosen to gain a general understanding of the otters' role in artificial and natural habitats (Fig. 1). From August 1993 until May 1994, otter presence was assessed by single surveys of 500 m lengths (of river and fish pond banks and swamp transects) for footprints and faeces (method according to Macdonald 1984). Data were collected on wetland habitat structure and faeces sampled and analysed for prey composition.

We inspected ricefields and asked farmers for evidence of destructive crabs and we recorded incidents of otters raiding ponds. Traditional methods to prevent otters from catching fish in pond areas were assessed (Fig. 2). For the purpose of this paper, we underscore results and conclusions from ricefield areas and fish pond schemes. For more general results please refer to Melisch *et al.* (in press) and Melisch (1995).

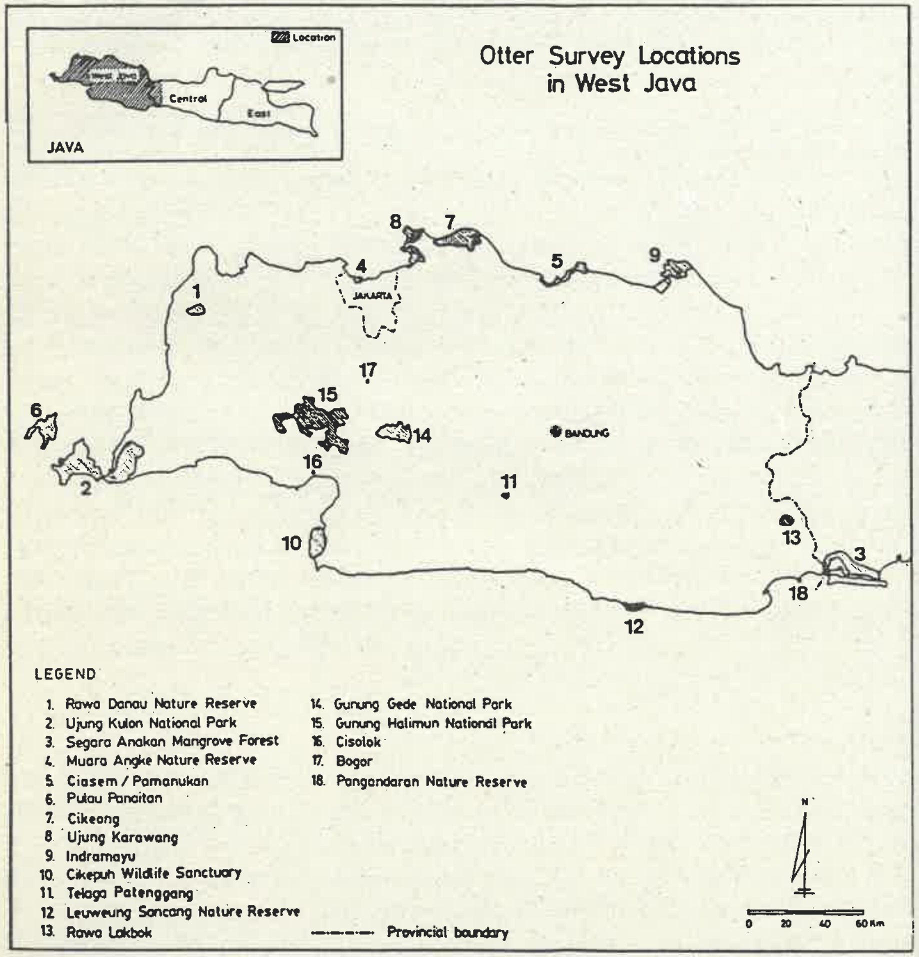

Fig. 1: Map of otter survey locations in West Java

Results

Assessment of 285 km showed two species of otter live in West Java. From this and historical records (Melisch 1995) we conclude that only two otter species occur on the whole island. While the Asian Small-clawed otter *Aonyx cinerea* is rather common and occurs from sea-level up to 2,000 m, the smooth-coated otter *Lutrogale perspicillata* is rare and confined to mangroves and other coastal wetlands. Of all survey units (500 m lenghts), 31.3 % showed evidence of otters. In 95 % of the surveyed ricefields (n=104 survey units) problems with destructive crabs (i.a., *Parathelphusa* sp) were discovered. Crabs tunnelled ricefield dams and thus caused irrigation problems. The crabs also fed on rice seedlings. In the mangrove reforestation schemes of the Javan North Coast, crabs damaged roots and bark of seedlings (*Rhizophora* sp, *Avicennia* sp).

In artificial and natural habitats crabs were the dominant prey identified from 145 spraint samples (87 % of its diet; bulk prey) for *A. cinerea*. In only 1 % of all spraints were no crab remains identified. Other prey remnants included fishbones and fishscales, vertebrae, ribs and scales from water snakes (*Homalopsinae*), unidentified mammalian hair, unidentified vertebrae, shrimps and aquatic insects. Mollusc remains were present at 3 % of the feeding sites.

The sample size of spraints of the smooth-coated otter was much smaller (n=34). Bulk analysis showed fish as the dominant prey item of *L. perspicillata*, followed by crabs. Only at one site, a river in Ujung Kulon, freshwater shrimps (Atyidae spp, Palaemonidae spp, Mysidacea spp) formed the bulk of the prey in spraints. For a more detailed account on otters' prey in West Java see Lubis (1995), Lubis (in preparation) and Melisch *et al.* (in press). A detailed examination of Asian small-clawed otter and smooth-coated otter diets in mangrove-fish ponds is presented in this volume (Lubis *et al.*).

In West Java, analysis of habitat preference showed *A. cinerea* and *L. perspicillata* to be dependent on structurally rich wetland vegetation, consisting of elements of high herbs, bushes or trees. Monotonous ricefield areas with uncovered dams, or mangrove plantations at an early stage showing no diverse vegetation structure suitable to serve as otter shelter were clearly avoided by both otter species. Otters can cause significant damage to small-scale freshwater or brackish-water fish farming if no preventive protection devices are employed. However, no signs of otters were found in large-scale brackish-water pond schemes with poor vegetation structure, although suitable prey (fish, snakes and shrimps) was present. We also found a high rate of pesticide use (and misuse) in ricefield agriculture and pond-aquaculture of West Java. Of all the pesticides found to be in use in our survey area (n=39), the application of 51 % was totally prohibited in or around aquaculture according to Indonesian national regulations. For details of pesticide misuse see Melisch *et al.* (in press). Traditional devices to protect fish ponds against otter attacks in West Java were assessed (Fig. 2). Table 1 lists crustaceans which may contribute to Southeast Asian otters' prey, but found to be destructive in aquaculture.

Table 1. Crustaceans destructive in aquaculture, which may contribute to the prey of otters in Southeast Asia

Species	Occurence	Economic importance
Parathelphusa spp (Potamonidae, Brachyura) *Potamon* spp (Potamonidae, Brachyura) *Potamiscus* spp (Potamonidae, Brachyura)	freshwater swamps, rivers, inland ricefields and ponds	tunneling ricefield dams thus causing irrigation problems; feeding on rice, esp. rice seedlings
Malayapotamon granulatum (Potamonidae, Brachyura)	small rivers and ricefields (1,000 - 2,000.m a.s.l.)	
Cardisoma spp (Gecarcinidae, Brachyura)	fresh water swamps including adjacent ricefields	feeding on rice
Sesarma spp (Grapsidae, Brachyura) *Metaplax* spp (Grapsidae, Brachyura)	fresh water and brackish water swamps including adjacent ricefields	tunneling ricefield and pond dams; causing acceleration of tidal erosion on dams; feeding on young mangrove plants
Thalassina anomala (Callianassidae, Macrura)	mangroves and adjacent ricefields and ponds	tunneling ricefields and pond dams; causing acceleration of tidal erosion on dams

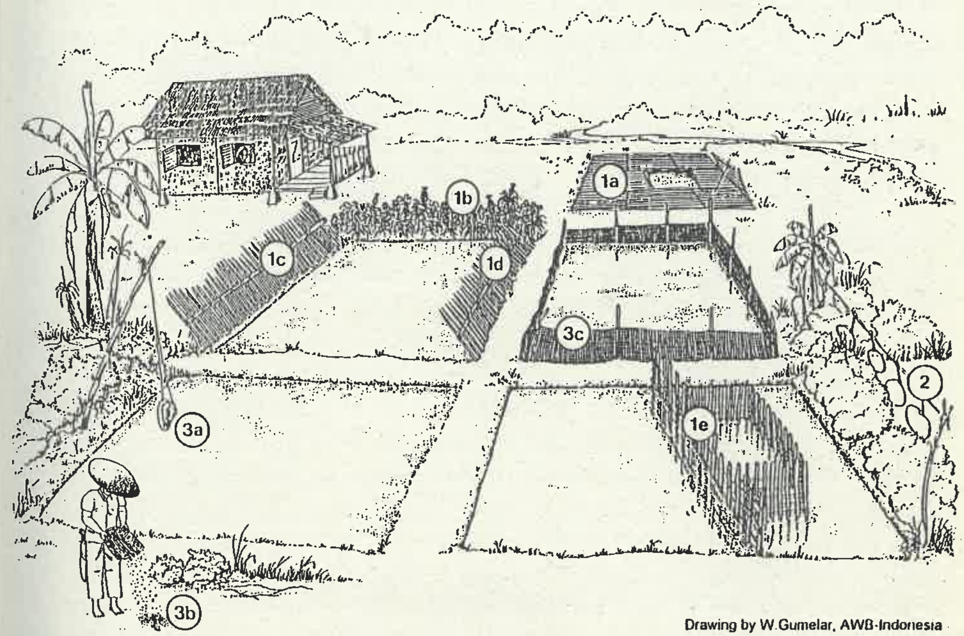

Fig. 2: Traditional devices used to protect ponds against otter attacks in West Java

Legend:
1 a) A fish pond covered with bamboo lattice (suitable for shadow-tolerant fish species).
1 b) "Living fence"- protection provides safety and supplementary food (e.g. pineapple or *Pandanus* plants).
1 c) Pond encircled with sharpened bamboo fences, bent outward. More construction material needed than in option 1 d), but no otter can reach the pond.
1 d) Pond encircled with sharpened bamboo fences, bent inward. Otters will enter the pond with only little chance to escape. Although this option includes considerable loss of fish, it is very popular throughout West Java, probably because of otters getting trapped. Farmers usually kill the trapped otters.
1 e) Fish shelter placed in the centre of the pond.
2) A line of snares. This method will kill an otter.
3 a) Noise generating gear (e.g. metal plate and stone), to be triggered by an otter entering the pond, or operated by a remote thread.
3 b) The spreading of broken glass on otter toilet sites or the local burning of their faeces will deter otters from returning to their traditional latrines.
3 c) (Old) nets set around a fish pond will confuse and irritate carnivore fish predators.

Discussion

Detailed follow-up studies of the diet of both otter species in three selected habitats as presented by Lubis (1995) concurred with preliminary results from an earlier analysis of our study (Asmoro *et al.* 1994). Findings showed a distinct prey specialisation of *A. cinerea* for crabs and *L. perspicillata* for fish. Both species, however, may locally well behave opportunistically and prey on different animals (e.g., shrimp feeding of *L. perspicillata* in Ujung Kulon).

For Java's growing human population an increase in food production was and still is required. Consequently, conversion of natural wetlands into ponds and rice production areas is occurring. Javan wetland habitats and their biota suffered from deforestation, fragmentation, pollution, or even total loss (Giesen 1994). For example, the extent of freshwater swamp-forests and peatswamp forests decreased from an original area of 72,000 hectares to 1,250 hectares in 1993, and only 11 % of Java's original mangrove cover remained as isolated fragments in 1988-90 (Giesen 1994). These developments, especially if occurring on an intensive large-scale basis, were identified as the main obstacle of the long-term survival of otters in West Java. Comparison of current findings with historical data suggest that the populations of both otter species in West Java are declining.

The Asian small-clawed otter appears to be adaptable to wetlands which were converted from a natural state into ricefields. Traditional ricefield agriculture serves very well as a natural habitat-substitute for many freshwater crustaceans, and consequently suits its natural enemy, *A. cinerea*. An artificial oversupply of fish (e.g., ponds at villages north of Leuweung Sancang Nature Reserve) and this combined with a scarcity of crustaceans in natural riverine habitat (e.g., Telaga Patengang) have locally led to a high frequency of otter-raids on ponds and predation on fish. However, otters can only survive in converted wetlands, if they have a degree of structural richness in vegetation (Melisch *et al.* in press, Melisch 1995). Moreover, modern cultural practices (pesticide application, clearance of riverine vegetation) pose additional threats to these mammalian aquatic top-predators. The population of the smooth-coated otter in West Java is fragmented into small subpopulations confined to coastal wetlands, which are isolated from another. Today this species is considered to be 'critically endangered' after IUCN criteria (Melisch 1995) and represents one of the most endangered carnivore species of Java.

Management Suggestions and Conclusions

As a result of the First Indonesian Otter Symposium held in April 1994, the Indonesian Minister of Forestry gave his commitment for full protection of all four otter species occurring in the country (Melisch *et al.* 1994). But will this step alone safeguard future otter populations ? In an integrated conservation approach, traditional local knowledge in addition to appropriate rural awareness is crucial for any project to succeed. Otter conservation needs a well-balanced land-use management. *A. cinerea* has a significant role in the control of ricefield crab populations, if only the ricefield's environment would include suitable shelter for the otter. The establishment of a structural rich vegetation along ricefields and coastal pond-schemes, and the implementation of a pesticide-control programme supports otters as well as other pest-predators (Frantz & Davis 1991). Pond-raiding by otters can be avoided through low-cost methods (Fig. 2): traditional pond-fencing techniques may also include means for a local resource increase (e.g., "living fences" of dense pineapple). An important first step has been achieved by introducing a wetland education tool for teachers (Nirarita & Helvoort 1993). Fisheries and agriculture extension workers may now encourage remote farmers, whose ponds suffer from otter raids, to share the experience of other fish pond keepers in the various preventive methods. Furthermore, the role of otters as pest crustacean predators allows a different approach in applied species conservation outside of protected areas.

Along the Javan north coast a sound mangrove reforestation programme would link and regain habitats for isolated and endangered populations of *L. perspicillata* and other species, e.g., Fishing Cats *Prionailurus viverrinus* (Melisch *et al.* 1996) and waterbirds (Sunarto & Melisch 1995). As aquatic top predators, otters reflect the condition of natural wetlands. From the aquatic food chain they accumulate compounds toxic to the people and their environment. As such, otters may also function as bio-indicators as suggested by Asmoro *et al.* (1994). Thus, environmental planning agencies active in Indonesian wetlands are encouraged to incorporate the role of aquatic predators into the scope of Environmental Impact Assessments as proposed by Howe *et al.* (1991).

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References

Asmoro, P.B., Melisch, R. & L. Kusumawardhani 1994. Hubungan antara berang-berang dengan manusia. In PHPA & AWB-Indonesia: Prosiding Simposium Pertama Mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi manusia. Bogor, 7. April 1994. PHPA/AWB-Indonesia, Bogor. pp. 63-72.

Balss, H. 1956. Decapoden als Schädlinge. In H.G. Bronn: Klassen und Ordnungen des Tierreichs Band V. (1)7, 1488 (foll.).

Bartels, E. 1934. Eenige gegevens omtrent den kleinen javaanschen vischotter. De Tropische Natuur 23, 41-44.

Boonkird, K. and B. Kanchanasaka 1988. Status of otters in Thailand. Presented at the International Asian Otter Symposium, 14-22 October 1988 Bangalore, India.

Chan, H.T. 1988. Rehabilitation of logged-over mangrove areas using wildings of *Rhizophora apiculata*. Journal of Tropical Forest Science 1(2), 187-188.

Ferguson, D.S. 1951. Construction of coastal bunds in Malaya. The Malayan Agricultural Journal (34), 3-12.

Foster-Turley, P., Macdonald, S.M. and C.F. Mason (ed.) 1990. Otters - an action plan for their conservation. IUCN, Gland. 126 pp.

Frantz, S.C. and D.E. Davis 1991. Bionomics and integrated pest management of commensal rodents. In J.R. Gorham (ed.): Ecology and management of food-industry pests. Washington. pp. 243-313.

Giesen, W. 1994. Habitat changes in wetlands of the Greater Sunda's and Implications for Biodiversity. In PHPA & AWB-Indonesia: Prosiding Simposium Pertama Mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi manusia. Bogor, 7. April 1994. PHPA/AWB-Indonesia, Bogor. pp. 45-55.

Groombridge, B. (ed.) 1993. 1994 IUCN Red List of threatened animals. Compiled by the World Conservation Monitoring Centre. IUCN, Gland. 286 pp.

Howe, C.P., Claridge, G.F., Hughes, R. and Zuwendra 1991. Manual of guidelines for scoping EIA in Indonesian Wetlands. AWB-Indonesia/PHPA, Bogor. 315 pp.

Iqbal, A. 1994. Kepiting dalam ekosistem tanaman padi sawah. In PHPA & AWB-Indonesia: Prosiding Simposium Pertama Mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi manusia. Bogor, 7. April 1994. PHPA/AWB-Indonesia, Bogor. pp. 95-97.

Jordan, H.D. 1957. Crabs as pests of rice on tidal swamps. Empire Journ. of Exper. Agric. 25(99), 197-206.

Lim, G.S., Samy, J. and C.C. Phang 1971. A preliminary study on the control of paddy field crabs with insecticides. MARDI Kuala Lumpur I (5), 13 pp.

Lubis, I.R. 1995. Aspek makanan Berang-berang Cakar Kecil (*Aonyx cinerea*) dan Berang berang Bulu Licin (*Lutrogale perspicillata*) di Cagar Alam Rawa Danau, Hutan Bakau Pamanukan, dan Taman Nasional Gunung Gede-Pangrango. Skripsi Sarjana Satu. Universitas Padjadjaran, FMIPA, Bandung.

Lubis, I.R. (in preparation). Diet and faeces composition of West Javan otters.

Lubis, I.R., Melisch, R. and S. Rosmalawati 1996. Diet of Asian small-clawed otter (*Aonyx cinerea*) and smooth-coated otter (*Lutrogale perspicillata*) from spraint analysis in the Pamanukan mangrove-Fish ponds, West Java, Indonesia. In: Proceedings of the Workshop 'Otters and Fishfarms' 8.-9. February 1996, Litschau (this volume).

Macdonald, S.M. 1984. British National Survey method. IUCN/SSC Otter Specialist Group - European Section Bulletin 1, 11-12.

Melisch, R. 1995. Zur Biologie und Erhaltung der Otter (*Carnivora, Mustelidae*) in Westjava, Indonesien. Diplomarbeit, Institut für Zoologie, Universität Hohenheim, Stuttgart. 85 pp.

Melisch, R., Asmoro, P.B. and L. Kusumawardhani 1994. Major steps taken towards otter conservation in Indonesia. IUCN Otter Specialist Group Bulletin 10, 21-24.

Melisch, R., Asmoro, P.B., Lubis, I.R. and L. Kusumawardhani 1996. Distribution and status of the Fishing Cat *Prionailurus viverrinus rhizophoreus* Sody, 1936 in West Java, Indonesia. Faun. Abh. Mus. Tierkde. Dresden 20(17), 311-319

Melisch, R., Kusumawardhani, L., Asmoro, P.B. and I.R. Lubis (in press). The otters of West Java - a survey of their distribution and habitat use and a strategy towards a species conservation programme. PHPA/ AWB - Indonesia, Bogor.

Nirarita, C.E. & B.E. van Helvoort 1993. PHPA and AWB wetland teacher's kit. PHPA / AWB-Indonesia, Bogor.

Rukyani, A., Sumarno, Sumarsini & H. Luntungan 1992. Peningkatan kinerja Dinas Perikanan dalam rangka penerapan usaha mina padi untuk menambah pendapatan petani di Daerah Tingkat II Klaten, Jawa Tengah. Kertas Kerja Praktek Kerja Lapangan, Sekolah Pemimpin Administrasi Tingkat Madya Lembaga Administrasi Negara - Departemen Pertanian, Klaten.

Scharff, J.W. and M.W.F. Tweedie 1942. Malaria and the mud lobster. Transactions of the Royal Society of Tropical Medecine and Hygiene 36, 41-44.

Schuster, W.H. 1952. Fish-culture in brackish-water ponds of Java. FAO Indo-pacific Fisheries Council Special Publication 1, 1-143.

Sunarto & R. Melisch 1995. Die Vogelwelt zweier Mangrovenbestände in Westjava, Indonesien. Mitt. Zool. Ges. für Arten- und Populationsschutz 11(1), 15-17.

Wayre, P. 1974. Otters in West Malaysia with observations on their status, distribution and habits. IUCN & WWF. Malaysia. 38 pp.

THE PRESENCE OF OTTER (*LUTRA LUTRA* L.) IN DANISH FISH FARMS A STATUS REPORT ON CURRENT RESEARCH ACTIVITIES

Irene O. BRUUN-SCHMIDT

Key words: Lutra lutra,Oncorhynchus mykiss, fish farms, damage, Denmark

Also in Denmark the European otter (*Lutra lutra* L.) is an endangered species. In 1980 the population in Denmark was estimated to about 200 animals even though fully protected since 1967. This negative development hopefully has changed. In the national survey of 1991 the amount of positive otter localities (localities with signs of otter) had risen in the core area of otter distribution, which is the Mid- and Northwestern part of Jutland.

There are 482 registered freshwater fish farms in Denmark all except one situated on the mainland of Jutland. They produce about 35,000 tons of fish per year. The overall dominant fish species raised is the rainbow trout (*Oncorhynchus mykiss*).

Some fish farmers in Denmark have complained about otters in their fish farms in the past. Since there is now a good possibility that otters are growing in number complaints might increase in number too, and this leads to the present study, with the aim to forestall any future problems. However, no special permissions are granted for the killing of otters on fish farms, and Denmark does not have a compensation policy.

The present study aims to enlighten the behaviour of otter on a fish farm, and to estimate the extent of damage caused by otters. This is related to other predators (such as herons) and fish farmer opinion. Also the hypothesis, whether otter is to be found where fish farms are, is investigated. Comments on whether 'otters in fish farms' is a winter problem are made.

The study includes questionnaires send to all registered fish farms in Denmark, a comparative investigation of otter distribution related to the geographical distribution of fish farms, field studies with 'direct observations' and videorecordings using infrared light, and the registration and collection of spraints on a fish farm in the northwestern part of the country.

A high number of questionaires were returned among other things giving information on: if how the otter is observed; the fish farmer's attitude towards otters on his fish farm; whether the otter is expected to cause any problems, and in that case the estimated loss due to otter presence. Also informations on other fauna are given.

One fish farm was monitored with a video camera at night during a period of 4 months. Most often at least one person was in the field at the time of otter presence, which made it possible to improve (zoom) recordings of the foraging otter. Almost 4 hours of recordings of otter on a fish farm are to be analysed. Frame-grapping (video pictures), where computer software is used to measure and relate body proportions of otter, will be used to establish whether one ore more animals were involved. Diurnal recordings are made for one month in continuation of the night recordings. 'Date', 'number' and 'place' of spraints have been registered in order to relate this to what was actually seen on the video-recordings. The fish farm will be visited regularly (almost on a weekly basis) until June of 1996 to see if the otter is present in terms of spraints and or tracks.

EFFECTS OF THE OTTER ON SPORT FISHING IN THE PYRENEAN MOUNTAINS (NORTH-EAST SPAIN)

Jordi RUIZ-OLMO and Franceska CASADESÚS

Key words: Lutra lutra, Salmo trutta, streams, damage, sport fishing, Spain

In north-eastern Spain, the production of fish in fish ponds has not been developed. Only fish farms, always located close to rivers, have proliferated mainly for the production of salmonides (for consumption and fishing). It is not infrequent for otters to enter those which have taken no security measures (e.g. fences) but, given the damage which they cause (economic loss) it is evident that the majority do take these measures.

However, fishing as a sport has developed notably over the last ten years, initially brown trout fishing (*Salmo trutta*) although other species are also becoming progressively more popular in mountainous areas. The recuperation of predator populations in these areas (*Ardea cinera* and *Phalacrocorax* in winter and the otter all year round) has provocated progressive numbers of complaints.

For this reason the role of the otter was studied in five stretches of Pyrenean river (585 - 935 m a.s.l.): four with otter presence and one without (control), all inhabited by brown trout. The estimated otter density oscillates between 0.05 and 0.2 individuals per kilometre (0.3 - 1.1 kg otter / km using the average weight of Spanish otters found by Ruiz-Olmo (1994), being 0 in the control stretch.

According to the density and weight of otters, found in the Pyreneas, and according the results from Kruuk *et al.* (1993) about daily food requirements, otters need 14.6 - 58.4 kg food per kilometre and year (95.4 - 98.2 % being fish), which represents 6.8 - 40.2 kg of fishable trout (TL > 19 cm) per kilometre and year. In fact the otters consume 35.8 - 148.9 fishable brown trout per kilometre and year, depending on the stretch, against 0 in the control stretch (in all stretches except one there are only brown trout, but no other fish in the river).

Electrofishing, however, showed that otters only consume 3 - 14 % of fishable trout (TL > 19 cm) throuhout the year. It should be kept in mind that there is also the positive effect on the fish population caused by superpredation when otters eat other fish predators in abundance (the water snake *Natrix maura*, and the brown trout itself). In this context it seems remarkable that there was no significant difference in brown trout density between the streches with otter predation and the the one without otters.

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References

Kruuk, H., Carss, D.N., Conroy, J.W.H. and Durbin, L. 1993. Otter (*Lutra lutra* L.) numbers and fish productivity in rivers in north-east. Scotland. Symp. Zool. Soc. Lond., 65, 171-191.

Ruiz-Olmo, J. 1995. Observations on the predation behaviour of the otter *Lutra lutra* in NE Spain. Acta Theriologica, 40(2), 175-180.

INFLUENCE OF DIFFERENT SPRAINT SAMPLING METHODS ON THE RESULTS OF OTTER DIET STUDIES

Michael KNOLLSEISEN and Andreas KRANZ

Summary

Otter diet was investigated by spraint analysis from a fish pond area in northern Austria and the southern Czech Moravian Highlands. Spraints were collected using three different sampling methods in the field:

- six times per year: 27 otter spraints from an area of 36 km^2 containing 140 fish ponds
- once each month, spraints from activity centres of two radio-tagged female otters
- at least once a week spraints from a single fish pond

The subsequent analysis of over 1,000 spraints showed striking differences in the otters' diet of the three samples. It is argued that these differences are partly a result of the spraint sampling method in the field. According to the surveys, spraints originated not from the same ponds, but they were in close vicinity, and habitat and food availability were very similar. Current research will point out some more aspects of these preliminary results.

Key words: Lutra lutra, diet, excrement, field sampling method

Introduction

Dietary studies using otter spraints (faeces) are frequently the first approach to study otters (e. g. Rauer-Gross 1989; Knollseisen 1995). A high number of articles about otter diet reflects this. Erlinge (1968) was the first to test spraint analysis methods carring out feeding experiments with captive otters. In the last years Carss & Parkinson (1996), Hansen & Jacobsen (1992) and Knowles (1991) focused on the reliability of spraint analysis and quantification of the results.

The way how spraints were collected in the field (where, how many and how frequently) are often not described properly in the papers. Carss & Parkinson (1996) and Conroy *et al.* (unpubl.) are among the few mentioning some of the problems with the sampling methodology in their feeding trials. Own experiences cast doubt that this matter is negligable.

The aims of this paper is to point out such methodological problems by comparing the results of three different spraint sampling methods:

- collecting six times per year very few (27) spraints over a 36 km^2 survey area (140 ponds and interconnecting streams)
- collecting once a month most available spraints in the activity centres of radio-tagged individuals (up to 10 ponds)
- collecting at least once a week spraints from one single pond

Study Area

The study area is situated in a fish pond area on the border between Austria and the Czech Republic, in the northern Waldviertel and in the southern Czech Moravian highlands. The landscape is characterized by a large number of small-medium sized fish ponds (mostly between 0.2 and 5 ha), areas of artificially grown spruce and pine forests, arable land and grassland. The majority of the ponds are 0.5 to 1.5 m deep and stocked annually with common carp (*Cyprinus carpio*, about 90 %). Tench (*Tinca tinca*), pike (*Esox lucius*), pikeperch (*Stizostedion lucioperca*), rainbow trout (*Oncorhynchus mykiss*),whitefish (*Coregonus sp.*), perch (*Perca fluviatilis*) and sometimes small other cyprinids are also stocked (Bodner 1995, Krechler, pers. commun.).

Material and Methods

Sample 1: Otter spraints were collected six times a year between December 1992 and October 1993 in a 36 km2 study area which contained 140 fish ponds. The 36 km2 area was divided into nine 4 km2 sampling areas and from each three fresh (up to two weeks old) spraints were taken (27 per survey, 175 per year). Spraints of different ages were collected from different parts of the 4 km2 squares to avoid finding the remains of only one otter meal in all three spraints.

Sample 2: Once a month spraints were collected in the activity centres of two radio-tagged otters (109 spraints from a subadult and 269 from an adult female otter) which comprised 1 - 10 ponds (Kranz 1995). Sprains were not labelled with radioactive isotopes.

Sample 3: Another 536 spraints were collected between August 1995 and August 1996 at a single medium sized fish pond (7.2 ha). This pond had a known stocking level and harvesting regime. Surveys (at least once a week) provided information about the frequency with which otters used the pond and what they ate on each visit. By following otter tracks in the snow large numbers of spraints belonging to individual otters were collected.

All the spraints were stored frozen. For analysis they were soaked for 24 hours in detergent water and washed through a 0.9 mm strainer (Knollseisen 1995). The remaining bones, scales and feathers were analyzed with a binocular (6x - 50x) microscope and identified from reference collections and drawings taken from literature (Brohm unpubl., Conroy *et al.* 1993, Engelmann 1986, Libois *et*

al. 1987). The sizes of the most important fish species were estimated by measuring the vertebrae lengths (Conroy *et al.* 1993, Wise 1980). Results are shown as relative frequencies of occurrence (Conroy *et al.* 1993, Erlinge 1967, Hansen & Jacobsen 1993). The availability of fish in the ponds is an estimation based on stocking data (Bodner 1995 and Krechler pers. comun.). Data on the availability of fish in the little streams were available from a few reference streams in and close to the 36 km2 sampling area (Schlott 1990, Spindler 1992). Fish numbers and biomass of the little streams are not included in the figures showing the availability of fish.

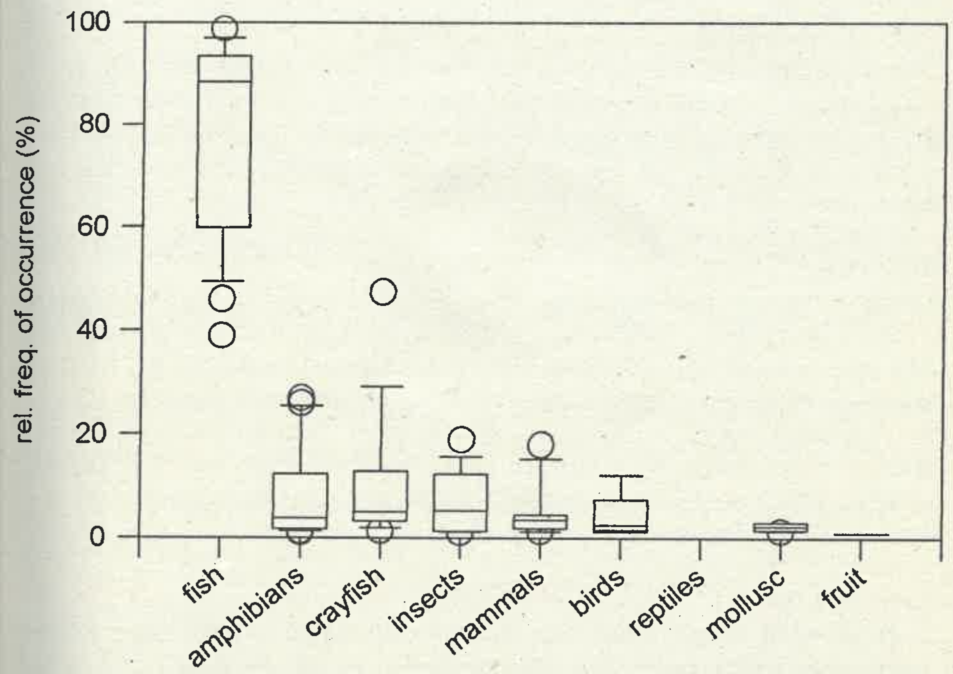

Fig. 1: Variability of different prey categories in the otter diet (34 monthly samples, n = 1,089 spraints)

Results

The proportion of fish varied considerably between the 3 samples: in *sample 1* fish ranged from 79.5 to 97 %, in *sample 2* from 39 to almost 100 % and in *sample 3*, the single pond, from 67.1 to 100 % (Fig. 1). However, there was little variation between the samples concerning carp. Though carp was the fish with the highest biomass in the ponds throughout the year, otters selected other prey such as perch, small cyprinids (*Rutilus rutilus, Gobio gobio* and *Leucaspius delineatus*) and, seasonally and locally amphibians (up to 27 %), crayfish (up to 47 %) and birds (see Fig. 1). This negative selection for common carp was based on analysis of over 1,000 spraints (Fig. 2 and 3). The proportion of carp was highest in winter reaching 14.7 % in *sample 1* (140 ponds) and around 70 % in *samples* 2 and 3. During the rest of the year low numbers of carp were taken by otters (*sample 1*: mean 5,1 %; *sample 2*: mean 5,3 %). Higher amounts of carp were taken only at the single pond (monthly mean 38,8 %; *sample 3*).

The amount of other economically important fish such as trout, pike, pikeperch and whitefish was low throughout the year in *sample* 1. In all three *samples* higher proportions of trout were found than expected by their availability in the ponds (Fig. 2 and Fig. 3). The same is true for cyprinids other than carp and tench, and for perch.

Discussion

Otters consumed far more often other fish than carp, in particular small cyprinids and perch. This contrasts with the availability according the stocking. The real availability of cyprinids other than carp and tench, and for perch is unknown, because they are of little or no economic interest. In many cases, they are even considered as pest species in the carp pond. They are numerous particularely in large ponds, where fish can also migrate into the feeder creeks. In *sample 1* and 2 the high proportion of these species originates partly from the streams, but in *sample 3*, the single pond, this was not the case

Sample 1

A rather small sample of spraints was collected within a rather large area to describe the diet of otters. Special attention was payed to collect spraints well distributed over the hole area in order to get spraints from as many different individuals or at least different meals. The higher effort of collecting spraints in a large area was far compensated by the small number of spraints to be analysed.

However, current work, using the same method and the same 36 km2 area, but collecting more spraints will show, wether this alters the rank order of spieces in the otter diet.

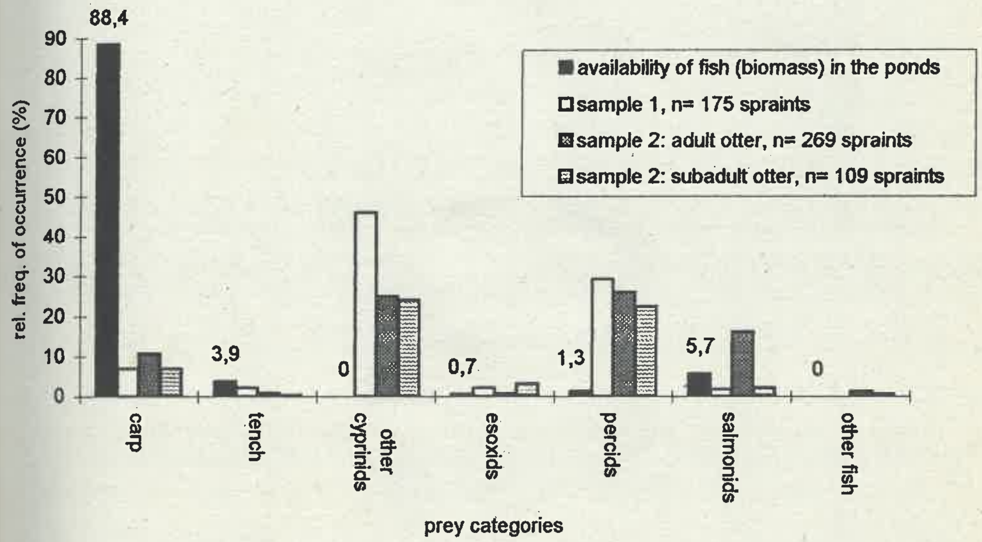

Fig. 2: Availability of commercial fish in the ponds and prey selection of otters: *sample 1*, n = 175 spraints, six monthly samples, December 1992 - October 1993; *sample 2*: radio-tagged adult female otter, n = 269 spraints, 10 monthly samples, May 1992 - February 1993; *sample2*: radio-tagged subadult female otter, n = 109 spraints, 7 monthly samples, July -November 1992)

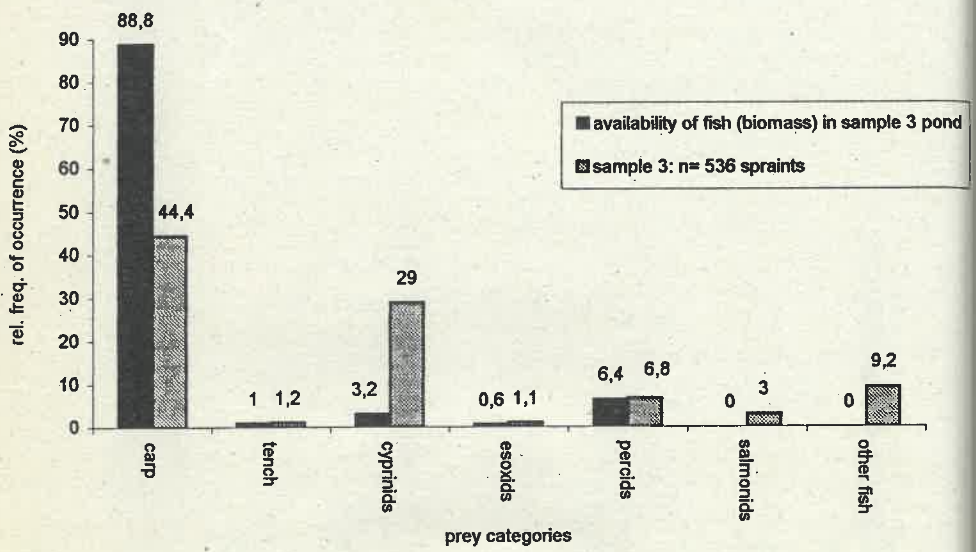

Fig. 3: Availability of fish in *sample 3* (one single pond) and prey selection of otters (n = 536 spraints, 13 monthly samples (August 1995 - August 1996)

Sample 2

This sample tends to reflect the diet of two single radio-tagged otters in this area of fish ponds. The spraints were collected once a month in areas the animals visited over long periods of time (weeks) to avoid finding remains of food items taken by the otters in another area the night before. Consequently, the spraints represent only food taken in the main activity centres of the otters. Because animals were not labelled with radioactive isotopes, some of the spraints analysed could belong to other animals present in the area. However, in most of the spraints collected in a certain area and the same time the same prey species were found. Two reasons might be responsible for this. The animal changed its diet when moving to a new area. Additionally, several spraints might have originated from a single otter meal, because as many spraints as possible were collected only once per month from the actual activity centre of the animal. The analysis of spraints collected during snow surveys from individual otters showed the remains of single large fishes (found as food remains at the beginning of the tracks) occurring in up to 13 consecutive spraints). Carss & Parkinson (1996) also found remains of single prey items in several spraints.

Sample 3

This approach focus on a single case study pond. A high number of spraints and frequent collecting intervalls (at least once per week) should give a maximum of information what and how much otters eat in such a pond which is quite typical for many of its size in this region. Such information is of particular interest when discussing fish losses. The diet data on their own are of limited use for understanding the feeding ecology of otters in this area, because sometimes, e.g. when the pond is covered with a thick layer of ice, the otters are not present at the pond at all. However, from a methodological point of view, it seems remarkable that fish species not present in the pond but only in a 1.5 km distant stream (e. g. *Salmo trutta*, *Leuciscus* sp.) were found only in very low occurrences. Hence, the spraints found in a certain place seem to contain what the otter was eating there. This source of bias seems negligable for larger ponds quite isolated from other habitats such as streams with decent fish populations.

Drawing a conclusion, it became clear that different spraint sampling methods are likely to be responsible for differences in the output of diet studies. More detailed investigations are on the way to show the power and limits of each method.

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References

Bodner, M. 1995. Fischotter und Teichwirtschaft. Forschungsbericht Fischotter 3, Forschungsinstitut WWF Österreich.

Brom, T.G. (unpubl.). Microscopic identification of feather-remains after collisions between birds and aircraft, Zoologisch Museum Amsterdam & Royal Netherlands Air Force.

Carss, D. N. and Parkinson, S. G. 1996. Errors associated with otter *Lutra lutra* faecal analysis. 1. Assessing general diet from spraints. J. of Zoology, London 238, 301-317.

Conroy, J. W. H., Kruuk, H., Leitch, A. F., Ekanayake, U., Davidson, H. P. B. and Grant, D. A. D. (unpubl.). Methods of evaluating the diet of otters *Lutra lutra* L. from faecal analyses of their spraints (faeces), unpubl. report, ITE Banchory Research Station.

Conroy, J. W. H., Watt, J.,Webb, J. B. & Jones, A. 1993. A guide to the identification of prey remains in otter spraints. Occasional publication No. 16, The Mammal Society, London.

Engelmann, W. E. 1986. Lurche und Kriechtiere Europas. DTV Enke.

Erlinge, S. 1967. Food habits of the fish-otter *Lutra lutra* L. in South Swedish habitats. Viltrevy 4, 371-443.

Erlinge, S. 1968. Food studies on captive otters *Lutra lutra* L. Oikos 19, 259-270.

Hansen, H. & Jacobsen, L. (1992): Aspekter af odderens (*Lutra lutra* L.) fodebiologi i Danmark, Specialerapport, Arhus Universitet.

Knollseisen, M. 1995. Aspects of the feeding ecology of the Eurasian otter *Lutra lutra* L. in a fishpond area in Central Europe (Austria and Czech Republic). Diplomarbeit Universität Wien.

Knowles, J. E. 1991. The feasibility of spraint analysis in determining the quantity of salmon and trout in the diet of the European otter (*Lutra lutra*). Bsc Thesis, University of Aberdeen.

Kranz, A. 1995. On the ecology of otters (*Lutra lutra* L.) in Central Europe. Dissertation at the University of Agricultural Sciences Vienna.

Libois, R. M., Hallet-Libois, C. and Rosoux, R. 1987. Elements pur l'identification des restes cranies des poissons dulcaquioles de Belgique du nord de la France. Centrae de recherches Archeologiques du CNRS. APDCA. Juan-les-Pins, 1-15.

Rauer-Gross, B. 1989. Zur Bedeutung von Fischen im Beutespektrum des Fischotters (*Lutra lutra*) im Waldvietel (Österreich). Stapfia 20, 155-168.

Schlott, G. 1993. Die Fischarten im Einzugsgebiet der Lainsitz - Teil 2: Reißbach, Romaubach, Braunaubach, Schwarzabach. Ber. Ökol. Stat. 4, 33-41.

Spindler, T. 1992. Fischereiliche Untersuchung ausgewählter Waldviertler Bäche.Studie im Auftrag d. Forschungsinst. d. WWF Österreich.

Wise, M. H. 1980. The use of vertebrae in scats for estimating prey size of otters and mink. J.Zool., London 192. 25-31.

PREDATION BY OTTERS AT A SALMON HATCHERY, EVIDENCED BY DIET STUDIES

Edel M. O'NEILL, Keith R. DAY and James P.H. PATERSON

Summary
The diet of otters in the vicinity of a salmon hatchery on the River Bush in Northern Ireland was assessed by analysing spraints collected there between June 1992 and May 1993. Distinct seasonal variations in the occurrence of a number of different prey types were noted. Salmonids were the most important fish through most of the year except in the summer months when eels predominated. Examination of trends in sizes of fish taken suggested rates of predation which reflected seasonal patterns of prey availability. Comparisons of the relative proportions of salmon and trout in the diet showed that trout were much more frequent, and that otters were unlikely to be exploiting the tanks of the nearby hatchery as a ready food source. One year later however, the hatchery experienced severe problems, losing several thousand microtagged salmon to otter predation over a period of 6 to 8 weeks. Spraint analysis showed a marked increase in the proportion of salmon in the diet, with high frequencies of the size classes taken from the tanks.

Key words: Lutra lutra, predation, fish farms, salmonids, Northern Ireland.

Introduction

The ability of the otter *Lutra lutra* to exploit a wide variety of aquatic habitats is unquestioned. Their ecology and diet has been described in coastal (Elmhirst 1938; Kruuk & Moorhouse 1990, 1991; Heggberget 1993), riverine (Erlinge 1969; Green *et al.*, 1984; Lopez-Nieves & Hernando 1984; Broyer *et al.* 1988; Durbin 1993), lacustrine (Gormally & Fairley 1982; Kemenes & Nechay 1990) and other wetland areas (Bekker & Nolet 1990; Kyne & 1990) throughout the species distribution. It is generally accepted that the otter is highly piscivorous, but study of the feeding ecology of the species has been almost exclusively directed towards assessing the effects of limited food availability on the survival and success of otters (e.g. Kruuk *et al.* 1991; Kruuk *et al.* 1993) and very little attention has been focused on the possibility that predation by otters may directly affect salmonid stocks either in the wild or in fish farms. Carss (1990) reviewed the literature relating to avian and mammalian predation at fish farms and concluded that the majority of reports of otters were of an anecdotal nature and therefore unreliable. It was suggested that the study of possible otter/fish farm interactions would be useful in assessing any problems, whether they were real or perceived.

Irish otters are judged to be among the most abundant in Europe (Chapman & Chapman 1982; Chanin 1985; Macdonald 1989) and their populations are probably close to carrying capacity. They have not been subject to the pollution of freshwaters and population has not declined dramatically as in the rest of Europe (Chanin & Jeffries 1978; Mason & Macdonald 1986). There have been numerous Irish investigations of otter diet (Gormally & Fairley 1982; McFadden & Fairley 1984; Breathnach & Fairley 1993; O'Sullivan 1994; Tangney & Fairley 1994), most of which have concentrated on the populations in the west and south of the country with one study carried out in the midlands (Kyne *et al.* 1989). The last published study of otter diet in Northern Ireland was carried out in autumn-winter 1970 (Fairley & Wilson 1972) and no studies thus far have addressed the issue of interactions between otters and fish farms. This issue may become increasingly sensitive at a time when the public is well-informed of otter abundance and anecdotal reports of otter activity at fish farms may result in their illegal persecution. There is a clear need for quantitative evidence on the frequency and level of damage caused to hatchery stocks by otters.

Macdonald & Mason (1990), in the recently published "Action Plan for European Otters", recommended the initiation of research into otter ecology here which would be comparable with the base-line work carried out in the Munster Blackwater catchment. As part of a wider study of the ecology of the species in Northern Ireland (O'Neill 1995), the seasonality in the diet of otters at Bushmills on the River Bush was assessed using spraints collected from a 1.2 km stretch from June 1992 to May 1993. The presence of a Department of Agriculture (DANI) salmon hatchery at Bushmills provided an ideal opportunity to assess both the influence of a fish farm on prey choice by otters and the impact of otter predation on salmonid aquaculture.

Study Area

The River Bush catchment area is approximately 340 km^2. The river rises above Altnahinch dam in Co. Antrim and flows into the sea on the north coast. In the early 1970's, the Department of Agriculture (N.I.) acquired a 30 year lease of the river and initiated a salmon (*Salmo salar*) population biology research project, establishing a trapping, hatching and rearing facility at Bushmills, 3.5 km from the mouth of the river. The river flow is diverted through the hatchery grounds via a lade system, to facilitate the counting of wild salmon smolts as they migrate to the sea. Juvenile salmon are reared in a number of outdoor tanks and are released annually with the wild smolt run. Potential predation by birds is kept to a minimum with the use of overhead netting. Although the tanks themselves are not fenced individually, the hatchery grounds are fenced from the river and the surrounding urban area. Salmonids, including brown trout (*Salmo trutta*) dominate the fish fauna; and other species include eel (*Anguilla anguilla*), stickleback (*Gasterosteus aculeatus*), stoneloach (*Neomacheilus barbatulus*), brook lamprey (*Lampetra planeri*), roach (*Rutilus rutilus*) pike (*Esox lucius*) and bullhead (*Cottus gobio*), the latter three species occurring in small numbers. Along the 1.2 km study site which includes the hatchery, the river flows through both a relatively secluded and an urban area, and is used intensively by anglers. The river consists of deep sluggish angling pools separated by boulder groynes, and varies from 15 to 20 m in width.

Methods

The study area was searched for signs of otters on a fortnightly basis. The contents of all spraints collected were soaked in a saturated solution of a biological washing powder at 37°C. The hard remains were rinsed through a 0.25 mm mesh sieve and then dried by placing the sieve over a convection heater for 2 minutes. This quickened the cleaning process considerably and was unlikely to introduce any bias in diet estimation, since Wise (1980) has stated that oven-drying scats at 50°C does not cause significant bone shrinkage. Fish remains were identified using a reference collection and a number of keys (Webb 1976; Conroy *et al.* 1993; Maitland 1972; Härkönen 1986). Salmon and trout were distinguished using the characteristic atlas bone (the first vertebra) (Feltham & Marquiss 1989). Frog remains were identified using Yalden's (1977) key and reference bones. Initial investigations indicated that other prey items made a comparatively small contribution to otter diet, so these were classified simply as birds, mammals, insects and molluscs. The constituents of the diet were expressed in terms of percentage frequency of occurrence (the number of spraints containing that prey item expressed as a percentage of the total number of spraints), and chi-square tests were used to check seasonal variation in the occurrence of different prey species.

A microscope fitted with a graticule was used to measure all vertebrae, otoliths, pharyngeal teeth and stickleback ventral shields in order to estimate the original size of fish prey eaten. Casteel (1976) found that a single regression equation

which predicts fish length from some criterion of bone size yielded the most accurate results. The equations used in the calculations are listed in Table 1.

Table 1: Equations used in calculation of fish lengths: FL = fish length, TVL = thoracic vertebra length, CVL = caudal vertebra length, AVW = atlas vertebra width, OL = otolith length, VSL = ventral shield length (all units in mm).
Note: Equations from Wise (1980) and Thom (1990) have been adjusted for use with fish and vertebral lengths measured in mm.

Species	Equation	Source
Salmonid	Log FL = 0.941 Log CVL + 1.973	Calvert (1992)
	Log FL = 0.927 Log TVL + 2.029	Calvert (1992)
	Log FL = 1.105 Log AVW + 1.817	Calvert (1992)
Salmon	FL = 88.4 OL - 45.1	Härkönen (1986)
Trout	FL = 107.9 OL - 87.7	Härkönen (1986)
Stickleback	FL = 47.1 CVL + 7	Thom (1990)
	FL = 43.3 TVL + 2.4	Thom (1990)
	FL = 3.38 VSL + 1.07	Doornbos(1984)
Stoneloach	FL = 59.3 CVL + 5.1	Thom (1990)
	FL = 48.9 TVL + 5.2	Thom (1990)
Eel	Log FL = 1.084 Log CVL + 2.095	Calvert (1992)
	Log FL = 1.016 Log TVL + 2.088	Calvert (1992)
	FL = 189.57 OL - 44.211	Härkönen (1986)
Pike	FL = 83.3 CVL + 26.6	Wise(1980)
	FL = 81.5 TVL + 34.2	Wise(1980)
Roach	Log FL = 0.981 Log CVL + 1.796	Calvert (1992)
	Log FL = 0.935 Log TVL + 1.815	Calvert (1992)

The equation used to calculate fish length from atlas vertebra width is applicable to both salmon and trout (Feltham & Marquiss 1989). Estimation of frog size was not carried out. Analysis of the size distribution of fish was accomplished using the percentage frequency of bones assigned to 1 cm size classes (e.g. 4 cm = 4.0-4.9 cm). A problem with this approach is that many remains from one fish may overemphasise the importance of that size class. This well known limitation associated with otter spraint analysis is assessed and discussed elsewhere (O'Neill & Day, in prep.)

During the analysis it was found that some spraints were composed of very large numbers of vertebrae, in many cases, upwards of 400 bones. This usually occurred when small salmonids or sticklebacks had been consumed. The bones involved were tiny and brittle and, as a result, were damaged easily. It was decided that in such extreme cases, a subsample of the vertebrae would be measured and the remainder counted (so that the appropriate number of vertebrae could be assigned to each size category). Efforts were made to measure a representative subsample of the bones, reflecting the size ranges present.

Results

A total of 396 spraints were collected over the twelve month study period. Vegetation and small pebbles found in a small number of the spraints were assumed to have been collected accidentally with the sample. The percentage occurrence of the prey items recorded are displayed in Table 2, together with the results of chi-square tests for seasonal variation in the diet. A number of the tests for differences in occurrence of prey types across the seasons were rendered invalid because in these cases, either one or more cells had expected values <1, or more than 20 % of the cells had expected values <5, or both. The months of the year were categorised as follows: Summer: June, July, August; Autumn: September, October, November; Winter: December, January, February; Spring: March, April, May.

While fish were certainly the principle component of otter diet at Bushmills, there was considerable seasonal variation in the percentage occurrences of a number of different prey types. Salmonids appeared to be the most important prey item through most of the year, with the exception of the summer when their remains occurred in less than half of the sprainst collected. This was mirrored by an opposite trend in eels, the occurrence of which peaked in the summer months.

Both stickleback and stoneloach made fairly consistent contributions to the diet in terms of occurrences in the spraints, although frequency of stone loach was lower in winter compared with other seasons. The remaining fish species appeared to supplement the diet only in a very minor way. Frogs occurred most frequently in spring samples although they also appeared to be important in the winter diet - this is probably due to the inclusion of February spraints (in which frog remains were very frequent) in the winter category. Use of a more specific timescale in the analysis would probably confirm this but difficulties in statistical verification with reduced sample sizes precluded this refinement. Insects occurred in a significantly higher percentage of summer spraints. In many studies of otter diet, they are assumed to be accidental prey items but the majority of insects in these spraints proved to be the remains of Dytiscus beetles, a species upon which otters are known to selectively feed (Foster & Turner 1991).

Table 2 : Seasonal differences in percentage occurrence of prey types in spraints, Summer 1992 - Spring 1993. (n = number of spraints) NS = Not significant, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

	Percentage Occurrence					
Prey	Summer n = 54	Autumn n = 66	Winter n = 106	Spring n = 170	χ^2(3df)	Sig.
Salmonid	42.6	75.8	89.6	82.9	50.5	***
Stickleback	27.8	31.8	44.3	38.8	5.3	NS
Stoneloach	25.9	16.7	13.2	27.1	8.9	*
Eel	61.1	27.8	14.2	20.6	45.5	***
Cyprinid	3.7	3.0	2.8	7.7	4.4	NS
Pike	1.9	-	5.7	1.8	-	
Flatfish	-	-	-	0.6	-	
Bullhead	3.7	-	-	-	-	
Frog	-	7.6	16.0	20.0	16.3	***
Insect	11.1	3.0	4.7	1.2	11.5	**
Mammal	3.7	1.5	-	-	-	
Bird	1.9	1.5	-	-	-	

Sizes of all fish prey recorded were assessed using the techniques described above. However, investigations (using these samples) into the biases involved in spraint analysis have shown that, in terms of relative weight proportions, salmonids comprised the bulk of food eaten (O'Neill & Day, in prep.). In view of this, and the fact that most concern about the effects of otter predation is related to their impact on these important game fish, detailed discussion and illustration of size selection by otters is limited here to salmonids, with a brief description of sizes of other fish prey taken. Stickleback ranged from 2-7 cm, with most of the fish taken in the 3-5 cm size class. This was consistent through all seasons.

Stoneloach appeared in a larger range of sizes, from 3 cm but never any greater than 10 cm. The majority were found to be 5-7 cm long. There were insufficient numbers of bones from cyprinid, pike, flatfish or bullhead in the samples to give a clear indication of whether or not there was any size selection of these species by otters. Eel remains were considerably more frequent, but only summer and spring spraints produced an adequate range of bones to allow examination of size selection. The median lengths of fish taken in these two seasons (summer, 17 cm; spring, 18 cm) were not significantly different (Mann-Whitney U Test: u=80104.5, NS), but there did appear to be some variation in the distribution of size classes. In summer spraints, the frequency distribution of sizes taken suggested a bimodal distribution with one peak in the smaller (7-11 cm) size classes and another in the 25-27 cm classes. In spring, eels around 18 cm long were the most frequent.

Salmonid bones occurring in the spraints collected at Bushmills indicated that the otters were feeding principally on small fish (Fig. 1). Nevertheless, comparisons of the median sizes eaten during the study period revealed significant seasonal differences (Kruskal Wallis: c2 = 60.5, $P < 0.001$), with the median size in summer spraints 2 cm larger than in the remainder of the year. However, the high incidence of 0+ fish in the summer diet, reflecting predation on juvenile salmon, was notable.

In autumn, winter and spring, small fish appeared to predominate in the diet, with a smaller proportion of larger fish than in the summer. High frequencies of very small fish in the spring diet suggest predation on 0+ trout which hatch earlier in the year than salmon. The results indicate that fish were taken with a frequency which reflected seasonal patterns of availability, with apparent shifts

through the size classes as the year progressed. It is of interest that larger fish appeared to be more frequent in the summer diet than in other seasons, but summer was also the season in which salmonid percentage occurrence dropped dramatically (Table 2). A number of possible explanations for this can be considered:

- The prey fish are larger, but they are not consumed in their entirety. This results in a smaller proportion of the bones being consumed, with correspondingly fewer spraints containing remains of those fish.
- Larger, heavier fish are caught, and this results in an otter having to fish less often, because of the increased mass of food provided by larger catches. This also could result in a drop in percentage occurrence.
- The increased swimming speed and preference for deeper habitat of larger fish (Kennedy & Strange 1982), make them more difficult to capture, and this may result in fewer occurrences in real terms. It may therefore prove to be energetically more profitable to pursue and exploit prey such as eel which are slower moving, and consequently more easily captured.

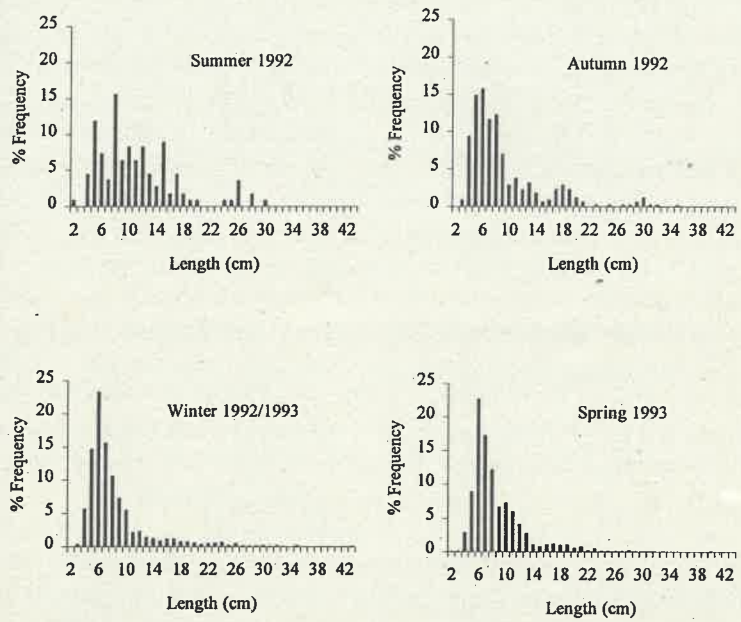

Fig. 1: Length of salmonids occurring in the diet of otters at Bushmills, Summer 1992 to Spring 1993.

In the early stages of this study, several anecdotal reports of otter activity in the area were confirmed by spraint surveys on the river bank, both upstream and downstream of the hatchery. Otters were known to be entering the hatchery grounds via a number of holes in the fences (B. Jones, pers. comm.) but they did not appear to be causing any problems. In the course of the fortnightly collections of spraints in 1992/93, spraints and tracks were noted on numerous occasions on both sides of the fence, mostly in the vicinity of these holes. However, damage of a serious nature was still not being reported by hatchery staff. The occurrence of prey items appeared to follow the seasonal patterns evident at other Northern Irish sites (O'Neill 1995), and the high percentage occurrences of salmonids were expected on an important salmon river such as the Bush.

If otters were using the station as an easily exploited food source it was expected that salmon bones would be the most frequent in the diet since the fish reared in the hatchery are almost all salmon. Conveniently, sufficient numbers of atlas bones and otoliths were found in autumn, winter and spring spraints to allow the illustration of the relative frequency distributions of the sizes of salmon and trout in the diet in these seasons. Summer spraints contained only four of these diagnostic bones, two each of trout and salmon. The salmon bones came from fish 10 and 11 cm in length and the trout from 2 and 17 cm fish. In autumn, winter and spring, it was found that salmon bones comprised only 11.4 %, 37.2 % and 22.8 % respectively, of the atlases and otoliths occurring in the spraints. The relative size distributions of these two species of fish are illustrated in Fig. 2. In the autumn spraints, the median sizes of trout and salmon were not significantly different (Mann Whitney U Test: u = 57, NS), but the number of bones involved in this season's sample was comparatively small : 41, in comparison with the 261 and 311 found in winter and spring spraints. In the latter two seasons, the median sizes of the two species were highly significantly different (Mann Whitney U Test: winter: u = 5885, P<0.001; spring: u = 6553.5, P<0.01). If the few occurrences of large trout are disregarded, it is clear from the frequency distributions that the trout in the diet were consistently smaller than the salmon.

Trout have high growth rates in both autumn and spring (Mills 1971) and the slight shift in the median size (from 7 cm to 8 cm) of trout from winter to spring may reflect a change in the availability of different size classes. Unfortunately, electrofishing data for this stretch of river is not available, so the relative frequencies of salmon and trout in the diet cannot be compared with their availability.

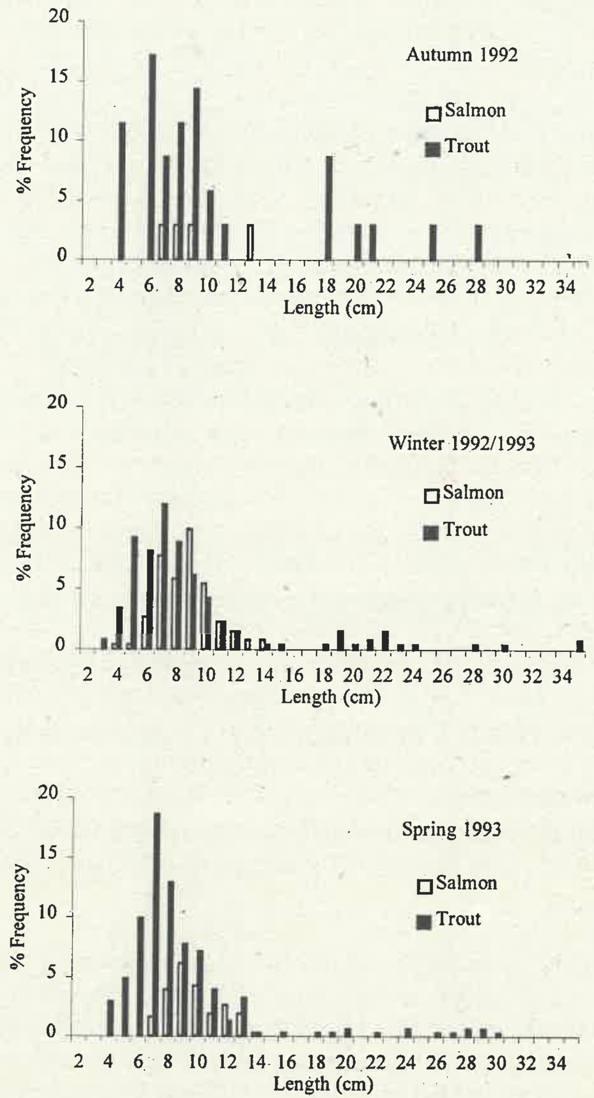

Fig.2: Relative percentage frequencies of size classes of salmon and trout in the diet of otters at Bushmills.

Overall, however, the low numbers of salmon bones occurring in the spraints suggests that the otters' use of the hatchery salmon as a source of food was fairly minimal in 1992/93.

An otter predation problem did eventually occur at the hatchery. In early March, 1994, staff noticed that the numbers of salmon in two tanks had dropped dramatically. The discovery of large quantities of spraint material in the vicinity of the tanks resulted in the otter being blamed for the losses. In total 5,000 smolts disappeared but because of a structural problem with one of the tanks, up to 2,000 may have escaped. All of these fish were destined for a long term project on the River Lagan and had been microtagged. Until some or all of those 2,000 escapees are recorded returning from the sea to the river, all losses will be attributed to otter predation. Because of the flood conditions which persisted in early 1994, staff had not been able to see into the tanks in the preceding 4 to 6 weeks, so it is therefore possible that the fish had escaped or been removed by predators at any time within the two months leading up to the discovery of the losses. A teaspoon-sized sample of spraint material was analysed in the hatchery laboratory and was found to contain 17 microtags. The contents of a number of spraints (n = 11) collected from the hatchery grounds were analysed and salmonids were the only prey species which occurred; all of the spraints contained large numbers of bones, one in excess of 800 vertebrae. The frequency distribution in Fig. 3, showing the sizes eaten, is a good representation of the sizes of fish taken from the hatchery tanks (Walter Crozier, pers. comm.). An examination of the salmon and trout bones found in the spraints showed that, unlike previous occasions, they were present in almost equal proportions (salmon 49.8 % of bones) (Fig. 4). It can be seen that the occurrences of salmon were limited to the 10 - 15 cm size classes while there were a couple of occurrences of juvenile trout and greater numbers of larger trout.

Estimations of the biomass of salmon from spraint material indicated that a family group of otters (adult and two cubs), which have reportedly been sighted in Bushmills, would be capable of eating at least the 3,000 fish which were known to have been lost to predation over the two months leading up to March, 1994. Electric fences and net covering are now used around the tanks and no further problems have been reported.

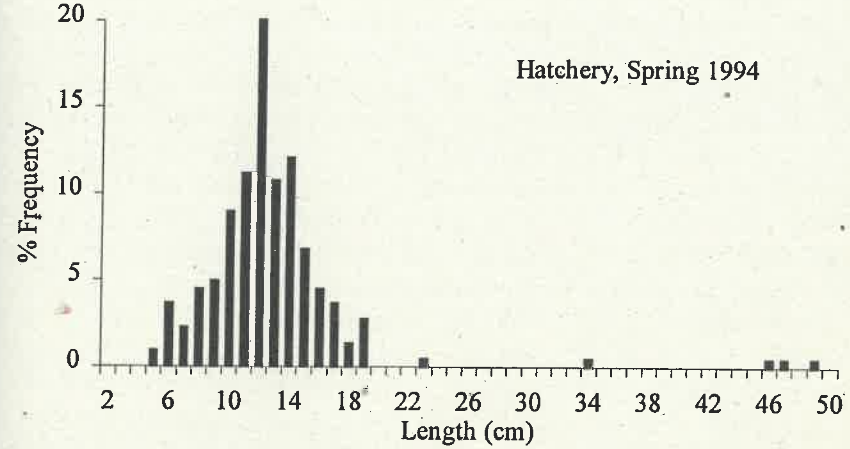

Fig.3: Length of salmonids occurring in the diet of otters at Bushmills Salmon Hatchery, Spring 1994.

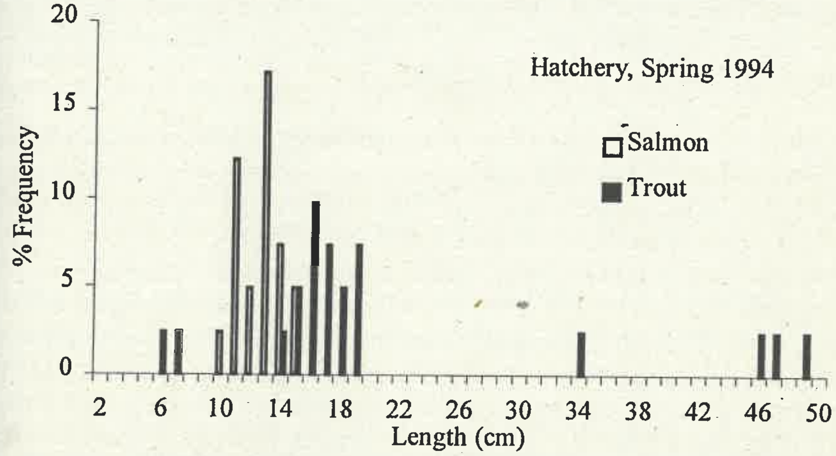

Fig. 4: Relative percentage frequencies of size classes of salmon and trout in the diet of otters at Bushmills Salmon Hatchery, Spring 1994.

Discussion

Hitherto, almost all published diet studies have shown that the otter is a highly piscivorous but opportunist predator (in Chanin 1985; Mason & Macdonald 1986) and the results of this investigation have confirmed these findings. There are distinct, statistically significant, seasonal variations in the percentage occurrence of a number of prey items in the diet, and it seems clear that a drop in the contribution of one prey type is compensated by a corresponding increase in the importance of others. The low salmonid frequency in summer diet agrees closely with the trend observed in other comparable investigations (e.g. Jenkins & Harper 1980; Wise *et al.* 1981) but contrasts with that indicated by Durbin (1993). He reported a spring reduction in predation on salmonids which appeared to coincide with the general reduction in the species biomass in the area (N. E. Scotland) at that time of year. This reduction was associated with increases in the relative importance of birds, mammals and amphibians, but the causal factor in the relationship is not clear (i.e. are non-fish prey taken to compensate for the reduction in salmonid biomass, or are the non-fish prey increasingly vulnerable, and preferred, at that time of year?). A late winter and early spring increase in the percentage occurrence of frogs (which is almost certainly related to exploitation of temporary congregations of spawning frogs (Weber 1990)) was observed in this study but was not associated with a significant drop in salmonid importance. However, salmonids were replaced by eels in the summer diet of otters which seems to conform with Durbin's (1993) idea of compensatory changes in predation with changes in prey availability.

It is difficult to establish causality in this relationship. Salmonids suffer temperature-induced reductions in performance in winter (Rimmer *et al.* 1985; Heggenes *et al.* 1993), leaving them considerably more vulnerable to predation (Webb 1975). However, in the summer months, their susceptibility would be reduced by their greater sustained swimming speed and acceleration compared with other species (Bainbridge 1958). In addition to this, the availability of eels at this time of year increases as temperatures rise and they emerge from the mud (Moriarty 1978). The associated increase in the occurrence of eels in otter diet has been commented upon by numerous other studies (Breathnach & Fairley 1993; Erlinge 1967; Gormally & Fairley 1982; Jenkins & Harper 1980; McFadden & Fairley 1984; Murphy & Fairley 1985; O'Sullivan 1994; Wise *et al.* 1981). So salmonids are more susceptible to predation in winter while torpid eels are unavailable, and in contrast eels are increasingly available to otters in the summer, compensating

for the reduced vulnerability of salmonids. Clearly, attempts to class prey types as either preferred or avoided by otters may be unwarranted.

The sizes of salmonid bones recorded in spraints indicated that small fish (5 - 12 cm) were most important in the diet, with peaks in the frequencies of 0+ and 1+ fish, and this corresponds with findings in other rivers (Breathnach & Fairley 1993; Jenkins & Harper 1980; McFadden & Fairley 1984). Wise *et al.* (1981) reported that fish were taken according to their availability as shown by electrofishing. None of these studies looked at seasonal changes in the size of salmonids taken which here were found to be larger fish during the summer compared with fish consumed during other seasons. In general, the frequency distributions reflected the expected patterns of fish availability. A study of river otter (*Lutra canadensis*) predation on juvenile salmonids in spring also showed that otters consumed their prey in proportion to the availability of sizes (Dolloff 1993).

A lack of electrofishing data for the study site limited the conclusions which could be drawn about the differences in the extent of predation on salmon in comparison with trout. The diagnostic bones recorded in spraints collected in three of the four seasons showed that trout comprised from 62 - 88 % of the salmonids taken. These are similar figures to those recorded for the upper reaches of the same river (O'Neill 1995) where electrofishing data suggested that at several sites 0+ salmon were much more frequent than trout. If the proportions in Bushmills are similar, it would seem clear that otters were selectively feeding on trout. From the sizes of these fish it appears that the juvenile (0+, 1+) trout in the diet were smaller than the salmon. The different spawning times of the two species may account for this, although salmon fry on the River Bush are restricted to shallower, higher gradient areas than trout of the same age class (Kennedy & Strange 1982). Salmon possess a larger pectoral fin, and are physically better adapted to negociate waters where the increased turbulence may affect an otter's ability to pursue small prey. Rather than indicating active selection of small trout over salmon of the same age, the results may reflect the otter's choice of foraging habitat.

It has long been known that piscivorous birds pose predation problems at fish farms (Carss 1990) but authenticated reports of the impact of otters have been limited. Otters were unquestionably responsible for at least some of the losses at the Bushmills salmon hatchery. The occurrence of microtags in spraints and the seasonal change in sizes of salmonids and proportions of salmon in the diet testify to this. The numbers, sex or social status of otters ranging in this area are unknown so it is difficult to determine reasons for the sudden increase in the otters use of hatchery tanks as a source of food. A suggestion could be that one or more transient animals moved into the area and serendipitously came upon a reliable and concentrated source of food. In any case, it seems that resolving the conflict was relatively straightforward - electric fences around the tank area have prevented a reoccurrence of the problem.

The need for quantitative data on this subject is especially clear if there is a danger of persecution as a result of unconfirmed reports of damage to valuable fisheries. For example, cape clawless otters (*Aonyx capensis*) on the Upper Kairezi River, Zimbabwe were blamed for a decline in regularly re-stocked rainbow trout (*Oncorhynchus mykiss*). However, Butler & du Toit (1994) reported that the otters preyed mainly on crabs, and trout occurred in only 1 % of their spraints. In addressing the difficulties which are occasionally encountered by fisheries owners in Britain, Jeffries (1987) felt that otters were unlikely to be killed in order to protect fish stocks, but drew attention to the dangers of attempting to trap and remove otters from such areas. His concern was that otters may be continually attracted to an empty but profitable fishing area. This particular problem appears to be occurring on the River Kairezi studied by Butler & du Toit (1994), who reported that eight cape clawless otters had been trapped in 6 years on a trout farm where they were judged to be a regular pest. The experience gained at Bushmills would suggest that improved fencing and protection for the farm tanks is a simple and effective solution to the problem.

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References

Bainbridge, R. 1958. The speed of swimming fish as related to size and to the frequency and amplitude of the tail beat. J. Exp. Biol. 35, 109-133.

Bekker, D.L. and Nolet, B.A. 1990. The diet of otters *Lutra lutra* in the Netherlands in winter and early spring. Lutra 33, 134-144.

Breathnach, S. and Fairley, J.S. 1993. The diet of otters *Lutra lutra* in the Clare River system. Biology and Environment. 93B (3), 151-158.

Broyer, J., Aulagnier, S. and Destre, R. 1988. La loutre *Lutra lutra* angustifrons Lataste, 1885 au Maroc. Mammalia 52 (3), 361-370.

Butler, J.R.A. and du Toit, J.T. 1994. Diet and conservation status of Cape clawless otters in eastern Zimbabwe. S. Afr. J. Wildl. Res. 24 (3), 41-47.

Calvert, R.F. 1992. Development of a system for the identification and measurement of fish species from their remains found in pellets and scats of piscivorous birds and mammals. Unpubl. B Sc.(Hons) Dissertation. University of Ulster, Coleraine.

Casteel, R.W. 1976. Fish remains in archaeology and paleo- environmental studies. Academic Press, 1-165.

Carss, D.N. 1990. The impact of freshwater fish farming on birds and mammals. In: Fish Farming and the Scottish Freshwater Environment. A report prepared for the Nature Conservancy Council.

Chanin, P.R.F. 1985. The Natural History of Otters. Christopher Helm, London.

Chanin, P.R.F. and Jeffries, D.J. 1978. The decline of the otter *Lutra lutra* in Britain: an analysis of hunting records and discussion of causes. Biol. J. Linn. Soc.10, 305-328.

Chapman, P.J. and Chapman, L.L. 1982. Otter Survey of Ireland 1980-1981. Vincent Wildlife Trust.

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

Dolloff, C.A. 1993. Predation by river otters *Lutra canadensis* on juvenile coho salmon *Oncorynchus kisutch* and Dolly Varden *Salvenius malma* in Southeast Alaska. Can. J. Fish. Aquat. Sci. 50, 312-315.

Doornbos, G. 1984. Piscivorous birds on the saline lake Grevelingen, the Netherlands: Abundance, prey selection and annual food consumption. Neth. J. Sea Res. 18 (3/4), 457-479.

Durbin, L. 1993. Ecology of otters on the River Don. Ph.D. Thesis. Aberdeen University.

Elmhirst, R. 1938. Food of the otter in the marine littoral zone. Scott. Nat. 1938, 99-102.

Erlinge, S. 1967. Food habits of the fish otter *Lutra lutra* L. in south Swedish habitats. Viltrevy 4, 371 - 443.

Erlinge, S. 1969. Food habits of the otter *Lutra lutra* L. and the mink *Mustela vison* S. in a trout water in Southern Sweden. Oikos 20, 1-7.

Fairley, J.S. and Wilson, S.C. 1972. Autumn food of otters *Lutra lutra* on the Agivey River, Co. Londonderry, Northern Ireland. J. Zool., Lond. 166, 468-469.

Feltham, M.J. and 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. J. Zool., Lond. 219, 113-122.

Foster, J. and Turner C. 1991. Insects and otter diet. The Entomologist. 110 (4), 166-169.

Gormally, M.J. and Fairley, J.S. 1982. Food of otters *Lutra lutra* in a freshwater lough and an adjacent brackish lough in the West of Ireland. J. Zool., Lond. 197, 313-321.

Green, J., Green, R. and Jeffries, D.J. 1984. A radio-tracking survey of otters *Lutra lutra* L. on a Perthshire river system. Lutra 27, 85-145.

Härkönen, T. 1986. Guide to the Otoliths of the Bony Fishes of the Northeast Atlantic. Hellerup: Danbiu ApS.

Heggberget, T.M. 1993. Marine-feeding otters *Lutra lutra* in Norway: Seasonal variation in prey and reproductive timing. J. Mar. Biol. Ass. U.K. 73, 297-312.

Heggenes, J., Krog, O.M.W., Lindås, O.R., Dokk, J.G. and Bremnes, T. 1993. Homeostatic behavioural responses in a changing environment: brown trout *Salmo trutta* become nocturnal during winter. J. Anim. Ecol. 62, 295-308.

Jeffries, D.J. 1987. The effects of angling interests on otters, with particular reference to disturbance. In: Angling and Wildlife in Freshwaters. ITE symposium no. 19. (Maitland, P.S. and Turner, A.K. eds)

Jenkins, D. and Harper, R.J. 1980. Ecology of otters in Northern Scotland II. Analyses of otter *Lutra lutra* and mink *Mustela vison* faeces from Deeside, N.E. Scotland in 1977-78. J. Anim. Ecol 49, 737-754.

Kemenes, I. and Nechay, G. 1990. The food of otters *Lutra lutra* in different habitats in Hungary. Acta Theriol. 35, 17-24.

Kennedy, G.J.A. and Strange, C. D. 1982. The distribution of salmonids in upland streams in relation to depth and gradient. J. Fish Biol. 20, 579-591.

Kruuk, H. and Moorhouse, A. 1990. Seasonal and spatial differences in food selection by otters *Lutra lutra* in Shetland. J.Zool., Lond. 221, 621-637.

Kruuk, H. and Moorhouse, A. 1991. The spatial organization of otters *Lutra lutra* in Shetland. J.Zool., Lond. 224, 41-57.

Kruuk, H., Conroy, J.W.H. and Moorhouse, A. 1991. Recruitment to a population of otters *Lutra lutra* in Shetland in relation to fish abundance. J. Appl. Ecol. 28, 95-101.

Kruuk, H., Carss, D.N., Conroy, J.W.H. and Durbin, L. 1993. Otter *Lutra lutra* L. numbers and fish productivity in rivers in north-east Scotland. Symp. Zool. Soc. Lond. 65, 171-191.

Kyne, M.J., Smal, C.M. and 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. Proc. R. Ir. Acad. 89B, 33-46.

Kyne, M.J., Kyne, M.J. and Fairley, J.S. 1990. A summer survey of otter sign on Roundsone Bog, South Connemara. Ir. Nat. J. 23, 273-276.

Lopez-Nieves, P. and Hernando, J.A. 1984. Food habits of the otter in the Central Sierra Morena (Cordoba, Spain). Acta Theriol. 29 (32), 383-401.

McFadden, Y.M.T. and 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). J. Life Sci. R. Dublin Soc. 5, 65-76.

Macdonald, S.M. 1989. Ireland is one of the last strongholds of the otter. Living Heritage: Journal of An Taisce 6 (1), 4-6.

Macdonald, S.M. and Mason, C.F. 1990. Action Plan for European Otters. In: Otters: An Action Plan for their Conservation. Foster-Turley, P., Macdonald, S. M. and Mason, C.F. (eds). IUCN/SCC Otter Specialist Group. Gland, Switzerland.

Maitland P.S. 1972. A Key to the Freshwater Fishes of the British Isles. Freshwater Biological Association, Windermere.

Mason, C.F. and Macdonald, S.M. 1986. Otters: Ecology and Conservation. Cambridge University Press.

Mills, D. 1971. Salmon and Trout: A resource, its ecology, conservation and management. Oliver and Boyd, Edinburgh.

Moriarty, C. 1978. Eels: A Natural and Unnatural History. David and Charles, Vancouver, BC.

Murphy, R.P. and Fairley, J.S. 1985. Food of otters *Lutra lutra* on the south shore of Galway Bay. Proc. R. Ir. Acad. 85 (a), 47-55.

O'Neill, E.M. 1995. Resource use by otters *Lutra lutra* in riparian habitats. D. Phil Thesis. University of Ulster, Coleraine.

O'Sullivan, W.M. 1994. Summer diet of otters on part of the River Blackwater catchment. Ir. Nat. J. 24, 349-354.

Rimmer, D.M., Saunders, R.L. and Paim, U. 1985. Effects of temperature and season on the position holding performance of juvenile Atlantic salmon *Salmo salar*. Can. J. Zool. 63, 92-96.

Tangney, D.E. and Fairley, J.S. 1994. Otter signs and diet in Connemara National Park and its environs. Ir. Nat. J. 24, 434-440.

Thom, T.J. 1990. The ecology of otters *Lutra lutra* on the Wansbeck and Blyth river catchments in Northumberland. M. Sc. Thesis. University of Durham.

Webb, P.W. 1975. Hydrodynamics and energetics of fish propulsion. Bull. Fish Res. Board Can. 190: 1-159.

Webb, J.B. 1976. Otter Spraint Analysis. The Mammal Society, Reading.

Weber, J.M. 1990. Seasonal exploitation of amphibians by otters *Lutra lutra* in Northeast Scotland. J. Zool., Lond. 220, 641-651.

Wise, M.H. 1980. The use of fish vertebrae in scats for estimating prey size of otters and mink. J. Zool., Lond. 192, 25-31.

Wise, M.H., Linn, I.J. and Kennedy, C.R. 1981. A comparison of the feeding biology of mink Mustela vison and otter *Lutra lutra*. J.Zool. ,Lond. 195, 181-213.

Yalden, D.W. 1977. The Identification of Remains in Owl Pellets. The Mammal Society, Reading.

WHAT DO OTTERS (*LUTRA LUTRA*) FEED IN A CARP POND AREA IN SAXONY, EASTERN GERMANY?

Liana GEIDEZIS

Key words: Lutra lutra, diet, fish pond, conservation, Germany

Introduction

Over the past 100 years the distribution of the Eurasian otter (*Lutra lutra*) has been declining in many European countries, particularly in Central Europe (Mason & Macdonald 1986). In Germany the species is listed among the country's most endangered mammals. In north-east Saxony, a breeding population still survives, and this might be a source habitat from which the species could expand to areas where it is currently extinct. This small population exists in the Oberlausitz pondland (Ansorge 1994). In 1993 the Saxonian State Government implemented the "Otter Conservation Programme", the co-ordination of which lies with the Saxonian Department of Environment and Geology based in Radebeul.

As part of this programme, a study of the otter's diet in the Oberlausitz carp pondland was undertaken between June 1994 and June 1995. Such investigations in an economically used pond area are essential for two reasons:

- to get more information what otters eat in these areas, and, if required, to conserve or to im prove food supply.
- to determine precisely what species otters eat in fish pond areas to help determine the economic impact of otters on the commercial fish stock, and, consequently, implement better management strategies for solving conflicts between otters and fish farmers.

In all Europe the actuality of the problem "otters and fish ponds" is emphasized more and more, e.g. in Austria (Bodner 1996). With regard to the threatened status of the otter, steps are urgently required for protection and conservation of its populations in those areas where they still exist.

Study Area

The study area is located within the Biosphere Reserve "Oberlausitzer heath and pondland" in eastern Saxony. Since the Middle Ages the Oberlausitz pondland is characterized by carp pond farming, it is the largest interconnected pond area in Germany. Beside carp (*Cyprinus carpio*), other species may be stocked but in much lower densities; including pike (*Esox lucius*), tench (*Tinca tinca*), perch (*Perca fluviatilis*), pike-perch (*Stizostedion lucioperca*), catfish (*Silurus glanis*) and grass carp (*Ctenopharyngodon idella*). On average the ponds are 1 to 1.3 m deep, their important characteristic is their regular draining mainly during winter. Many of these ponds appear almost natural ensuring the necessary habitat structures with favourable feeding conditions for otters. The study area, covering 300 ha, contains 13 fish ponds measuring from 550 m^2 to 21 ha, in total 75 ha of water surface. A small river (7 m wide, up to 1.5 m deep) runs through the area. Both running and still waters of different sizes are close together and otters can easily migrate between them.

Material and Methods

The study area, particularly along pond and river banks, and ditches was searched for presence of otter signs such as spraint sites, spraints, tracks etc. An average of 130 "collecting sites" was visited over several consecutive days of each month, always in the same sequence. Only fresh spraints, less 24 h old, were collected, placed separately in polythene bags and stored deep-frozen. In the laboratory, they were oven-dried at 50°C for 48 h, weighed and soaked for 24 h in 0.2 l saturated solution of concentrated washing powder. For spraint analysis the undigested remains (e. g. scales, vertebrae, bones, teeth, fur, feathers) were identified from reference collections and with special identification keys. Identification of fish remains in the sprаints was mostly to species level. Cyprinids could be identified to species level if pharyngeal teeth, operculae, otoliths or, exclusive for carp, praemaxillare or dented fin rays were present. In the absence of these characteristic structures the fish was considered as "unidentified cyprinid". The results of the analysis are presented as frequency of occurrence (number of spraints in which prey type occurs x 100/total number of spraints) and relative frequency of occurence (number of spraints in which prey type occurs x 100/the sum of counts for all prey types). Data were divided into four seasons: summer (June - August), autumn (Sept. - Nov.), winter (Dec. - Feb.) and spring (March - May). The results are based on the analysis of 359 spraints, collected between June 1994 and June 1995.

Results

Fish, the dominant prey throughout the year, varied only between 84.7 and 93 % in the otter diet during different seasons (Fig. 1). Fish was found most frequently in spraints in autumn and least during summer months. Birds and mammals were

found only in summer. Crayfish, insects and amphibians were caught in every season. Crayfish (6 %) were most important in summer, decreasing over autumn (4.5 %) and winter (2.8 %) and increasing again in spring (5 %). Amphibians were found mostly during winter (5.5 %) and showed a decreasing tendency in diet over spring (3 %), summer (1.2 %) and autumn (0.6 %). Insects were not represented in spraints in any seasonality comparable to crayfish and amphibians.

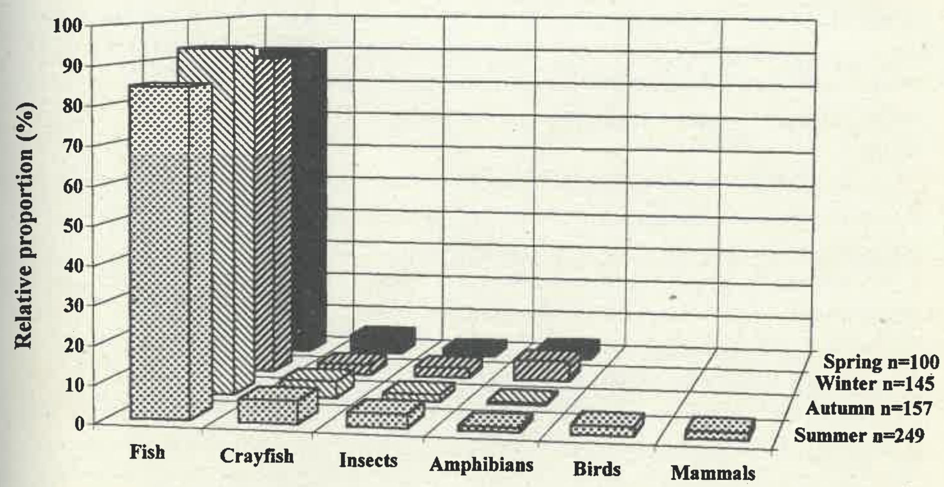

Fig. 1: Seasonal composition of otter diet in food categories (relative frequency of occurrence (%)) from Oberlausitz pondland. n = number of occurrences.

Table 1 lists all prey species which were found in spraints throughout different seasons. Within the prey group fish, carp and perch were the most important food source in almost every season. Carp was found in 42.4 to 50 % of spraints in different seasons. In winter, perch (44.2 %) was found in almost the same number of spraints as carp (45.5 %). Pike contributed only a small part to otter diet in summer but was found fairly often in autumn, winter and spring. In autumn *Leucaspius delineatus*, a small cyprinid species, was found in the diet as frequently as carp, being found in about half the spraints. In spring roach (*Rutilus rutilus*) was just as important as carp in 42.4 % of the spraints. *L. delineatus* contributed little to the diet in other seasons, and roach occured mainly in autumn and spring, rarely in summer and winter.

River crayfish (*Orconectes limosus*), the only crayfish species in the study area, were least common in winter diet. Aquatic insects such as back-swimmers (*Notonecta glauca*) and great water beetle (*Dytiscus marginalis*), were found in spraints. The former appeared throughout the year, most frequently in winter (one spraint, collected in February, contained five individuals and nothing else). Frogs were most frequently eaten in winter, the time of their hibernation. In spring during the spawning season they were more common, than in summer and autumn.

Remains of water-birds (feathers), northern mallard (*Anas platyrhynchos*) and little grebe (*Tachybaptos ruficollis*), and semi-aquatic mammals such as water vole (*Arvicola terrestris*), brown rat (*Rattus norvegicus*) and muskrat (*Ondatra zibethicus*), occured in spraints in summer.

Discussion and Conclusion

Fish were the most important prey of otters in the Oberlausitz fish farming area throughout the year. These results are similar to other studies from freshwater habitats in northern and Central Europe (Erlinge 1967, Webb 1975, Wise *et al.* 1981, Hansen & Jacobsen 1992, Hofmann & Butzeck 1992, O'Sullivan 1994). The proportion of fish in the otter diet varied seasonally but remained high (between 84.7 and 93 %). Seasonality in otter diet is described in other studies, e. g. Laanetu (1989), Weber (1990), Hofmann & Butzeck (1992). Adrian & Delibes (1987), however, found little seasonal differences in their work. In the present study the small variation in otter diet, with regard to different prey groups, is most likely due to the large amount of fish available, in particular carp, in every

Table 1: Seasonal percent frequency of occurrence of prey species in otter spraints from Oberlausitz pondland. n = number of spraints.

Prey species	Summer n=157	Autumn n=66	Winter n=77	Spring n=59
Fish				
Perca fluviatilis	29,3	34,9	44,2	23,7
Gymnocephalus cernua	0,6	6,1	3,9	5,1
Gasterosteus aculeatus	5,1	3,0		1,7
Esox lucius	2,6	25,8	19,5	22,0
Stizostedion lucioperca			2,6	
Cyprinus carpio	47,1	50,0	45,5	42,4
Rutilus rutilus	4,5	28,8	9,1	42,4
Gobio gobio	1,3	9,1		
Leucaspius delineatus	7,6	50,0	15,6	1,7
Leuciscus cephalus	0,6			
Tinca tinca			7,8	
Ctenopharyngodon idella			5,2	
Cyprinidae indet.	33,1	9,1	14,3	11,9
Pisces indet.	2,6	4,6		1,7
Crayfish				
Orconectes limosus	9,6	10,6	5,2	8,5
Insects				
Notonecta glauca	2,5	1,5	5,2	1,7
Dytiscus marginalis		3,0		
Coleoptera	3,2			1,7
Amphibians				
Rana spec.	1,9	1,5	10,4	5,1
Birds				
Anas platyrhynchos	0,6			
Tachybaptos ruficollis	0,6			
Anas spec.	1,9			
Aves indet.	0,6			
Mammals				
Arvicola terrestris	1,3			
Rattus norvegicus	1,3			
Ondatra zibethicus	0,6			

season. In winter, carp are stocked in ponds even in higher densities than in summer. These densely packed and almost still-standing carp are therefore easy to capture for otters. Consequently there is no need for otters to search for so-called "alternative prey". Diet was most diverse in summer when the non-fish-proportion of the diet was largest. This is probably due to the fishes' increased activity when water temperature is higher (Webb 1975), making them harder to catch. But it has to be taken into consideration that non-fish prey groups, like crayfish, insects, birds etc., are present in higher numbers in summer than in other seasons; probably they are more available for otters.

Beside stocked carp, fish species like perch, pike and roach which occur both in the ponds and the river, were eaten by otters in significant amounts throughout the year. Perch in particular contributed to the diet in all seasons, but especially in winter. A tendency for percids to be very important in winter was also found by Erlinge (1967), Webb (1975), Jenkins *et al.* (1979) and Hofmann & Butzeck (1992). Observations on foraging behaviour of otters in the Otter-Zentrum Hankensbüttel (Rogoschik 1995 pers. comm.) showed perch an easy prey for otters because of its anti-predator behaviour. They became motionless when an otter approached and therefore easy for the carnivore to catch.

Crayfish were the second most eaten prey group in summer, autumn and spring. They are considered an important prey item for otters, especially in summer, in other studies (Erlinge 1967, Adrian & Delibes 1987). Kruuk (1995) points out that crayfish can be an important food source for otters when, for example, fish numbers are decreasing in an area. Amphibians, insects, birds and small mammals were only occasionally taken by the otters in this carp pondland. These are also considered important alternative prey if for instance fish abundance / availability is declining (cf. O`Sullivan 1994), however, this does not seem to be the case here.

In this study it could be ascertained that otters use different fish species for prey in carp pond areas. Fish ponds and carp respectively, are one but not the only or the prefered food source of otters. Carp do, however, contributed considerably to the otter diet in every season, caused by the availability of carp in high numbers throughout the year and not by a preference for carp compared with other fish species (Geidezis 1996). The habitat's carrying capacity for a viable otter population depends more on available fish biomass as on species composition. A

decrease of available carp biomass in the Oberlausitz pondland could lead to considerably negative effects on the otter population if this would not be compensated by biomass increase of other species, for instance in rivers. Finally, it should be pointed out that the fish farmers, especially in the investigated pond area, are very appreciate of otter protection and conservation. Further management strategies have to be developed and implemented for future corporate life between otters and fish farmers.

References

Adrian, M.I. and Delibes, M. 1987. Food habits of the Otter (*Lutra lutra*) in two habitats of the Doñana National Park, SW Spain. J. Zool., Lond. 212, 399-406.

Ansorge, H. 1994. Zur Situation des eurasischen Fischotters *Lutra lutra* Linné, 1758 im Raum Oberlausitz-Sachsen. Säugetierkd. Inf., Jena 3(18), 617-622.

Bodner, M. 1996. Fischotter und Teichwirtschaft. WWF Forschungsbericht Fischotter 3, 26-44.

Erlinge, S. 1967. Food habits of the Fish Otter *Lutra lutra* L. in south Swedish habitat. Viltrevy 4, 371-443.

Geidezis, L. 1996. Food availability versus food utilization by otters (*Lutra lutra*) in the Oberlausitz pondland in Saxony, eastern Germany. IUCN Otter Spec. Group Bull. 13(2), 58-70.

Hansen, H.-M. and Jacobsen, L. 1992. Aspekter af odderens (*Lutra lutra* L.) fodebiologi i Danmark, Article 2, Institute of Biology, Århus University, Denmark.

Hofmann, Th. & Butzeck, S. 1992. Beitrag zur Ernährung des Fischotters *Lutra lutra* (L., 1758) im Spreewald. In: Semiaquatische Säugetiere, Wiss. Beitr. Univ. Halle 1992, 436-450.

Jenkins, D., Walker, J.G.K. and McCowan, D. 1979: Analysis of otter (*Lutra lutra*) faeces from Deeside, N. E. Scotland. J. Zool., Lond. 187, 235-244.

Kruuk, H. 1995. Wild Otters: Predation and Populations. Oxford: Oxford University Press.

Laanetu, N. 1989. Zur Ökologie des Fischotters *Lutra lutra* (L., 1758) in Estland. In: Populationsökologie marderartiger Säugetiere. Wiss. Beitr. Univ. Halle 1989/37 (P39), 59-70.

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

O'Sullivan, W.M. 1994. Summer diet of otters on part of the River Blackwater catchment. Ir. Nat. J. 24(9), 349-354.

Reuther, C. 1993. *Lutra lutra* (Linnaeus, 1758) - Fischotter. In: Handbuch der Säugetiere Europas. J. Niethammer & F. Krapp, eds.. Aula-Verlag Vol. V/II, 907-961. Wiesbaden.

Webb, J.B. 1975. Food of the otter (*Lutra lutra*) on the sommerset levels. J. Zool., Lond. 177, 486-491.

Weber, J.-M. 1990. Seasonal exploitation of amphibians by otters (*Lutra lutra*) in north-east Scotland. J. Zool., Lond. 220, 641-651.

Wise, M.H., Linn, I.J. and Kennedy, C.R. 1981. A comparison of the feeding biology of Mink Mustela vison and Otter Lutra lutra. J. Zool., Lond. 195, 181-213.

PRELIMINARY FINDINGS ON CARP *CYPRINUS CARPIO* PREDATION BY OTTERS *LUTRA LUTRA* IN THE TREBON BIOSPHERE RESERVE (CZECH REPUBLIC)

Kevin ROCHE

Summary
Faeces (spraint) of the otter *Lutra lutra* were collected bimonthly from 3 sites representing the widest possible range of diet and habitat within the Trebon Biosphere Reserve (Czech Republic). The Relative Frequency of Occurrence of carp *Cyprinus carpio*, the main economic species within the Reserve, was determined and an estimate of biomass taken by the otter made. Cycles of predation were observed at the three sites, peak predation taking place in summer at site 1 and winter at sites 2 and 3, the difference being statistically significant. The autumn/winter - spring/summer cycles were also found to be significant at all 3 sites. The highest level of predation was found at site 2, with 32.9 kg/per otter/per month taken in February 1996, when the only source of fish was a carp pond kept clear of ice. No specialisation was observed for particular age/size classes of carp. Carp was evidently an important dietary component at sites where other food sources were low, either spatially or seasonally. Where such alternative prey was available throughout the year, in high numbers or biomass, carp predation was relatively low.

Key words: Lutra lutra, Cyprinus carpio, diet, fish farm, Czech Republic

Introduction

The Trebon Biosphere Reserve supports one of the largest, and oldest, carp *Cyprinus carpio* farming centres in Europe, dating back around 700 years. Production of carp within the Reserve presently totals around 3,000 metric tonnes per year (F. Alexa, pers. comm.) and the fish are harvested on a 1, 2 or 3 year rotation. The now semi-natural, artificial wetland system of ponds, channels, wetland meadows, marshes and rivers, based around the River Lužnice, supports a thriving, population of otters *Lutra lutra* which spreads into both Austria and Germany. Extensive aquaculture techniques, and constant water management, provide a high biomass of fish in the connecting water bodies and ensures areas free of ice in winter. The Reserve therefore provides ideal conditions for the otter.

Recent decades have seen ever increasing production demands placed upon the fisheries and this, in turn, is beginning to have an effect on the fauna and flora of the Reserve. Predators of economic fish have, until now been tolerated in Trebon, however, as demand rises and prices fall, fish predators are beginning to be seen as a threat. Though there has been little or no demand for compensation to date, at least in Trebon, it is only a matter of time before such demands arise, especially as a system of payment for 'perceived' damages is presently in operation for Austrian fish farmers (Bodner 1995).

Information on predation of economic fish by the otter, and certainly on carp, is lacking, though there has been some recent work carried out on the neighboring smaller carp ponds in Austria (e.g. Knollseisen 1995). As part of a long-term study of the diet and foraging strategy of the otter in the Trebon Biosphere Reserve, particular reference is being made to predation on carp. This report presents some of the preliminary results of the study.

Method and Materials

Faeces (spraint) of the otter have been collected, bimonthly when possible, at three sites representing the widest possible range of habitat and food for the otter within the Reserve.

SITE 1 - The western banks of 2 ponds (Novy Vdovec and Zenich, approx. 100 ha in size) and the channels connecting the ponds to the River Luznice (approx. 0,5 km distant). These ponds (as well as the numerous surrounding ponds) are stocked mainly with k1 and k2 carp and contain a range of other commercial and non-commercial fish, e.g. zander (*Stizostedion lucioperca*), pike (*Esox lucius*) and roach (*Rutilus rutilus*). The site is part of an open system allowing small fish to move between the ponds and river. With the very high biomass of fish available, and both the ponds and lagoons on the river remaining open in winter, this site can be considered as typical of the best otter habitat in Trebon.

SITE 2 - The banks of a 25 ha pond (Novy u Cepu), stocked mainly with k1 carp and harvested every 2 years, and a small (<0,25 ha) juvenile rearing pond stocked with k0 carp. These ponds are entirely stocked, relying for its water supply on the surrounding watershed. The main drainage channels are dry for most of the year and the site is relatively far (for Trebon) from any other decent water body (≈ 3 km). Otters at this site, therefore, can be expected to get all or most of its prey from the ponds and surrounding wetland meadows.

SITE 3 - The western bank of the River Luznice meanders, 3 km downstream of the village Suchdol, and the associated ox-bows in the floodplain meadows surrounding the site. The site is relatively far from any ponds (≈ 4 km) and is prone to frequent flooding. Being upstream of the fishponds the river is unaffected by

pond management and maintains a low fish biomass (mainly large cyprinids), principally due to pollution from Austria (Jurajda & Roche 1994). The stocking regime of the nearest ponds is not, as yet, known.

A comparable area of approximately 2 km is searched at all three sites and, when spraint numbers were high, sub-sampling was employed. Numbers of otters range between 6 (summer) and 11 (winter) at site 1 (Kranz 1995). One male is resident at site 2 and 1 resident female (with a visiting male) at site 3 (K. Foerster, R. Dulfer pers. comm. and pers. obs.).

Spraint of less than 3 weeks old were stored frozen and then analysed wet in the laboratory with a x10 binocular microscope, using keys (e.g. Conroy *et al.* 1993, Libois *et al.* 1988, Day 1966) and a reference collection of skeletons, teeth, scales and fur. Prey items were identified to species level and the minimum number of individual items per spraint was assessed. Results were calculated as Percentage and Relative Frequency. For the purposes of this study, Relative Frequency of Occurrence (RFO = number of a particular prey item in all spraint / the sum of all prey items in all spraint) only will be presented. This process was undertaken for both total carp RFO and for the RFO of each age class of carp determined (Figures 1A & B). An estimate of the biomass of carp taken by 1 otter, on a monthly basis at each study site, was also assessed (Figure 2). It was assumed that an adult wild otter takes 1.5 kg of food per day (Chanin 1985, Mason & Macdonald 1986) and that RFO gives a reasonable estimate of the importance of species in the diet. The relative percentage of 1.5 kg that carp represented was determined and that figure multiplied by the number of days in the month. Analysis of statistical differences were determined between sites and between sample dates, with seasons being determined as the warmer, spring / summer (S/S), period from March to August and the colder, autumn / winter (A/W) period from September to February.

Results

As in most previous studies (see Chanin 1985, Mason & Macdonald 1986), fish formed the predominant prey item within the diet for most of the year, with RFO's of up to 100% at all sites in the winter period (Figure 1 A). The RFO for non-fish prey items was always highest in mid summer, being largely made up of aquatic bird prey. This corresponds with the high numbers of migratory birds using the Trebon ponds in this period (K. Roche 1995, in press).

Table 1. Comparison of the mean level of carp predation at the 3 study sites.

Site	Mean	SD	Variation	n
1	5.8 kg	5.50	30.23	296
2	14.8 kg	9.14	83.60	232
3	12.9 kg	7.63	58.16	117

When RFO data was plotted chronologically, seasonal cycles are apparent in the predation of carp (Figure 1A). However, the peak winter predation apparent at sites 2 and 3, the pond far from river and river far from pond respectively, appears to be reversed at site 1, the river and pond together. In addition, carp was predated upon at a much lower rate at site 1. When the RFO values were converted to kg of carp, per otter, per month (Figure 2), these patterns are clearly evident. There was a significant difference between the three sites (Kruskal -Wallis, H = 8.946, P = 0.011). A comparison of the means and standard deviations indicated that site 1 was, indeed, showing a different pattern of carp predation than sites 2 and 3 (Table 1). To test whether the perceived seasonal 'cycles' of carp predation were in fact 'real' differences, Wilcoxan signed rank analysis was undertaken on the chronological data. All three sites proved to have significant differences between seasonal predation, with otters taking more carp in the S/S period at site 1 (Z = -2.599, P = 0.009) and more carp being taken in the A/W period at sites 2 and 3 (Z =-2.936, P = 0.003 and Z = -2.666, P = 0.008 respectively (0 values excluded)). The estimated amount of carp taken was low throughout the year at site 1 (< 9.0 kg/o/m), with only August 1994 showing a relatively high peak of 20 kg/o/m. Sites 2 and 3 showed very similar levels, ranging from 2.5 to 26.8 kg at site 2 and 3.4 to 23.4 kg at site 3. The only apparent difference was a slight shift to a maximum level in spring (March 1995) at site 2.

Otters showed no particular specialisation for separate age classes of carp, all ages present being taken (Figure 1 B). Highest numbers taken tended to be of the most abundant stocked size/age class. At site 3, where the stocking regime is not known, k2 was the dominant age/size class.

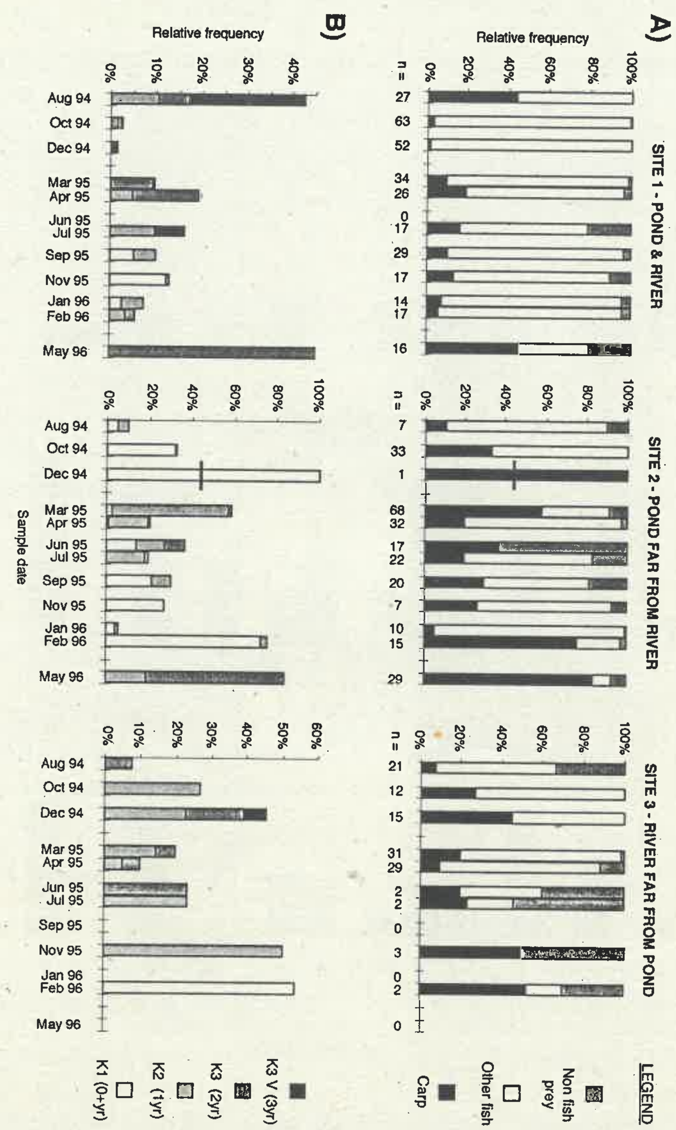

Figure 1: A) Relative frequency of occurrence (RFO) of carp Vs. other fish (mainly small cyprinidae <= 20cm) and non-fish prey (n = number of spraint in each collection); B) RFO of carp separated into age classes (Scales differ on the Y axis). (Note: In Dec. 1994, due to low spraint numbers, an extrapolated value of 44% was calculated)

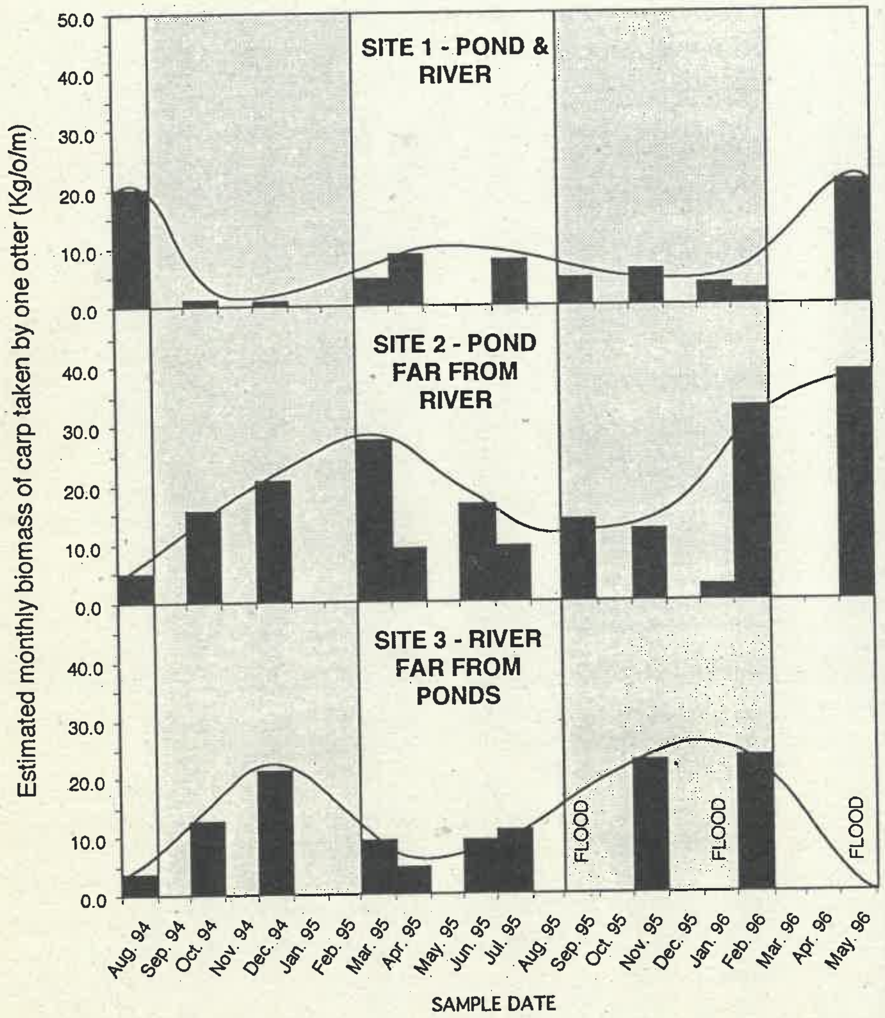

Figure 2: Estimated relative biomass of carp taken by 1 otter at each of the study sites per month. The shaded area indicates the colder, Autumn/Winter period and the unshaded area, Spring/Summer. The continuous line indicates the trend in predation throughout the study period (fitted by eye).

Discussion

The finding of seasonal cycles in the predation of carp at the three sites was relatively unexpected as one might expect carp, with its high biomass and high energy value, to be the dominant dietary item. However, at all 3 sites, other fish (principally smaller cyprinids of <= 20 cm) and non-fish prey formed a large proportion of the diet, especially in spring and summer (winter at site 1). The high predation on other fish may in fact be showing a negative preference for carp, fluctuations being due to the relative abundance and availability of the other cyprinids. This conclusion becomes particularly evident at site 1 where small cyprinids are constantly available in very high numbers, not only in the ponds, but also in the river and lagoons (both open in winter). These sites become highly stocked both with over-wintering fish and with small cyprinids, released following the pond harvests in September. Differences between the sites, therefore, appear to be due to the proximity of an alternative abundant food source, both sites 2 and 3 being relatively far from such alternative sites. This apparent preference for abundant sources of non-economic cyprinids has also been observed in Austria and is presently being tested by the provision of artificial ponds stocked with such fish (M. Bodner, pers. comm.).

A similar pattern of carp predation (i.e. highest in A/W) was observed by Knollseisen (1995) who studied the diet of otters in the border region of Austria and the Czech Republic. The ponds in this region are, in fact, similar to those at sites 2 and 3, both in size and distribution. In addition, Knollseisen´s data also showed that there was no apparent specialisation in age or size class of carp. Apparent changes in 'choice', evident in Figure 1B, can be explained by the restocking of the ponds and the change of age determination over the Winter period, i.e. 0+ to 1 year fish. At site 1, the unexpectedly high peak in August 1994, followed by 2 collections with unexpectedly low levels (October and December 1994) was probably due to the gradual draining of the pond over August, for harvesting, allowing easier foraging. The mild weather of 1994 caused cyprinids to spawn relatively early. The consequent release of large numbers of small and juvenile cyprinids into the drainage channels, following the September harvest, remained in the channels over winter. The result was that the otters fed almost exclusively on these small fish for a long period (Roche 1997). At site 2, high predation on k1 carp in the winter of 1996 was due to heavy ice formation that year preventing access to the main ponds, the juvenile pond being kept open (Figure 1B). Though the carp pond utilised by the otter at site 3 is not as yet known, it is possible to assume that it is stocked with k2 fish, though the move to k1 fish in February 1996 may also be evidence of foraging in a juvenile pond, as at site 2.

Though the otter at site 3 is evidently resident at the river (holts regularly used and track observation) carp is obviously a major food item. Unfortunately, the range size of this animal is not known as yet, however, to include a carp pond, it must be in the region of 7 km2. There is no evidence that the otter at site 2 utilises the river (> 4 km distant) and it must be assumed that the 'other fish' are caught in the ponds themselves.

The apparent shift to a maximum level of predation on carp in spring (March 1995) at site 2 was probably caused by a low estimate in December of 1994, undertaken due to low spraint numbers (Figures 1A & B). In addition, the low spraint numbers from June 1995 onwards, at site 3, will have affected the RFO's for this period and the data should be treated with caution. One factor causing the low number of spraint may have been the frequent floods that affected this area over the spring and winter of 1995-96, however, the finding of small tracks in January 1996 would indicate that the female had had at least 1 cub. The low sprainting tends to confirm the hypothesis that females tend to spraint in water more during this period (Green *et al.* 1984).

Previous to this study, a maximum estimate of 10 % predation on carp was made from spraint collected near site 1 (A. Toman, Pers. Comm.). Though this estimate seems to hold true for the majority of the year, at that site, it is clearly a large under-estimate for sites 2 and 3, where a figure of nearer 30 % would be more appropriate. Converted to estimated biomass (Figure 2) a range of around 5 - 25 kg/o/m at sites 2 and 3 is observed. As single or few otters tend to be resident at these sites, this represents a relatively low amount. At site 1, predation ranged between 0.7 and 20 kg/o/m, though the average was nearer to 5 kg. Though this is apparently a low amount, it should be remembered that 6 otters or more regularly use this area. A closer predation range may therefore be 6 - 60 kg/o/m, a higher level, in fact, than that at the other sites. These figures may well support the hypothesis of Bodner (1995) that "absolute damage increases with increasing pond size .... whilst relative damage decreases", though it is suggested that this is due, particularly at site 1, to the presence of higher numbers of otters at larger ponds. Larger ponds not only provide more food than small ones (relatively), but the greater hecterage would also allow the maintenance of

separate, overlapping ranges. Small ponds, i.e.those of around 0.5 ha, tend to support 1 or 2 otters only (pers. obs.).

In conclusion, carp are evidently an important source of food to the otter where other fish prey is limited, particularly in winter. Where this is not the case carp is taken in relatively low amounts. Though the level of predation is higher than that previously estimated, it is believed that losses are negligible, relative to the amounts of fish harvested from this region. Where ponds are small and/or privately owned, however, these losses may then be considered significant.

Acknowledgements

I should like to take this opportunity to thank the Peoples Trust for Endangered Species (UK) and the Trebon Otter Foundation (CR) for providing funding towards the long-term diet study of otters in the Trebon Biosphere Reserve. I should also like to thank F. Alexa of Rybarstvi Trebon a.s., the staff of CH.K.O. Trebonsko and all others who helped with information and access to the study sites.

References

Bodner M. 1995. Fish loss in Austrian fish-ponds as a result of otter (*Lutra lutra* L.) predation. I.U.C.N. Otter Specialist Group Bulletin, 12. 3-10

Chanin P. 1985. The natural history of otters. Croom Helm. London

Conroy J.W.H., Wat J., Webb J.B. and Jones A. 1993. A guide to the identification of prey remains in otter spraint: an occasional publication of the Mammal Society. No. 16, Reading.

Day M.G. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. Journal of Zoology, 148. 201-217

Green J., Green R. and Jeferies D.J. 1984. A radio-tracking survey of otters *Lutra lutra* L. on a Perthshire river system. Lutra 27, 85-145.

Jurajda P. and Roche K. 1994. The fish community of water bodies within the Trebon Biosphere Reserve. Annual report to the Trebon Otter Foundation.

Knollseisen M. 1995. Aspects of the feeding ecology of the Eurasian otter *Lutra lutra* L. in a fish-pond area in central Europe (Austria & Czech Republic). Diplomarbeit. University of Vienna.

Kranz A. 1995. On the ecology of otters (*Lutra lutra*) in Central Europe. Doctoral dissertation. University of Agriculture, Vienna.

Libois R.M. and Hallet-Libois. 1988. Éléments pour l'identification des restes craniens des poissons dulcaquicoles de Belgique et du nord de la France. in: Fiches d'ostéologie animale pour l'archéologie, Série A, No. 4., Centre de Recherches Archéologiques du CNRS, Belgium.

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

Roche K. 1997. The influence of diet and habitat structure on the home range activity of otters *Lutra lutra* within the Trebon Biosphere Reserve. In: (eds.: Toman & Hlavac) Proceedings of the 14th European Mustelid Conference, Kouty (Czech Republic) 51-55.

DIET AND DAMAGES BY OTTERS *LUTRA LUTRA* ON A SERIES OF PRIVATE PONDS IN SOUTHERN BOHEMIA (CZECH REPUBLIC)

Marcela KUCEROVÁ

Summary

The study focus on predation and damages by the otter *Lutra lutra* on a series of small private fish ponds and a trout river in southern Bohemia. Carp *Cyprinus carpio,* the main economic species in the surrounding area, is not the dominant species in most of the ponds investigared. Both stocking and harvesting is irregular. Relative frequency of occurence of prey species shows that carp, trout *Salmo trutta* and burbot *Lota lota*, all economically valuable species, are taken in appreciable amounts, though the amounts differ spatially. Only the autumn/winter period has been analysed to date. Otters foraged for what is most abundant in the immediate area of each sample site.

Key words:: *Lutra lutra,Salmo trutta, Lota lota*, diet, damages, Czech Republic

Introduction

The preliminary results presented are part of a Diploma thesis on the diet of otters *Lutra lutra* inhabiting an area including both a trout river and fish ponds in Southern Bohemia (Czech Republic). This study will later attempt to estimate levels of damage at this site. Diet studies are an important part of several projects being undertaken on the otter in Bohemia and Austria (e.g. Knollseisen 1995, Roche 1997). These studies focus mainly on carp *Cyprinus carpio* ponds with a regular harvesting cycle. In contrast, the ponds investigated in this study, concentrate on small private ponds with various fish species and no professional pond management (irregular stocking, harvesting cycle etc.). Information on the otter/fish relationships in such ponds will be particularly important for future management of otter populations in Central Europe and the integration of such management and protection into the local economy. Pond owners that maintain their ponds either as a hobby or as a source of supplementary income tend to be the chief source of complaints regarding the otter, both in Austria and the Czech Republic, at present.

Materials and Methods

An area comprising several small ponds and a river was selected around the village of Rychnov nad Malsí in the Cesky Krumlov region of South Bohemia (10 km south of Kaplice). The ponds range in size from less than 0,3 ha to 5 ha. Of the 9 ponds being studied (Table 1) only 3 have carp as the dominant species. All of the ponds are within 5 km to the River Malse.

Spraint collecting, undertaken at bimonthly intervals, began in October 1995 and will continue until November 1996. Bones, scales, teeth and other remains are identified using keys (Day 1966, Wise 1980, Libois 1988, Conroy *et al.* 1995) and a reference collection. The results are noted as relative frequency of occurrence (RFO = the number of occurrences of a particular item as a percentage of all recorded items). Though this method is not free of bias, it has been shown to give a relatively true picture of the importance of the main prey categories within otter diet (Erlinge 1968, Carss *et al.* 1996). Three collections have been analysed to date (October, December, February). The total number of spraint analysed is 113; 28 from site 1, 29 from site 2, 43 from site 3 and 13 from site 4. See Table 2 for the RFO of all prey species found thusfar.

Table 1. Description of sites investigated in this study.

Site	Habitat	Distance to river	Main fish species
1.	4 ponds < 1 ha not connected to the river	3.5 km	trout, perch,burbot, carp
2.	2 ponds < 1 ha connected to the river by a system of small streams and marshland	3.0 km	carp, trout, roach
3.	2 ponds < 1 ha connected to the river by a channel and both banks of river (0.7 km stretch)	0.8 km	carp (in the ponds) trout,grayling, bullhead, (in the river)
4.	1 pond of 5 ha connected to the river by a narrow channel	0.3 km	carp

Results

Fish formed between 88 and 100 % of the diet of the otter from sites 2, 3 and 4. At site 1, with 1 collection only, fish formed 48.6 % of the diet, the rest being made up of non-fish prey, predominantly amphibians and reptiles. A total of 15 fish species from 7 families were registered in spraints from the 4 study sites. The results show clear differences in the predation of the 3 main economic species (burbot, carp, and trout), principally related to the sampling site (Table

2). Carp were the dominant dietary element in all collections at sites 2 and 4 and were taken in appreciable amounts in Autumn at site 3. Trout were taken from all sites except site 4, though to varying degrees. Only at site 3, the site including a channel and a stretch of river, was trout taken in all collections and to a relatively high level during the winter months. Burbot was not taken in high amounts from any of the sites except in those samples taken in autumn from site 1.

The other fish species taken were perch *Perca fluviatilis* at sites 1 and 2; grayling *Thymallus thymallus*,, roach *Rutilus rutilus,* chub *Leuciscus cephalus* and bullhead *Cottus gobio* at site 3. Non-fish prey consisted of small mammals, amphibians, birds, reptiles and insects. Amphibians, reptiles and insects were the only prey classes occurring in appreciable amounts (i.e. above 5 %), both at sites 1 and 3. Birds and mammals were of limited importance (2 - 4%). Amphibians and insects formed an important part of the diet in the Autumn months at site 1, both comprising more than 20 % of the diet.

Discussion

The discussion will focus on the results from sites 2 and 3 as there are two complete collections (autumn and winter) available for analysis. At site 1, no spraints were found in winter as the ponds were completely frozen and the otter probably moved away from the area. Site 4 was added in December as the information provided about sites to be investigated was originally incomplete.

The results from site 1 indicate that, although one of the ponds is stocked with carp (mostly large specimens of over 40 cm), the fish in the diet were almost entirely small, i.e. <5 cm or <15 cm, particularly burbot, perch and trout (stocked). This finding confirms the results of previous diet studies (e.g. Wise *et al.* 1981, Kemenes & Nechay 1990, Jurajda *et al.* 1996,) which state that otters tend mainly to take fish of between 5 and 20 cm. The results from site 4 show that carp is the dominant species taken at this site during the winter months. This is probably due to the high dominance of 1 year carp in this pond and the fact that the pond was kept open during winter when others were allowed to freeze. Though there was no dominant species in the fish stocked at site 2, carp formed a dominant part of the diet at this site. This may be partly due to the carp stocked being favoured, possibly due to their small size (around 5 - 15 cm). However, the close vicinity of two ponds with a high abundance of carp (within 2 km) could also be influencing the assessed diet

Table 2.: The relative frequency of occurence (%) of all prey identified from the study sites (see Table 1 for site descriptions).

	Site 1 Aut 95 n = 28	**Site 2** Aut. 95 n = 5	**Site 2** Win. 95 n = 24	**Site 3** Aut. 95 n = 8	**Site 3** Win. 95 n = 35	**Site 4** Win. 96 n = 13
Trout	2.2	14.3	1.1	32.0	14.6	0.0
Grayling	0.0	0.0	0.0	0.0	8.5	0.0
Pike	0.0	0.0	0.6	0.0	0.3	0.5
Roach	0.3	0.0	3.4	0.0	13.2	2.0
Dace	0.0	0.0	0.0	0.0	1.4	0.0
Chub	0.3	0.0	0.6	0.0	10.9	0.0
Rudd	0.0	0.0	0.0	0.0	0.0	1.0
Tench	0.7	0.0	0.0	0.0	0.0	0.0
Gudgeon	1.0	0.0	0.0	0.0	4.4	0.0
Bleak	0.0	0.0	1.1	0.0	0.0	0.0
Carp	6.0	71.4	85.3	28.0	2.9	95.0
Eel	0.3	0.0	0.0	8.0	0.0	0.0
Burbot	18.5	7.1	4.0	4.0	2.3	0.0
Perch	17.8	7.1	0.0	0.0	0.9	0.0
Bullhead	0.0	0.0	1.1	8.0	34.0	0.0
Unident.	1.5	0.0	0.0	8.0	6.6	0.0
Non-fish	51.4	0.0	2.8	12.0	0.0	1.5

The number of species in spraints increased in the winter months at sites 2 and 3, from four to eight and six to eleven species respectively. At site 3, as winter drew in and the ponds froze over, the river apparently became an important source of food. Trout appeared to be the main target from the river, however, grayling and bullhead, both typical for this river, also formed a large part of the prey taken

(Table 2). At site 2 river species (e.g. bullhead, chub) also appeared in the winter diet, however, in much lower amounts. This could be due to the fact that the remains of these species were passed through the gut before arrival at the ponds as the sample site is more distant from the river than at site 3 (site 2 = 3 km and site 3 = 0.8 km). Although the number of spraints collected in autumn from sites 2 and 3 were low (one collection available for analysis), the increasing number of river species in the winter diet could indicate that the feeding activity of the otter was concentrated more at the river and less at the ponds. These ponds were partly or completely frozen and therefore the availability of fish was lowered at this feeding patch. Kruuk & Carss (1996) showed that there was a positive correlation between an otters use of a site and its fish density (i.e. availability) and that "at a critical level of prey availability, a relatively small reduction in net energy intake would make hunting unprofitable in a given area". This would be particularly true where hunting was relatively energy-expensive, i.e. for otters foraging in cold water or where ice cover was extensive or even complete. Therefore, an important part of the management of otter populations, particularly in fish pond areas, should be the provision or maintenance of alternative feeding patches during winter.

References

Carss, D. N. and Parkinson, S. G. 1996. Errors associated with otter *Lutra lutra* faecal analysis. I. Assessing general diet from spraints. J. Zool., London, 238, 301 - 317.

Conroy, J. W. H., Wat J., Webb, J. B. and Jones, A. 1993. A guide to the identification of prey remains in otter spraint: an occasional publication of the Mammal Society. No. 16, Reading.

Day, M. G. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. Journal of Zoology, 148, 201-217.

Erlinge, S. 1968. Food studies on captive otters *Lutra lutra* L.. Oikos, 19, 259-270.

Jurajda, P., Prasek, V. and Roche, K. 1996. The autumnal diet of otters *Lutra lutra* inhabiting four streams in the Czech Republic. Folia Zoologica. 45 (1), 9-16.

Knollseisen, M. 1995. Aspects of the feeding ecology of the Eurasian otter *Lutra lutra* L. in a fish pond area in Central Europe (Austria & Czech Republic). Diplomarbeit. University of Vienna.

Kruuk, H. and Carss, D. N. 1996. Costs and benefits of fishing by a semi-aquatic carnivore, the otter *Lutra lutra.* in: Aqutic predators and their prey (Eds. Greenstreet S. P. R. and Tasker M. L.): Fishing News Books, Blackwell Scientific Publications, Oxford, 3, 12 - 16.

Libois, R. M. and Hallet-Libois, C. 1988. Éléments pour l'identification des restes craniens des poissons dulcaquicoles de Belgique et du nord de la France. in: Fiches d'ostéologie animale pour l'archéologie, Série A, 4., Centre de Recherches Archéologiques du CNRS, Belgium.

Kemenes, I. and Nechay, G. 1990. The food of otters *Lutra lutra* in different habitats in Hungary. Acta Theriologica, 35 (1-2), 17-24.

Roche, K. 1997. The influence of diet and habitat structure on the home range activity of otters *Lutra lutra* within the Trebon Biosphere Reserve. Proceedings of the 14th European Mustelid Colloquium, Kouty (Czech Republic), 51-55.

Wise, M. H. 1980. The use of fish vertebrae in scats for estimating prey size of otters and mink. J. Zool. Lond., 192, 25-31.

Wise, M. H., Linn, I. J. and Kennedy, C. R. 1981. A comparison of the feeding biology of mink *Mustela vison* and otter *Lutra lutra* , J. Zool. Lond., 195, 181 - 213.

EFFECTS OF POND MANAGEMENT ON OTTER FOOD SOURCES IN WATERS ADJACENT TO PONDS

Pavel JURAJDA and Kevin ROCHE

Key words: Lutra lutra, prey, fish abundance, management, ponds, Czech Republic

Introduction

Most projects undertaken, whether about the biology, ecology or conservation of the otter (*Lutra lutra*), tend to include an element on the diet taken or required by the otter. It is therefore essential that a detailed study of the available prey, which consists primarily of fish (though small mammals, birds and even some insects will also be taken) is undertaken (Chanin 1988). This report presents some of the findings from one year (1994) of a two year investigation of the fish density and biomass at sites with differing impacts from pond management within the Trebon Biosphere Reserve.

Study Area, Material and Methods

All sampling was undertaken within the Trebon Biosphere reserve (a detailed description of which was provided by Dulfer (1993)) in an area consisting of an interconnected series of fish ponds, canals and the Rivers Luznice and Nová Reka (New River).

Three sites were chosen adjacent to 2 large ponds (Novy Vdovec and Zenich, 75 and 78 ha respectively) and another 2, less connected with a pond and further away (Fig. 1). Sites 1, 2 and 3 were located on a typical outlet canal, with an average depth of 75 cm, a width of 3 m, a sandy bottom with muddy silt and overhung by emergent vegetation (*Carex*). Site 4 was situated on the New River and was 15 m in width, 50 cm in depth, had a sand-gravel bottom and a stony artificial bank. The final site (No. 6) was situated on a 6 m wide canal with a depth of 1 m, a muddy bottom and with dense aquatic vegetation (*Ceratophylum*).

The study sites were explored six times during 1994, approximately every two months (March, May, June, July, September, November). These times were chosen to coincide with the collection of otter spraint from most of the sites, thereby providing useful information on species available to the otter at the time of feeding and sprainting (Roche - this volume, Roche 1997).

Electrofishing equipment was used to fish transects of about 100 - 150 m by the two-run removal method (Zippin 1956). All fishes were determined, measured (standard length) and weighed on the bankside and then released back to the water.

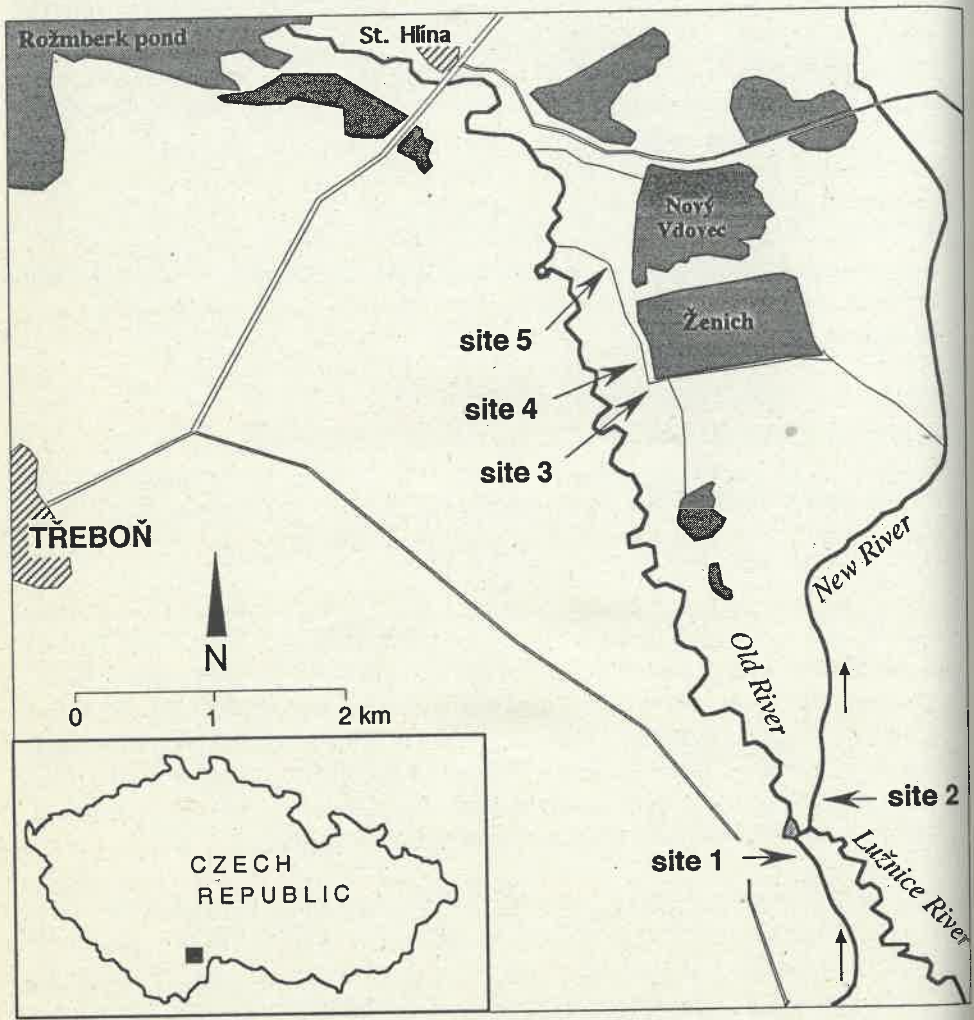

Figure 1. Map of the study area with study sites indicated.

Results and Discussion

The total species richness, from all the sites, was relatively high, with 19 species registered from 7 families. At separate sites, the species richness depended a great deal upon its position and character (Tab. 1). A markedly higher species richness was found at the canal sites connected with the ponds than in the, more or less natural, river. Canals connected to the pond systems were strongly influenced by fisheries management, particularly during the harvesting period (Fig. 2).

Table 1. Species structutre of the fish community at the five study sites over the whole sampling period (dominance in %).

species / site	1	2	3	4	5
Esox lucius	20.24			0.03	0.03
Rutilus rutilus	48.81	10.78	92.30	89.44	80.50
Leuciscus leuciscus	0.30	7.19	0.08	0.23	0.06
Leuciscus cephalus	0.60	13.77		0.03	0.04
Scardinius erythropht.	10.42			0.36	0.18
Leucaspius delineatus	0.30		0.08		0.01
Tinca tinca	2.08	0.60	0.08	0.03	0.07
Pseudorasbora parva			0.76	0.97	0.37
Gobio gobio	2.08	1.20	3.47	3.99	1.24
Alburnus alburnus	4.17	1.80	1.61	3.24	5.69
Blicca bjoerkna			0.42	0.71	11.05
Abramis brama	1.19				
Cobitis taenia				0.03	
Misgurnus fosilis				0.03	
Lota lota	0.30	26.35		0.06	0.01
Perca fluviatilis	9.52	37.73	1.18	0.84	0.68
Stizostedion lucioperca	1.19				
Gymnocephalus cernuus					0.04
Cottus gobio		0.60			
total sample	336	167	1 182	3 086	6 750
species richness	13	9	9	14	14

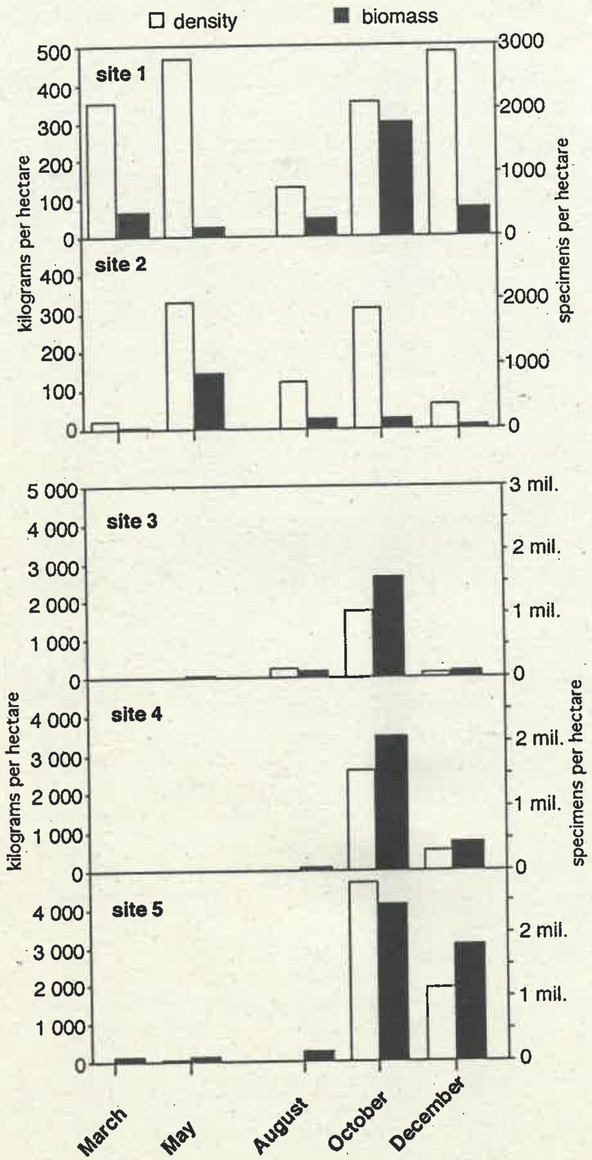

Fig. 2.: The seasonal pattern of density and biomass of fish in the two sites distant from the ponds (upper) and the three sites adjacent pond.

Qualitative indices (dominance, relative biomass) were relatively stable at almost all of the sites, with just one or two species predominating. In general, roach (*Rutilus rutilus*) was the most common species in the area and predominated in the canals adjacent to the ponds. Bleak (*Alburnus alburnus*) and silver bream (*Blicca bjoerkna*) formed the dominant part of the rest of the fish assemblage. At the New River site, rheophilous species were more common, namely dace (*Leuciscus leuciscus*) and chub (*L. cephalus*). Perch (*Perca fluviatilis*) occurred, in greater or lesser amounts, at all sites (Tab. 1).

The lowest density and biomass was found at site 2 (New River) during all seasons (Fig. 2). This site is separated from pond management activity and the fish community is dependant upon natural reproduction and low stocking of game fish by the local angling club. The second site, the canal far from any ponds, has a higher density and biomass of fish, throughout most of the year (Fig. 2). The highest changes were exhibited by the three sites closely adjacent to the ponds (sites 3, 4 and 5), according to their position with regard to the pond outlet (Fig 1). The density and biomass showed distinct peaks during autumn, just after pond harvesting, when extremely high numbers of fish were washed out from the ponds. Biomass increased by 10 times over this period, the numbers slowly declining towards the end of the year. This increase in coarse fish density in the adjacent canals lasts for a relatively short period in the year and occurs, irregularly, in most of the Trebon area, depending upon the pond harvesting time table and the character of the outlet. Otters quickly shifted their foraging activity to this very attractive feeding site as was shown by spraint analysis at that time (Roche - this volume, Roche 1997). Similar behaviour has been noted at fish ponds in Austria and experiments are presently underway to test the usefulness of providing such secondary sources of food to deter predation on economic species such as carp (*Cyprinus carpio*) (Bodner, pers.comm.). From both the conservation and fisheries management points of view, if managed well, this method would help reduce potential conflicts between aquaculture and this rare European mustelid, at least for part of the year.

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We are obliged to the Trebon Otter Foundation for financial support and for the instigation of this study. We should also like to thank CHKO Trebon for allowing access and the Trebon Fisheries a.s. for permission to fish the water bodies in the vicinity of their fish ponds. Similarly, we also thank the Trebon Angling Club (part of the Czech Angling Association).

References

Chanin P. 1988. The natural history of otters. Christopher Helm Ltd. London.

Dulfer R. 1993.Trebon Biosphere Reserve Otter Project - IUCN Otter Specialist Group Bulletin 8, 10-12

Roche K. 1997. The influence of diet and habitat structure on the home range activity of otters *Lutra lutra* within the Trebon Biosphere Reserve: Proceedings of the 14th European Mustelid Conference, 51-55.

Zippin C. 1956. An evaluation of the removal method of estimating animal population. Biometrics 12, 163-189.

DIET OF ASIAN SMALL-CLAWED OTTER *(AONYX CINEREA)* AND SMOOTH-COATED OTTER *(LUTROGALE PERSPICILLATA)* FROM SPRAINT ANALYSIS IN THE PAMANUKAN MANGROVE FISH PONDS, WEST JAVA, INDONESIA

Irwansyah Reza LUBIS, Roland MELISCH and Syofi ROSMALAWATI

Summary
Diet and prey preferences of Aonyx cinerea and *Lutrogale perspicillata* were assessed by analyzing otter faeces from a mangrove fish-pond area in West Java, Indonesia. Methods and techniques included estimated weight analysis and recording of percentage of occurrence. Differences in both species' diet and aspects of feeding behaviour are presented and discussed.

Key words:*Aonyx cinerea*, *Lutrogale perspicillata*, diet, spraint analysis, mangrove, fish-ponds, Java, Indonesia

Introduction

Indonesia is known for its carnivore species diversity among mammals (Corbet & Hill 1992), however, little research has been undertaken to gain ecological information which is urgently needed for the conservation of most of the carnivores, including otters. The first research programme on Indonesian otters, carried out in West Java, focussed on their distribution and habitat use, and included a strategy towards a species conservation programme (Melisch *et al.* in press).

Four species of otters occur in Indonesia, i.e. Asian small-clawed otter (*Aonyx cinerea*), hairy-nosed otter (*Lutra sumatrana*), smooth-coated otter (*Lutrogale perspicillata*), and Eurasian otter (*Lutra lutra*) (Foster-Turley *et al.* 1990, Corbet & Hill 1992). From surveys and analysis of historical records only two species, *A. cinerea* and *L. perspicillata* are believed to occur on Java (Melisch 1995, Melisch *et al.* in press). The IUCN 1994 Red List of Threatened Animals lists all purely Asian otter species as "suspected to be rare, vulnerable or endangered", stating that sufficient information is lacking (Groombridge 1993). All these otters are listed under CITES Appendix II which controls trade to mitigate threats to wild populations. Indonesian authorities proposed to have legal protection for all otter species as an output from the model project and the subsequent First Symposium on Indonesian Otters (PHPA-AWB 1994).

Most research on otter diet and foraging behavior has been on *L. lutra* in temperate countries (e.g., Jenkins *et al.* 1979, Mason & Macdonald 1986, Kruuk &

Conroy 1987, Beja *et al.* 1991). Not much is known from Asian otters' diet other than a few references from general local studies on the food of *A. cinerea* and *L. perspicillata* (Foster-Turley 1992b, Kruuk *et al.* 1993, 1994). Some preliminary studies on the diet of these two Asian otter species in the wild were conducted (Sody 1949, Nor 1989, de Silva 1991). Information on foraging ecology of *Aonyx capensis* and *Lutra maculicollis* from Africa (Purves *et al.* 1994, van der Zee 1981) can be used for comparisons with the Asian otters.

On Java, public opinion generally blames otters for being blood-thirsty animals raiding fish ponds and other aquaculture areas. They are therefore usually considered as pests which should be killed. However, research in other countries has shown that the Asian small-clawed otter is an invertebrate specialist, whereas the smooth-coated otter is a fish specialist (Foster-Turley 1992a,b). In Thailand, otters serve as natural pest control in rice fields with local farmers benefitting from the animals preying upon rodents and destructive freshwater crabs (Lekagul & McNeely 1988).

A study of the diet of otters from different habitats in West Java is necessary to determine whether or not these threatened species are causing economic damage and, if necessary, produce solutions for both human and otters' benefit. Results from this project are described in detail elsewhere (Lubis 1995, Melisch & Lubis this volume, Melisch *et al.* in press); the current paper examines part of this study - the analysis of West Javan otters' diet in mangrove fish ponds.

Study Area

The study was carried out in a coastal fish pond habitat at Pamanukan Mangrove Forest on the north coast of Java, approximately 6°15'S 107°46'E, from sea level to 5 m a.s.l. Banks and close environs of Blanakan and Ciasem Rivers were chosen as survey stretches. The area is owned and managed by Perum Perhutani, the state-owned forestry enterprise active on Java and Madura. Originally all these coastal stretches consisted of natural mangrove forest, which were eventually converted to fish ponds, or deforested for production forest (AWB-Indoensia 1992). Today, Perum Perhutani tries to operate a sylvofishery-scheme, aiming at sound mangrove management which integrates a component of coastal fish pond farming on the same area.

Methods

Spraints were collected in February 1994 at the end of the rainy season during the PHPA/AWB-Indonesia West Javan Otter Project and in June 1994. Spraints were analysed at the Biological Department of Padjadjaran University in Jatinangor and at a private house in Bandung from August to December 1994.

The best means of assessing the feeding ecology of otters which are crepuscular or nocturnal, without disturbing the population, is an indirect method such as faecal analysis. Otter faeces (spraints), were collected in survey areas following the shorelines, riverbanks and otter trails. Possible prey species (fish, crabs, molluscs, reptiles) occurring in the area were collected, identified and recorded, to form a reference prey collection. In addition, necessary data about the habitat and other relevant signs were recorded, and local people interviewed.

Mucilaginous material binding undigested remains was removed by soaking and shaking each spraint in water, adding a few drops of detergent. The spraints were then washed over a 0.5 - 1.0 mm mesh sieve. In the laboratory, spraints were oven-dried at 60° C for 48 hours, weighed and stored dry. After being dried, the undigested material was spread over a Petri dish and analysed as follows:

- identifying the contents of spraints using the reference prey collection, up to species level whereever possible
- the importance of a particular prey category in a spraint was scored visually, on a scale of 1 to 10, so that the total score for each spraint was 10
- the score for each prey category was multiplied by the dry weight of the spraint
- the total score of each prey category was expressed as:
  a) relative percentage of occurrence, calculated by totalling all the occurrences of all prey categories and expressing the actual occurrence of each prey category as a percentage of the total. The occurrence of each prey category recorded in each spraint sample accounted for one record, regardless of the bulk scored;
  b) bulk percentage, calculated by totalling all bulk scored of all prey items and expressing the importance of each prey item as a percentage of the total.

Percentage of occurrence analysis overestimates prey categories that occur frequently, but in small numbers, and underestimates prey categories that occur seldom, but in large amounts (Jenkins *et al.* 1979, Zee 1981). In our study area we found a variety of prey in every sample, so an attempt to correct the result was made by using the weight estimate analysis. Although this method is more laborious than the percentage of occurrence analysis, it is easier and quicker than the weight and/or volume analysis, and the result is believed to represent the compositions of prey remains in otter spraints quite accurately (Zee 1981, Foster-Turley 1992b). No statistical analysis was used for this study.

Results and Discussion

From surveys on two different occasions 52 spraints were collected (29 from *A. cinerea* and 23 from *L. perspicillata*). Analysis identified 19 prey taxa (Table 1).

Table 1: Diet of *Aonyx cinerea* (Ac) and *Lutrogale perspicillata* (Lp) in mangrove fish-ponds of West Java, Indonesia

Prey species / Prey category	Percentage of weight %		Percentage of occurrence %	
	Ac	Lp	Ac	Lp
Oreochromis mossambicus (Cichlids)	25.5	41.5	58.6	65.2
Chanos chanos (Milkfishes)	5.5	18.6	17.2	43.5
Mugilidae (Mullets)	6.4	20.0	24.1	47.8
Lates calcarifer (Barramundi)		1.2		4.3
Channa sp. (Snakeheads)		1.2		4.3
Clarias sp. (Walking catfishes)		0.6		4.3
Arius sp. (Sea catfishes)	7.3	1.9	20.7	13.0
Gobiidae (Gobies, Mudskippers)	2.2		6.9	
Trichogaster sp. (Gouramis)	1.5		3.5	
Monopterus albus (Swamp-eels)	0.9	2.6	3.5	17.4
Unidentified fish	3.2	1.3	31.0	17.4
Fish total	52.5	98.0		
Insecta	0.1	0.5	3.5	4.3
Brachyura (crabs)	28.9	0.3	62.1	4.3
Shrimps	11.4	5.1	51,7	26.1
Mamalia	3.4	0.3	27.6	8.7
Snakes	3.7	4.5	24.1	17.4
Non-fish total	47.5	11.0		
Sample number (n)	29	23		
Samples weight mean	2.36	2.0		

Diet of *A. Cinerea*

From 29 spraint samples of *A. cinerea*, crabs were the main bulk of prey (28.9 %), followed by cichlids (25.5 %). When looking at the differences between total percentage of weight, we noticed that *A. cinerea* consumed slightly more fish than non-fish prey. Shrimps were also important. Other important fish include walking catfishes (*Clarias* sp), mullets (Mugilidae) and milkfishes (*Chanos chanos*). All other prey categories were taken in small amounts. Similar results were obtained from percentage of occurrences values. Crabs were again the main prey found, followed by cichlids and shrimps. However, for mammals and snakes we recorded higher percentages of occurrence than for weight.

The fore feet of *A. cinerea,* which are human-hand-like, are very tactile and thus perfectly adapted for grabbing and feeling (Lekagul & McNeely 1988, Foster-Turley 1992b, Melisch *et al.* 1994). Asian small-clawed otters easily catch prey hiding in submerged vegetation and under stones. Also, the shape and form of the molar teeth are specialized for crushing crustcean shells (Pocock 1941, Lekagul & McNeely 1988, Asmoro *et al.* 1994).

Rice and fish farmers in areas occupied by Asian small-clawed otters benefit from the otter's predation on crabs which are pest in fish ponds or rice fields (Kalshoven 1981, Chan 1988, Melisch *et al.* 1996), as they dig their holes in dams and cause direct damage to plants. If water flows out of the ricefields and ponds, the respective culture dries out and water-dependent organisms will subsequently die. The control of crab populations by otters reduces farmers' time and energy to repair dams. Furthermore, we hardly found valuable crab species (such species which are sought after for consumption, e.g., *Scylla serrata*) in the Asian small-clawed otter's prey. Thus predation by otters on crabs did not lead to financial loss for farmers.

Cichlids (*Oreochromis mossambicus*) were the most available fish in the area because they can easily grow and breed without much effort from farmers (Kottelat *et al.* 1993). *O. mossambicus* digs pits in the bottom of the ponds where it lays its eggs (Kottelat *et al.* 1993, Adrim *et al.* 1988). This behaviour makes it vulnerable to otters because the narrowness of the holes make escape difficult, and because of the hand-like fore feet of *A. cinerea,* which are very suitable for catching preys in and on mud (Foster-Turley 1992b).

Milkfishes were also abundant in the study area, but the results from spraint analysis showed only a small weight percentage. We assume that this was the effect of greater agility of milkfishes compared to cichlids. Milkfishes probably have more chances to escape because they live in groups (Kottelat *et al.* 1993). Stephens (1957) and Chanin (1985) describe that an otter will easily detect fish in groups and subsequently will start chasing the prey. After having noticed the presence of otters, the fish will panic and escape in many directions. The otter then has to decide which individual fish to chase.

Unlike results reported by Foster-Turley (1992b) from Peninsular Malaysia, where gobies (Gobiidae) were the most important fish prey for *A. cinerea*, in Pamanukan we only found small amounts of these fish in the spraints. Although gobies were abundant in the study area, we assume that otters were more attracted towards slow moving fishes in the ponds and the river (such as cichlids) than to the rather passive gobies on the mudflats.

Other fish were consumed in small amounts, possibly because of their lower availability and vulnerability compared to cichlids and milkfishes. Sea catfishes (*Arius* sp), however, possess a venomous spine in their pectoral fins. That spine was often found in spraints, showing the Asian small-clawed otter's excellent digestive system, a special mucous protecting the epitel surface from sharp parts of prey remains; similarly to *Lutra* species (Mason & Macdonald 1986, Polechla 1991). From a fish farmers point of view, the consumption of sea catfishes by *A. cinerea* is a benefit, because this fish species has no economic value and is regarded as a pest in the ponds (Adrim *et al.* 1988).

Mullets were the most important wild fish for the fish farmers (Schuster 1952). *A. cinerea* consumed mullets in small amounts because other species were more readily available and more vulnerable. Nevertheless, according to the percentage of occurrence, mullets scored second after cichlids meaning that they are consumed regularly, but only in small amounts.

Fish farmers have also introduced shrimps into ponds as an additional income. Additionally, many wild shrimps also enter the ponds. The high availability of shrimps effected the predation by *A. cinerea*. Although shrimps are very agile, we assume that otters drive them with the other members of the pack into shallow water. This was reported by Harris (1968).

Water snakes are solitary but abundant in the area. Spraint analysis showed they had a low percentage by weight, but a higher percentage of occurrence. One of the main snake species in the Asian small-clawed otter's diet was probably *Cerberus rhynchops*, a fish eating water snake (and thus regarded as a pest) in fish ponds. Hair found in the spraints were probably from various species of rats, the most abundant mammals in the study area (unpubl. data R. Melisch).

Diet of *L. Perspicillata*

Compared with *A. cinerea*, *L. perspicillata* consumed more fish than non-fish prey (89 % of total percentage of weight). Eight fish species were identified from spraints, cichlid was dominant, followed by mullet and milkfish. For non-fish, shrimps were the main prey found, followed by snakes. Remains of crabs were only found in very small numbers. The remains of insects and mammals were found in unimportant values.

Remains of cichlids were found most often in spraints. Mullets and milkfishes were also important to smooth-coated otters. Other species caught which were less important, included shrimps, swamp-eels (*Monopterus albus*), snakes and sea catfishes. Vulnerability of cichlids are similar as described for *A. cinerea*. Mullets were more abundant in the river than in the ponds. As there was evidence in the field that *L. perspicillata* was often found close to the river banks, we also expected the level of predation on mullets to be high. This was verified. The small amount of mammal remains found in spraints in North Java is opposite to the results of Foster-Turley (1992b) from Malaysia and Kruuk *et al.* (1994) from Thailand. Both reported that rats were important for *L. perspicillata*. We assume that the low amount of rat remains in our results was due to the high availability of other prey species, e.g., cichlids, mullets and milkfishes. These fishes are easier for otters to catch than rats. In general, the feeding behaviour of this otter species is similar to other members of the genus *Lutra* from different habitats of the world (e.g., Jenkins *et al.* 1979, Mason & Macdonald 1986, Beja 1991). Group hunting by *L. perspicillata* has been described elsewhere (van Helvoort *et al.* 1996).

Comparison of Food of *L. Perspicillata* and *A. Cinerea*

L. perspicillata preyed more on fish and less on crabs than *A. cinerea*. Results showed that cichlids were dominant fish species taken by both species. Cichlids were highly abundant in the ponds. *L. perspicillata* predated more upon cichlids than *A. cinerea*. The latter, however, preyed more on invertebrates (crabs, shrimps and insects). Comparing fish prey, *L. perspicillata* fed on a larger variety of species than *A. cinerea* . Only sea catfishes, which inhabit muddy water, were taken more frequently by *A. cinerea.* With its tactile and sensitive forefeet the Asian small-clawed otter is adapted for looking for prey in muddy water or under stones. This ability made sea catfishes more vulnerable to them than to *L. perspicillata,* the latter relying more on their eyes and whiskers in searching for prey (de Silva 1991).

On the basis of diet, *A. cinerea* was categorized as an invertebrate specialist (Chanin 1985, Lekagul & McNeely 1988, Foster-Turley 1992a,b), while *L. perspicillata* was categorized as a fish specialist (Chanin 1985). This was confirmed within our study. Furthermore, according to Foster-Turley (1992b), the physiological system of *A. cinerea* needs a rather high amount of calcium, which *A. cinerea* could gain from crustacean shells. Both species proved to have their prey preference. Opportunistic behaviour while seeking for prey added to the diversity of the otters' diet.

Conclusion

A. cinerea feed on almost the same amount of fish and non-fish prey categories in mangrove fish ponds, although they had a preference for crustaceans. The high amount of fish in their diet was caused by a high availability and vulnerability of fish in the ponds.Food composition of *L. perspicillata* was dominated by fish, with non-fish categories only little represented. This diet was similar with the other species of the genus *Lutra* studied elsewhere in the world.

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References

Adrim, H., Hutagalung, H.P. & L. Effendi 1988. Ikan tambak dan habitatnya. Proyek Studi Potensi Sumber Daya Alam Indonesia, Pusat Penelitian dan Pengembangan Oseanologi, LIPI, Jakarta.

Asmoro, P.B., Melisch, R. & L. Kusumawardhani 1994. Hubungan antara berang-berang dengan manusia. In Prosiding Simposium Pertama Mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi manusia. Bogor, 7. April 1994. PHPA/AWB-Indonesia, Bogor. pp. 63-72.

AWB-Indonesia 1992. Mangrove rehabilitation, conservation, and sustainable management in Java.. Proposal to the ADB sponsored Sustainable Mangrove and Coastal Zone Management Project, Sulawesi, T.A. No. 1567-INI. AWB-Indonesia, Bogor.

Beja, P.R. 1991. Diet of otters (*Lutra lutra*) in closely associated freshwater, brackish and marine habitats in south-west Portugal. J.Zool. Lond. 225, 141-152.

Chan, H.T. 1988. Rehabilitation of logged-over mangrove areas using wildings of *Rhizophora apiculata.* Journal of Tropical Forest Science 1(2), 187-188.

Chanin, P. 1985. The natural history of otters. Christopher Helm, London.

Corbet, G.B. & J.E. Hill 1992. The mammals of the Indomalayan region. Oxford University Press, Oxford.

Foster-Turley, P. 1992a. Conservation aspects of the ecology of Asian small-clawed and smooth otters on the Malay Peninsula. IUCN/Otter Specialist Group Bull. 7, 26-29.

Foster-Turley, P. 1992b. Conservation ecology of sympatric Asian otters *Aonyx cinerea* and *Lutra perspicillata.* PhD.Thesis, University of Florida.

Foster-Turley, P., Macdonald, S.M. & Mason, C.F. (eds.) 1990. Otters - an action plan for their conservation. IUCN, Gland.

Groombridge, B. (ed.) 1993. 1994 IUCN Red List of Threatened Animals. Compiled by the World Conservation Monitoring Centre. IUCN, Gland.

Harris, C.J. 1968. Otters: a study of recent *Lutrinae.* Weidenfeld and Nicholson, London.

Helvoort, B. E. van, Melisch, R., Lubis, I.R. & B. O'Callaghan 1996. Aspects of preying behaviour of smooth-coated otters *Lutrogale perspicillata* from Southeast Asia. IUCN Otter Specialist Group Bull. 13(1), 3-7.

Jenkins, D., Walker, J.G.K. & D. McCowan 1979. Analysis of otter (*Lutra lutra*) faeces from Deeside, N.E. Scotland. J. Zool. London, 187, 235-244.

Kalshoven, L.G.E. 1981. Pests of crops of Indonesia. Ichtiar Baru, Jakarta.

Kottelat, M., Whitten, A., Kartikasari, S.N. & S. Wirjoatmodjo 1993. Freshwater fishes of Western Indonesia and Sulawesi - Ikan air tawar Indonesia bagian barat dan Sulawesi. Periplus, Singapore.

Kruuk, H., Kanchanasaka, B., O'Sullivan, S. & S. Wanghongsa 1994. Niche separation in three sympatric otters Lutra perspicillata, *L. lutra*, and *Aonyx cinerea* in Huai Kha Khaeng, Thailand. Biological Conservation 69, 115-120.

Kruuk, H., Kanchanasaka, B., O'Sullivan, S. & S. Wanghongsa 1993. Identification of tracks and other sign of three species of otter, *Lutra lutra, L. perspicillata*, and *Aonyx cinerea* in Thailand. Nat. Hist. Bull. Siam Society 41, 23-30.

Kruuk, H. & J.W.H. Conroy 1987. Surveying otter (*Lutra lutra*) populations: a discussion of problems with spraints. Biol. Conserv. 41, 179-183.

Lekagul, B. & McNeely, J.A. 1988. Mammals of Thailand. Association Conservation Wildlife, Bangkok.

Lubis, I.R. 1995. Analisis makanan Berang-berang cakar kecil (*Aonyx cinerea*) dan Berang-berang bulu licin (*Lutrogale perspicillata*) berdasarkan faeces dari Cagar Alam Rawa Danau, hutan bakau Pamanukan, dan Taman Nasional Gunung Gede-Pangrango. Skripsi Sarjana, FMIPA, Jurusan Biologi, Universitas Padjadjaran, Jatinangor.

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

Melisch, R., Kusumawardhani, L., Asmoro, P.B. & I.R. Lubis (in press). The otters of West Java. A survey of their distribution and habitat use and a strategy towards a species conservation programme. PHPA/Wetlands International-Indonesia Programme, Bogor.

Melisch, R. & I.R. Lubis 1996. Otters (*Mustelidae, Carnivora*) and their role in ricefields and fish ponds of West Java, Indonesia. Proceedings of the Workshop 'Otters and Fishfarms' 8.-9. February 1996, Litschau (this volume).

Melisch, R. 1995. Zur Biologie und Erhaltung der Otter (*Carnivora, Mustelidae*) in Westjava, Indonesien. MSc Thesis, Institute of Zoology, University of Hohenheim, Stuttgart.

Melisch, R., Asmoro, P.B. & L. Kusumawardhani 1994. Pengenalan Berang-berang di Indonesia khususnya yang terdapat di Jawa Barat. In Prosiding Simposium Pertama Mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi manusia. Bogor, 7. April 1994. PHPA/AWB-Indonesia, Bogor. pp. 1-17.

Nor, B.H.M. 1989. Preliminary study on food preference of *Lutra perspicillata* and *Aonyx cinerea* in Tanjung Piandang, Perak. The Journal of Wildlife and National Parks (Malaysia) 8, 47-52.

PHPA/AWB-Indonesia 1994. Prosiding Simposium Pertama mengenai Berang-berang di Indonesia. Peranan Berang-berang bagi Manusia. Bogor, 7 April 1994. PHPA/AWB-Indonesia, Bogor.

Pocock, R.I. 1941. Fauna of British India: Mammalia. Vol. II. *Carnivora* (cont. from Vol. I), Suborders *Aeluroidea* (part) and *Arctoidea*. Taylor & Fracis, London. pp. 267-317.

Polechla, P.J. 1991. A preliminary review of the anatomy and physiology of the otters (*Carnivora, Mustelidae, Lutrinae*). In Reuther, C. & Röchert, R. (eds.) Proceedings of the V. International Otter Colloquium. Habitat 6, 85-94.

Purves, M.G., Kruuk, H. & J.A.J. Nel 1994. Crabs *Potamonautes perlatus* in the diet of otter *Aonyx capensis* and water mongoose *Atilax paludinosus* in a freshwater habitat in South Africa. Z. Säugetierkunde 59, 332-341.

Schuster, W.H. 1952. Fish-culture in brackish-water ponds of Java. FAO Indo-pacific Fisheries Council Special Publication (Bangkok) 1,1-143.

Silva, P.K. de 1991. A survey on the distribution of the otter (*Lutra lutra*) in some selected areas of Sri Lanka. In Reuther, C. & Röchert, R. (eds.) Proceedings of the V. International Otter Colloquium. Habitat 6, 75-78.

Sody, H.J.V. 1949. Notes on some Primates, *Carnivora* and the Babirusa from the Indo-Malayan and Indo-Australian regions. Treubia 20(2), 121-190.

Stephens, M.N. 1957. The natural history of the otter. A report to the Otter Commitee. UFAW, Otter Commitee.

Zee, D. van der 1981. Prey of the Cape clawless otter (*Aonyx capensis*) in the Tsitsikama National Park, South Africa. J.Zool. London 194, 467-483.

DAMAGE TO STOCK IN FISH PONDS AS A RESULT OF OTTER (*LUTRA LUTRA* L.) PREDATION

Michaela BODNER

Summary
The population of the Eurasian otter (*Lutra lutra*) has increased in the northern Waldviertel in the past few years. Simultaneoulsy, complaints of fish farmers about otter damage to their ponds have increased, too. Since 1984, fish farmers have been compensated for their losses due to otter predation. In this study, the data of all the damage cases were analysed for any possible patterns of damage. The experiences with this compensation system, its advantages and draw-backs are discussed.

Key words: Lutra lutra, compensations, fish farming, species management, Lower Austria

Problem

As in many other European countries, the population of the Eurasian otter *Lutra lutra* L. has decreased in Austria during the past decades. Although fully protected throughout the country since the early 1950s (Kraus 1981), otter distribution in Austria has declined and reached a minimum with only one viable population in the Northern Waldviertel, Lower Austria. This area has a long-standing tradition in carp farming. Since the early 1980s, fish farmers have been complaining about increasing otter damage to their ponds (Bodner 1993) due to an increase in the otter population of this area. This increase was apparently caused by the thriving of the fish farming industry itself with the number of artificially built ponds increasing each year (Vogel 1988). It was argued that the otters would benefit in particular from newly built, very small ponds, as they made foraging very easy. As *Lutra lutra* is an endangered species, since 1984 Austrian fish farmers have been compensated for their losses due to predation by the otter. These compensations were paid voluntarily by four different organisations (the Department for Nature Conservation of the Government in Lower Austria, the hunters association in Lower Austria, the organisation for the conservation of nature (NÖNB) and the WWF Austria). Since 1995, they have been paid by the "Landschaftsfonds Niederösterreich". About 300 cases have been reported in the past 12 years.

In this study data of damage claims were analysed. Results are discussed with special emphasis on their implications for conservation work.

Introduction

Fish Farming in the Waldviertel

In the northern Waldviertel about 1,800 artificially built fish ponds exist at present. Their size ranges from 15 m^2 to 60 ha, the total water surface area is 2,000 ha. The main fish species farmed is carp (*Cyprinus carpio* L.) comprising more than 95 % of the total fish biomass. Other species of commercial interest are rainbow trout (*Oncorhynchus mykiss*), tench (*Tinca tinca*), pike (*Esox lucius*), zander (*Stizostedion lucioperca*) and whitefish (*Coregonus lavaretus*). The ponds are stocked, drained and restocked at regular turnover intervals (mostly 6 or 12 months).

Documentation of Damage Cases

Fish loss was officially attributed to otter predation under the following conditions:

- Evidence of the presence of an otter by the pond (spraints, tracks, slides, food remains) had to be reported and immediately confirmed by an expert.
- The fish farmer had to keep records on the quantity of stocked fish, on any possible fish diseases, etc..
- The fish farmer had to analyse the water quality regularly and to keep records. Minimum requirements were measurements of oxygen, pH and ammonium compounds. From the amount of fish missing at the time of pond drainage a certain percentage (according to data from literature) was subtracted as natural loss. Amounts estimated to be taken by other predators such as heron (*Ardea cinerea*) or cormorant (*Phalacrocorax carbo*) were also substracted. Deductions were also made if fish mortality was caused by other obvious factors (e.g. very high water temperature in summer).

For each damage case, the following parameters were known:

- pond size (ha)
- turnover interval (months or years)
- summer ponds: ponds stocked in April and drained in Oktober
- winter ponds: ponds stocked in October and drained in April
- absolute biomass of fish stocked, seperately for each fish species and fish age class (kg), summed up for each pond
- absolute biomass of fish harvested, separately recorded for each fish species and fish age class (kg), summed up for each pond

- absolute otter predation (kg): the difference between expected harvest (total possible harvest minus natural loss and minus loss due to reasons other than the otter) and the real harvest in any one pond
- absolute damage (in ATS): biomass of fish removed by otter predation multiplied by current local fish price).

Analysis of Data

Between 1984 and 1995, about 300 damage cases were recorded. For the present analysis, only the years 1991 till 1994 (207 cases) were analysed. In addition to the parameters already mentioned, the following calculations were made:

- number of different fish species in each pond
- number of different fish age classes in each pond (different species were automatically different age classes)
- relative damage (ATS/ha): damage (ATS) per unit area (ha)
- relative predation (kg/ha): predation (kg) per unit area (ha)
- %-predation: ratio of otter predation (kg fish biomass) to expected harvest (kg fish biomass)
- shortest distance of any one pond to the nearest natural river (m): measured from maps (1:50,000)
- relative biomass of fish stocked (kg/ha): stocked biomass per unit area
- relative biomass of fish harvested (kg/ha): harvested biomass per unit area
- the %-predation was calculated seperately for each fish age class for each fish pond.

Results

Trends in Compensation Claims

Both the number of damage cases and the total amount of compensations paid have been rapidly increasing from 1988 onwards (Fig. 1a and b). This development culminated in a total amount of 95 damage cases with 1.9 Mio. ATS (190,000.- USD) being claimed for 1995.

Pond Size and Damage

The size of the ponds susceptible to otter damage was examined: contrary to the assumption that most damage should occur at relatively small ponds, the analysis (Mann Whitney U-test, $p < 0.001$, $n = 1,016$) showed that "damaged ponds" were on average larger than "existing ponds" (Fig. 2).

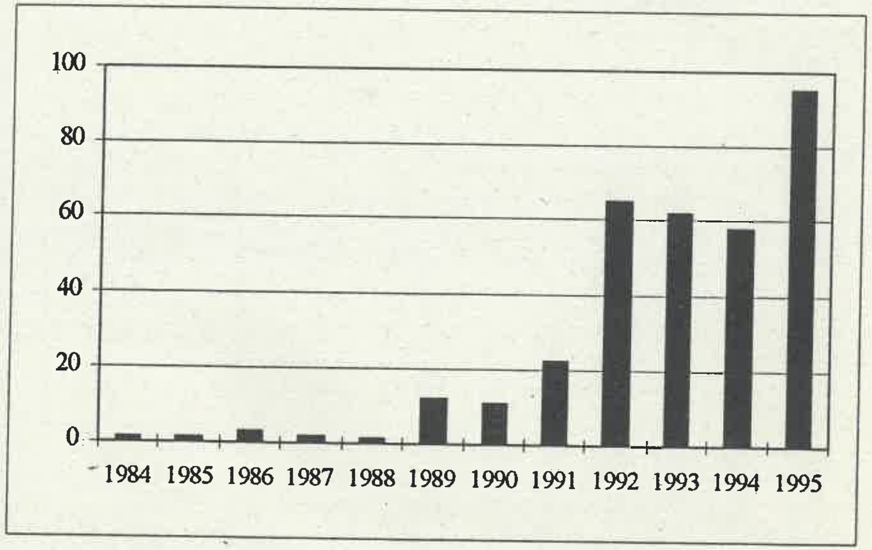

Fig. 1a: Number of damage cases, 1984-1995

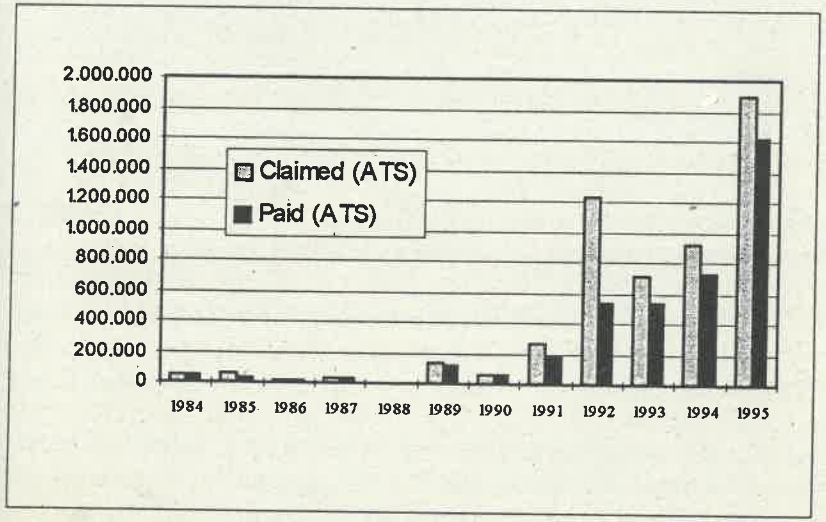

Fig. 1b: Damage amounts (ATS), 1984-1995; left column shows total amount claimed by fish farmers, right column shows total amount recognised as otter damage by experts and paid out

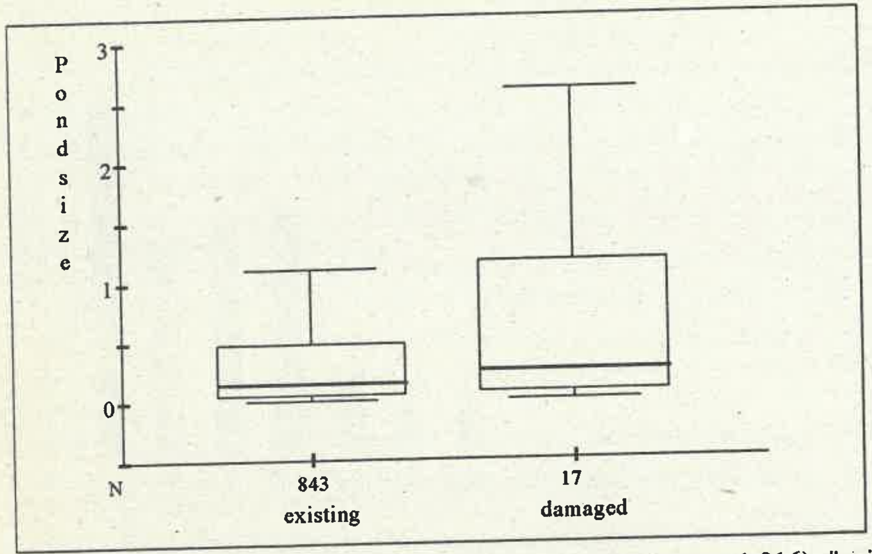

Fig. 2: Comparison of pond size in ha (U-test, $p < 0.001$, n = 1,016): "existing" contains all ponds that exist in the district of Gmünd, "damaged" contains all ponds that reported otter damage, data for 1994

Patterns of Damage

The amount of absolute damage (ATS) increased with: (1) increasing pond size (Spearman Rank Correlation (SRC), r = 0.6345, $p < 0.01$, n = 207), (2) decreasing distance to the nearest river (SRC, r = -0.1765, $p < 0.05$, n = 207), (3) increasing absolute stocked fish biomass (SRC, r = 0.6593, $p < 0.01$, n = 207). No correlation was found between amount of damage and duration of turnover interval, number of fish species and number of fish age classes, respectively. The amount of relative damage (ATS/ha) increased with: (1) decreasing pond size (SRC, r = -0.7564, $p < 0.01$, n = 207), (2) increasing distance to the nearest river (SRC, r = 0.3471, $p < 0.01$, n = 207), (3) increasing relative stocked fish biomass (SRC, r = 0.8653, $p < 0.01$, n = 207). The difference between absolute and relative damage can only be understood knowing that the biomass of fish kept in the pond in the first place varies with pond size: whereas the absolute biomass (kg) of fish increases with increasing pond size, the relative fish biomass (kg/ha) decreases with pond size as large ponds in relation to small ones are more difficult to manage for fish farmers.

Thus, they are less densely stocked. These connections are important as a similar pattern can also be found in damage analysis (see above).

Predation by the Otter

As with the damage, the predation by otters varies with pond size: the absolute predation increases (SRC, r = 0.6322, $p < 0.01$, n = 207) and the %-predation decreases (SRC, r=-0.5183, $p < 0.01$, n = 207) with increasing pond size (Fig. 3).

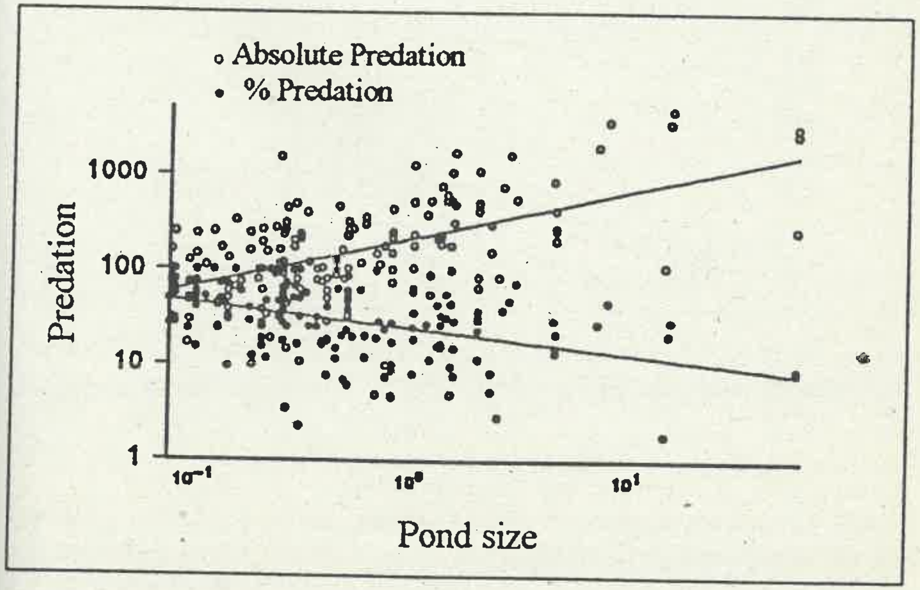

Fig. 3: Correlation between pond size and absolute resp %- otter predation (SRC, r = 0.6322 resp r = 0.5183, $p < 0.01$, n = 207)

Otter Predation on Different Fish Species

The comparison of otter predation on different fish species showed significant differences within the 6 species (H-Test of Kruskal and Wallis $p<0.001$). Tukey and Kramer's a posteriori test showed the following (n=341, $p<0.1$): predation on carp is higher than predation on trout, zander, pike or whitefish. Predation on trout is higher than on any other species except tench.

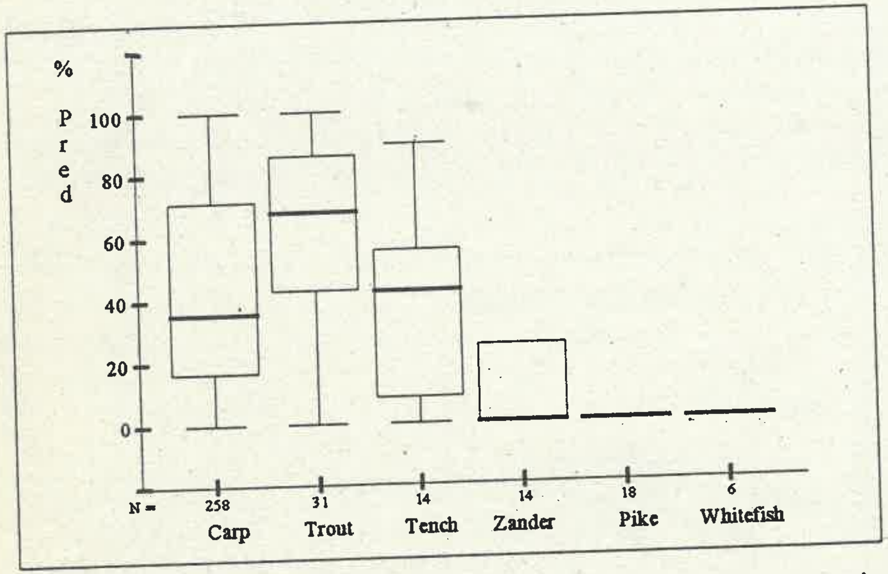

Fig. 4: Predation on different fish species (H-test, p<0.001,n=341, a posteriori Tukey and Kramer, n = 341, p < 0.1)

Comparison of Summer and Winter Ponds
Ponds with a 6 month interval were compared. Winter ponds had a higher density of stocked fish (U-test, p < 0.01, n = 73) (Fig.5) and suffered higher damage (U-test, p < 0.05, n = 73). There was no difference in the sizes of these.

Surplus Killing
Surplus killing (i.e. more fish are killed than actually eaten) occurs only in winter and is extremely rare (12 cases in 2 winters in an area with 1,800 ponds). Ponds where surplus killing occurred were smaller than other damaged ponds (Mann-Whitney-U-test, p < 0.05, n = 207), their stock density was higher (U-test, p < 0.01, n = 207).

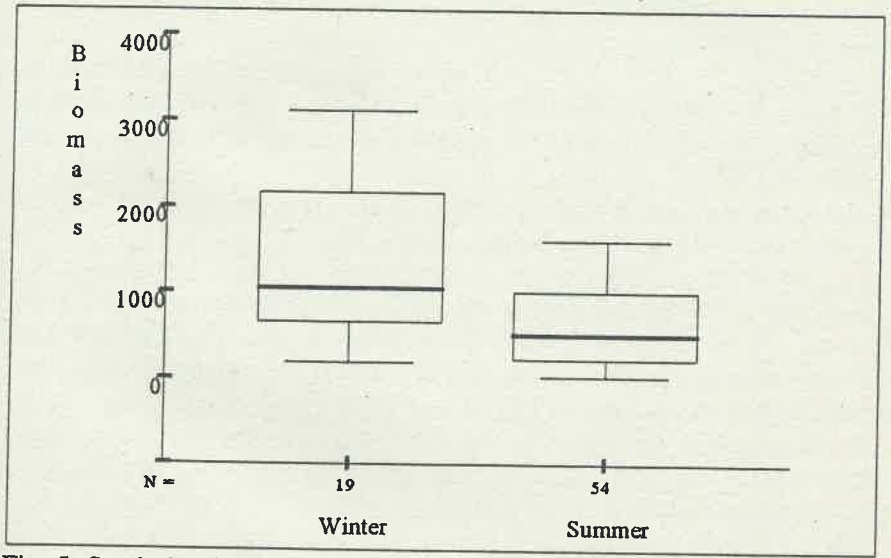

Fig. 5: Stock density (kg/h) a in ponds with 6 months' turnover (U-test, p < 0.05, n = 73)

Discussion
Results of the Analysis
Otter damage was low between 1984 and 1988 but thereafter started to increase and reached ist preliminary climax in 1995 (Fig. 1). In the 1980ies, no data were available on the distribution of the otter in the Waldviertel nor on the number of individuals this population contained. Meanwhile, Kranz (1995) confirmed that, the otters have started spreading south. This indicates an increase of the otter population in the core area of the northern Waldviertel. Previous assumptions that the otter damage has reached its maximum and will stay constant at the level of 1992 (Bodner 1995) have clearly been proved wrong in 1995.

Contary to initial expectations, the importance of small ponds as food source for the otter could not be confirmed: large ponds are over-represented in the damage cases. These results confirm an investigation conducted in 1994 (Kranz, unpubl.) who found signs of otters at only 42 % of ponds smaller than

0.5, wheras 100 % of ponds larger than 5 ha showed otter signs. Two reasons are suggested for this:

- Larger ponds are closer to the main river. Otters while roaming around use the waterways, thus the otter finds large ponds with a higher probability than small ones which sometimes lie at a distance of several hundred metres to the main river.
- Ponds built in recent years are generally small. Thus, otters are more likely to use a large, old pond than a small, new one.

Clearly, the potential for damage is affected by the distribution of stocked fish. The otter can only eat what is there in the first place, thus it is to be expected that patterns of fish distribution will be reflected in the damage as well. The amount of otter damage can be looked at in two ways:

- Absolute damage (in ATS): increases with increasing pond size. Large ponds contain more potential food for the otter than small ones as the total absolute fish biomass is higher.
- Relative damage (in ATS/ha): decreases with increasing pond size. In large ponds the density of stocked fish is comparatively low.

Percentage predation also follows a similar pattern, being higher in small ponds than in large ones: otters eat net amounts of fish and any amount will be represented with a higher percentage predation in a small pond with a small total amount of fish.

The comparison of predation on different fish species showed a high percentage of predation both for carp and for trout. In the case of the carp, however, it must be considered that the predation calculated from the fish loss not only contains fish eaten by the otter but also includes secondary damage (weight loss, parasites, etc.) if carp are disturbed by the otter while overwintering. Carp is taken by the otter as one prey species out of several, but otters in the Waldviertel have by no means specialised on this fish species. Knollseisen (1995) confirmed this when he found an annual average of 8.9 % for carp plus tench in the otter's diet by spraint analysis. The ratio of predation in the damage cases investigated is highest for trout, thus indicating the otter's preference for this species in fish ponds. Pike and whitefish are taken least of all, it is unclear however if the otter actively avoids them or if these species are just more difficult to catch.

Both analysis and interpretation of resuls are biased. Firstly, there is no possibility to distinguish between actual otter predation and secondary damage to the carp. Secondary damage might on a smaller scale occur in other fish species, too, if for example fish are left injured in the pond and then die from skin infections. Secondly, otter predation is calculated from the end weight of the fish at the time of pond drainage. Especially carp has a very fast growth rate: a two year old carp at 0.5 kg gains 1kg in weight, that is a growth rate of 200 %, during a one year's stocking period. Actual otter predation for both reasons must be lower than the results from the data analysis indicate. Therefore, any attempts at estimating the number of otters via the amount of fish loss in the ponds have to fail.

Compensations as Conservation Strategy

When looking at the conditions for paying compensations, only 2 hard facts are evident:

- there is evidence for otter presence by the pond at least once during the stocking period
- fish are missing when the pond is drained.

Anything else, i.e. the number of missing fish, the percentage of damage that was caused by the otter, is debatable. When talking about otter damage, it is essential to think more generally about why fish die in ponds. In the northern Waldviertel, several reasons can be thought of: fish diseases, chemical and physical extremes (ph-value, temperature, nitrogen-level); poaching; predation by heron, cormorant, otter, muskrat (*Ondatra cibethicus* L.), American mink (*Mustela vison*). This wide choice clearly points out that part of the "otter damage" is probably not caused by the otter.

When the compensation system began in 1984, conservationists hoped to suppress and stop fish farmers from illegally killing otters. This strategy has not been fully successful. Rumours about illegal killings are frequent, two attempts could be confirmed when dead otters were found containing lead shot in their corpses (Gutleb 1994). Nervertheless, the compensation system has lead to a long-standing co-operation between fish farmers, conservationists and hunters. Clearly, the existence of a fish predator such as the otter in a traditional fish farming area represents a problem that will never be solved to everybody's total satisfaction.

It has to be assumed (for the lack of better evidence to the contrary) that "otter damage" was actually due to the otter. Common sense suggests that a compensation system which defines otter damage as any damage not caused by other reasons invites the possibility of misuse. A lot of general scientific knowledge is lacking. For example, while carrying out the study, there was one case when about 200 carp at 1.5 kg each died within a period of 3 weeks. The pond was fenced in (and not even the fish farmer blamed the otter), the water quality was analysed and found good, no parasites or other diseases could be found. The reason for this fish loss has remained undetected.

Implications for Conservation Work

Otter conservation activities in the Waldviertel will have to concentrate on two different aspects: firstly, preventive startegies such as fences or diversion ponds have to be applied in order to keep otter predation in the ponds on a tolerable level. Secondly, research has to concentrate on fish deseases in ponds, in particular on the impact of both physical and chemical extremes e. g. of temperature or pH. Moreover, the influence of other predators, in particular, the role of the American mink has to be further investigated.

Aknowledgements

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References

Bodner, M. 1993. Otters and fish-farming. Hystrix 7(1-2), 223-228.

Bodner, M. 1995. Fish loss in Austrian fish ponds as a result of otter predation. IUCN OSG Bull. 12, 3-10.

Gutleb, A. 1994. Todesursachenforschung Fischotter. Grundlage für ein Schutzkonzept für *Lutra lutra* L. 1758. Bericht für die Jahre 1990 - 1992. WWF Forschungsbericht Fischotter 2, 12-25 (in German).

Kranz, A. 1995. Verbreitung der bayerisch-böhmisch-österreichischen Otterpopulation (*Lutra lutra* L.) 1994 in Österreich. BOKU-Berichte zur Wildtierforschung und Wildbewirtschaftung 9, 1-48 (in German, with English summary).

Knollseisen, M. 1995. Aspects of the feeding ecology of the Eurasian otter (*Lutra lutra* L.) in a fish pond area in Central Europe (Austria and Czech Republic). Diploma thesis, University of Agricultural Sciencis, Vienna.

Kraus, E. 1981. Untersuchungen zu Vorkommen, Lebensraumanspruch und Schutz des Fischotters (*Lutra lutra* L.) in Niederösterreich. Ph D Thesis, Univ. Vienna (in German).

Vogel, P. 1988. Fischproduktion. Eine Produktions- und Einkommmensalternative für landwirschaftliche Betriebe in einem entwicklungsschwachen Gebiet. Diploma thesis, University of Agricultural Sciencis, Vienna. (in German).

OTTER DAMAGE COMPENSATION IN THE CZECH REPUBLIC

Ales TOMAN

Key words: Lutra lutra, fish pond, compensation, Czech Republic

Some protected species raise conflicts with human interests. Due to the legal status, the responsiblitity for these species and any subsequent damage is that of the state. However, there must be found a balance between public interests on the one hand (the interest to have some species living in the country) and compensation claims of privat interests on the other hand. The species concerned and covered in this compensation model (the final law is in preparation) are the bear (*Ursus arctos*), the beaver (*Castor fiber*), the cormorant (*Phalacrocorax carbo*), the lynx (*Felis lynx*), the moose (*Alces alces*), the otter (*Lutra lutra*) and the wolf (*Canis lupus*). The assessment of damage for each species is of course different. Here the procedure for otter damages is outlined.

According this model, compensation for otter damage can only be payed for artificial fish ponds. Predation in rivers and streams is not accepted as a damage. The fish, wether wild or stocked is not the property of those who have the right to fish there, though the right to fish has some value. And when there are less fish, the value of the river for anglers will go down. However, this has to be delt with a change in attitude of anglers and with habitat improvment measurements. There does not exist any realistic approach how to calculate otter predation in rivers and any subsequent damage for anglers.

In fish ponds (fish farms), it is not the actual amount of fish missing which can be compensated, because reasons for fish losses are frequently unclear and usually it is a combination of several reasons. In order to keep compensation claims on a realistic level, several estimates and assumptions have to be done:

- The total amount of money available for damage compensation is based upon the number of otters living in the Czech Republic which has to be estimated every three years.
- It is assumed that no more than one otter or one family (female with cubs) use a single pond during a certain night and that one otter consumes no more than 0.5 kg commercial fish per night (according spraint analysis data in fish pond areas. The amount of comercial fish consumed by a female with one cub is 1.5 times higher than for a single otter, with two cubs, 2 times.

- A special trained expert has to estimate the otter presence according the number and age of spraints found at the pond. There exist three categories of otter presence: 300 days per year, 100 days and 30 days.
- Compensation payments are then calculated from the otter presence (number of days x 0.5 kg) and the average fish price. However, payments will also depend upon the pond size: For ponds smaller than 1 ha, 100 % of the calculated loss will be payed. For ponds of 1 - 5 ha, 70 % and for ponds of 6 - 15 ha 30 % of the calculated price will be payed. No compensation is available for ponds larger than 15 ha.

The model described is neither free of errors nor can it be fully just in every case of damage. It is, however a compromise, accepted by both sides, nature conservation and fish farmers. The feasibility of damage estimates in the field, and the bureaucracy of payments ruled the model. It is definitely connected with the total number of otters in the country and a realistic amount of commercial fish consumed by otters. This model should avoid an exponential increase of claims independent of the number of otters as it came to being with the compensation practices in Lower Austria. However, the experiences of the following years have to show the value of the Czech compensation model. It is out of discussion that the appropach described here can only be one of several to reduce the conflict. Other activities such as habitat improvements and public relation campaigns will be important as well. The status of otters in the future, however, will prove success or failure.

HOW MANY OTTERS LIVE `HERE´? A DISUSSION ABOUT COUNTING OTTERS

Andreas KRANZ and Michael KNOLLSEISEN

Key words: Lutra lutra, population census, method, Austria

The question about otter numbers is of general interest in an area with plenty of fish farms and an increasing otter population. Otter numbers are not just of scientific interest or a key question in otter conservation. Fish farmers, and conservationists in particular, but also politicians, governmental authorities, hunters and people not directly involved in the conflict around otters and fish farms, would like to know otter numbers. The way most people not involved in otter research pose questions, e. g. how many otters live `here´, as well as their expectations (a concrete number of otters for either an undefined area or an actual pond) indicates a need to discuss how estimates of otter numbers come into being. This paper focuses on the situation in Central Europe and gives examples from northern Austria.

The Reference Area

Whatever the reason for the interest in the number of otters, it is essential to define the reference area. For example:

- the total area inhabited by a (meta-)population
- an ecological unit such as a river system
- a unit of water surface or river bank
- a politically defined area such as a district.

An estimate of the number of otters living in an entire population, e.g. the Austrian-Czech-Bavarian population, is essential for conservation efforts, in particular, when assessing risks facing the entire population (e.g. genetic depression). The number of otters in ecologically or politically defined areas is of interest for political decisions and management activities, e.g. the maximum amount of compensation payments available for an area (i.e. Toman, this volume). The number of otters present at a single pond or stretch of river will be in focus when discussing potential (or actual) fish losses and the respective claims of people who feel damaged by the otter.

How to Count Otters?

The estimation of numbers of otters in Central Europe faces many problems. Otters are mainly nocturnal and dense bankside vegetation makes visual observations almost impossible. Hence a visual census, such as carried out in Spain (Ruiz-Olmo 1995) will not work effectively. Estimates based upon main holts, as used on the Shetland islands (Kruuk *et al.* 1989, Conroy & Kruuk 1995) are also not possible. In contrast to the Shetlands, where otters sleep mainly in conspicuous underground dens in moorland, otter resting sites are not so easily found in Central Europe. It is suggested that snow tracking, as conducted by Erlinge (1967, 1968) in Sweden or Sidorovich (1991) in Belarus, is the only feasible approach at present to estimate otter numbers in Central Europe. However, this method also has its´ drawbacks. The success depends on good snow conditions as well as a capable team of snow trackers. In severe winter periods, radio tracking has indicated that otters may not move much on the surface at all, prefering to stay underground or under the snows' surface, often leaving no visible tracks at all for more than a week (Kranz unpubl.). Therefore, in cases such as these, there is a considerable risk of an under-estimation of otter numbers.

Radio telemetry, providing data upon home range size, in combination with the use of radio isotopes detectable in spraints (Mitchell-Jones *et al.* 1984, Durbin 1993, Kruuk *et al.* 1993), are frequently mentioned as a feasible approach. The relationship between the ratio of radioactive and unlabled spraints should indicate the approximate number of individuals present in a certain area, which was used e.g. by Kruuk *et al.* (1993) for estimating otter presence on the River Dee. However, Durbin´s results (1993) and own observations indicated that sprainting activity of otters with different social status can be highly variable as well. Much depends upon the social status of the otter with the isotope, low status (reduced sprainting activity) resulting in an over-estimate of all otters, high status (much sprainting activity) resulting in an under-estimate.

A new approach to determining actual otter numbers is by the identification of individuals from their tracks using discriminant analysis. This technique has been successfully used for mountain lions (Smallwood & Fitzhugh 1993) and is currently being tested for otters by Hertweck (pers. comm.) in Saxony. The identification of individuals by means of DNA analysis of spraints (in development by ITE Banchory and the University of Aberdeen, Scotland) may be another useful method for the future.

Otter Numbers in Northern Austria

Otters in northern Austria are part of the Bavarian-Bohemian-Austrian population which covered an area of around 15,000 km^2 in 1994 (Kranz 1995a). About 70 % of the area is in southern Bohemia and Moravia (Toman 1992), 20 % in Austria (Kranz 1995a) and 10 % in Bavaria (Mau 1992). The Austrian part may be devided into two main otter habitats:

- Small and medium sized oligotrophic rivers in the highlands of the western Waldviertel region and the Mühlviertel region. The main fish species, both in terms of biomass and economic importance, are brown trout (*Salmo trutta f. fario*) and grayling (*Thymallus thymallus*). In this habitat type, fish ponds are rare and very small (usually < 0.2 ha).
- Small and medium sized meso- and eutrophic rivers in the northern Waldviertel, inhabited mainly by cyprinids and percids, and in addition approximately 1,500 small ponds, used for carp production.

The Rivers

Information on otter distribution is based upon the presence and absence of spraints along all rivers of the Wald- and Mühlviertel (Kranz 1995a). The number of otters were identified by snow tracking carried out in the upper catchment area (313 km^2) of the River Kamp (Waldviertel region) during several winters. There, a figure of one otter per 10 km of oligotrophic highland river (> 3 m wide) was calculated. Extrapolating the results from the River Kamp on the neighbouring and very similar river systems of the the entire Wald- and Mühlviertel regions, this estimate gives a total number of 60 otters for the riverine habitats in 1994. In 1996 there may already have been about 20 % more otters around, as indicated by a range expansion into neighbouring river systems (Kranz, unpubl.). Moreover, the otter density nowadays may be generally higher along rivers (> 1 otter per 10 km) as indicated by more spraints and tracks, but no systematic snow surveys have quantified that so far.

The Ponds

The estimation of otter numbers in pond habitats is far more difficult. Radio telemetry data (Kranz 1995b and unpubl.) indicate that, rather than the fish stocking density of ponds, the pond size and in particular the number of ponds

may be a key factor in the calculation, probably because single ponds do not provide a secure food base over all the year. The range of five radio-tagged female otters in the above study in Austria and the Czech Republic encompassed 20 to 30 ponds per individual plus some riverine habitat. In Austria, small scale snow surveys (up to 55 km^2) produced similar results: three individuals using about 30 ponds altogether (an average of 1 otter per 10 ponds). In the Czech Republic, such snow surveys produced an otter density twice as high as in Austria (1 otter/5 ponds), but these ponds are also considerably larger.

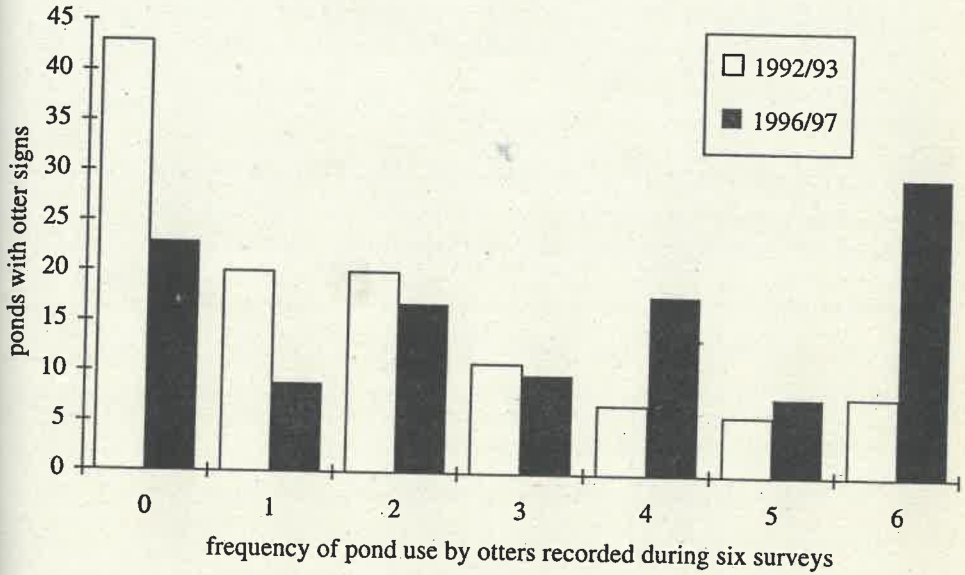

Fig. 1: Number of fish ponds with otter signs during six surveys per year (n = 115 ponds)

Any extrapolation of these results to the entire pond region is, however, very problematic. The snow surveys and radio telemetry tracking were carried out near the Czech border, an area which presumably holds a higher otter density than areas further south. Moreover, the total number of ponds of the entire region is unknown, as many of them are illegal. Estimates go from 1,400 up to 2,000 ponds in the area of northern Austria concerned, though it is likely that only about two thirds are used by otters. In accordance with the situation along the rivers, otter numbers seem to be increasing around the ponds. In 1992/93, only 64 % of ponds, out of a sample of 115 in an area of 36 km2, showed the presence of otters at least once during six surveys. This percentage increased to 80 % in 1996 (Fig. 1).

Considering the discussion about otters and fish farms in that region, there seems to be a real need to settle this question with more accuracy, than it is possible at present. Otter numbers have to be seen as one very important pre-requisite for realistic political decisions and successful otter management.

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References

Conroy, J and Kruuk, H. 1995. Changes in otter numbers in Shetland between 1988 and 1993. Oryx 29 (3), 197-204.

Durbin, L. 1993. Food and habitat utilization of otters (*Lutra lutra* L.) in a riparian habitat. Dissertation at the University of Aberdeen, Scotland.

Erlinge, S. 1967. Home range of the otter *Lutra lutra* in Southern Sweden. Oikos 18, 186-209.

Erlinge, S. 1968. Territoriality of the otter *Lutra lutra* L.. Oikos 19, 81-98.

Kranz, A. 1995a. Verbreitung der bayerisch-böhmisch-österreichischen Otterpopulation (*Lutra lutra*) 1994 in Österreich. BOKU - Berichte zur Wildtierforschung und Wildbewirtschaftung 9, 1-25

Kranz, A. 1995b. On the ecology of otters (*Lutra lutra* L.) in Central Europe. Dissertation at the University of Agricultural Sciences Vienna.

Kruuk, H., Moorhouse, A., Conroy, J. W. H., Durbin, L. and Frears, S. 1989. An estimate of numbers and habitat preferences of Otters *Lutra lutra* in Shetland, UK. Biol. Conserv. 49, 241-254.

Kruuk, H., Carss, D. N., Conroy, J. W. H. and Durbin, L. 1993. Otters (*Lutra lutra* L.) numbers and fish productivity in rivers in north-east Scotland. Symp. zool. Soc. Lond. 65, 171-191.

Mau, H. 1992. Fischottervorkommen in Niederbayern. Schlußbericht an Bayer. Landesamt für Umweltschutz.

Mitchell-Jones, A. J., Jeferies, D. J., Twelves, J., Green, J. and Green R. 1984. A practical system of tracking otters *Lutra lutra* using radiotelemetry and 65-Zn. Lutra 27, 71-84.

Ruiz-Olmo, J., 1995. Visual census of Eurasian otter (*Lutra lutra*): a new method. Proc. VI. Intern. Otter Colloquium Pietermaritzburg 1993. Habitat 11, 125-130.

Sidorovich, V. E. 1991. Structure, reproductive status and dynamics of the otter population in Byelorussia. Acta Theriologica 36 (1-2), 153-161.

Smallwood, K.S. and Fitzhugh E.L. 1993. A rigorous technique for identifying individual mountain lions *Felis concolor* by their tracks. Biological Conservation 65: 51-59.

Toman, A. 1992. Prvni vysledky akce vydra. Vydra 3, 3-8.

REINTRODUCTION OF THE EUROPEAN OTTER (*LUTRA LUTRA* L.): EXPERIENCES FROM OTTER RELEASE IN SWEDEN

Thomas SJÖÅSEN

Key words: Lutra lutra, reintroduction, survival rate, interactions, activity pattern, conservation, Sweden

Background

During the last three decades interest in otters has increased throughout Europe. The main reason for this is to try and save the otter and to bring it back to its former native areas. The first detailed scientific studies of the species were made in Sweden during the 1960s (Erlinge 1966, 1967, 1968a 1968b). Since then the biology of the otter has been described by several authors (Reuther & Festetics 1980, Chanin 1985, Mason & Macdonald 1986, Kruuk 1995).

In the mid 1970s scientists and hunting associations, at least in England and Sweden, showed that the otter population was declining (Erlinge 1972, Chanin & Jefferies 1978, Erlinge & Nilsson 1978). For example in Sweden, the number of otters killed during the hunting seasons fell from approximately 1,500 animals in the end of the 1940s to only 50 in 1968 (Erlinge 1972). This led to extensive otter surveys in many European countries, of which showed that the otter population except for the most eastern and western parts of Europe had declined dramatically and was on the edge of extinction in many areas (Macdonald & Mason 1994).

Otter surveys in Sweden between 1983 and 1987 showed that the population was fragmented (Olsson & Sandegren 1983, Olsson *et al.* 1989). In the southern part of the country, otters remained in only two areas where. One of these was later chosen for an otter reintroduction programme (Sjöåsen & Sandegren 1992, Sjöåsen 1996, Sjöåsen 1997).

Many different explanations for the decline have been discussed, such as habitat destruction, eutrophication, acidification and toxic chemicals (Chanin 1985, Mason & Macdonald 1986).

In most countries in the world - and the European countries are not an exception - there have been and still are great changes in the extent and quality

of wetland and freshwater habitats. These changes have most probably a severe influence on the vital condition of otters. Habitat degradation is, however, relatively a slow process and can not alone explain the dramatic decline of the otter population during the 1960s and 1970s. Nevertheless, these changes have to be considered as long term problems.

In 1966, PCBs (polychlorinated biphenyls) was identified as an environmental contaminant (Jensen 1972, Jensen *et al.* 1977), suggested as a reason for the decline of the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations (Hook & Johnels 1972, Olsson *et al.* 1992). At the beginning of the 1980s, it was also suggested that PCBs were the main reason for the otter decline (Olsson & Sandegren 1983, 1984). This opinion was important when the reintroduction project was planed in Sweden. Otter release was not possible until the concentration of PCBs decreased to acceptable levels. In the interim an otter breeding station was built, as a preparation for future otter release (Sandegren *et al.* 1980).

In Sweden there is an on-going national monitoring program to study time trends of different contaminants in different organisms in the environment and one such contaminant is PCB. It has been shown that PCB concentrations in Sweden declined to relatively low levels during the end of the 1980s and the beginning of the 1990s coinciding with an increase of the Baltic grey and harbour seal (*Phoca vitulina*) populations both species having suffered serious PCB pollution in the past (Bignert *et al.* 1985, Olsson & Reutergård 1986, Sjöåsen *et al.* 1997). As a result of these fundings the reintroduction project in Sweden started in 1987 (Sjöåsen & Sandegren 1992).

Study Area

The aim of the otter reintroduction project was to boost a low- density otter population in an area where the environmental suitability was judged to be good. The study area, approximately 5,200 km^2, is situated in southern Sweden. This area has an abundance of lakes and rivers, and most waters are very productive (mesotrophic or eutrophic) with dense shore vegetation. Analyses of fish from the area showed low levels of PCBs (less than 0.4 mg PCB/kg lipid weight). The area was one of the two areas in southern Sweden where otters remained during the 1980s. Before the reintroduction project started otter surveys had been carried out during two summers and one winter. The number of otters within the area was estimated to be less than 10 individuals (maybe as few as five). Because otters still remained in the area, the release project was a re-stocking exercise rather than a reintroduction.

Material and Methods

During 1987 and 1988, 11 otters were released. All were marked with an individual code tattooed on the inside of the lip. Between 1989 and 1992 a further 36 otters were released, 11 wild otters caught in box traps from the Norwegian coast and 25 otters born of two females in captivity from the Swedish breeding station (Sjöåsen 1996). These 36 otters also had a code tattooed on the inside of the lip, but were also equipped with implanted radio-transmitters.

Radio-tracking to locate the first signal from an otter was carried out by car with an omni-directional antenna. To determine the position of the otter, two or three further bearings were taken using a directional antenna. If there were problems in locating the otter from the ground, radio-tracking was carried out from an aeroplane. The usual range of the transmitter was 500 to 2000 metres, but on some occasions less than 100 metres when otters were staying in holts or diving in water. This range increased to approximately 3 to 9 km from the aeroplane.

Radio-tracking was carried out between May 1989 and February 1994. Each animal was tracked almost daily, but due to difficulties in locating the animals, otters were observed on 64 % of all possible radio-tracking days (Sjöåsen 1996). The mean distance driving by car was approximately 200 km per day. Radio-tracking also occurred at nights to follow individual otters to get information about its habitat use and activity pattern. Therefore, it was necessary to have one person working during the day and another person during the night. Thus, there were always two persons working in the area.

The survival rate of otters with radio transmitters was estimated for the first 12 months after release. Calculations of the survival rate of released otters were carried out by using the Kaplan-Meier estimation with staggered entry (Pollock *et al.* 1989a, b). In this analyse missing animals do not change the survival rate but increase the variance of the survival.

Results and Discussion

Survival Rate

The survival rate of the 36 radio equipped animals was 54 % (Table 1; Sjöåsen 1996). There was a significant difference in the survival rate between the group of wild-caught otters and the group of captive-bred otters. Wild-caught otters had a survival rate of 79 % and captive-bred 42 %. Among the captive-bred otters, the survival rate of offspring from one breeding female was 71 %, from the other 21 %. It was a significant difference between the offspring from the two breeding females (2 = 4.00, d.f. = 1, $p < 0.05$; Sjöåsen 1996).

Among captive-bred otters, the time between separation from the breeding female to the time of release was five to 98 days. This group of captive-bred otters was divided into two sub-groups - otters with a separation-release period less than 49 days, and otters with a separation-release period of more than 49 days. The survival rate of captive-bred otters with short periods was 80 %, while this figure only was 13 % of otters with long periods (Sjöåsen 1986).

A test was made to analyse whether the breeding female or the length of the separation-release period was the main factor of the survival of captive-bred otters. This showed a significantly higher survival rate in otters with short separation-release periods (mean = 0.71) compared to long periods (mean = 0.17; two-way ANOVA $F(1, 14) = 7.57$, $p < 0.05$). There was no significant difference between the offspring from the breeding female compared to the offspring from the other breeding female (Sjöåsen 1996). Thus, the difference in survival rate among captive-bred otters was most likely due to the handling after separation from the mother but before release. A possible explanation could be that longer separation-release periods caused stress and a reduce in the survival rate of this group.

Thus, the survival rate of captive-bred otters with short separation-release periods was equal to the survival rate of wild-caught otters. The survival rate of these two groups of released otters were also comparable to the survival rate in wild otter populations of the same age group - for instance the otter population in Shetland with a survival rate of approximately 80 - 85 % (Kruuk & Conroy 1991).

Table 1. Kaplan-Meier estimates (Pollock *et al.* 1989) of the survival rate in otters for staggered entry of new animals and the variances of the estimates. (from Sjöåsen 1996)

Group of otters	Sample size	Survival rate
All reintroduced otters	36	0.54
All males	17	0.45
All females	19	0.68
Wild-caught otters	11	0.79
Captive-bred otters	25	0.42
Offspring from female no. 1	12	0.71
Offspring from female no. 2	13	0.21
Short separation-release period (<49 days)	12 (7 from female no 1 : 4 from female no. 2)	0.80
Long separation-release period (49 days)	13 (5 from female no. 1 : 9 from female no. 2)	0.13

Fate of Released Otters

Out of the 36 otters, 14 otters were radio tracked more than one year, the radio contact was lost with eight animals - in one case because of radio failure - and 14 otters died (Sjöåsen 1996). It was not possible to know what was happened to otters where radio contact was lost. However contact with most of these individuals occurred when they were very mobile and moving over large traits of country. The reason of the losses was most likely their movements away from the area. Most deaths occurred during the first four months. Among the 14 otters that died, seven otters died of non-traumatic causes and it can not be rejected that some of them died because of adaptation problems in the new environment.

Movements from Release Site

The otter release was designed to give answers on otter movements from the release site depending on if the area of release was occupied or unoccupied by other otters. The knowledge of the otter situation in the area was based on earlier surveys. After the two first years, some new releases were carried out in a lake which had no otters before the project started, but where released otters

had become established. This was to test if these new released otters behaved in a similar way as otters released there during the first two years.

The main movements from the release site occurred during the first 10 to 15 weeks after release (Sjöåsen 1997). The distance between the release site and the arithmetic mean point the 10th week after release was significantly greater in otters released in occupied areas (11.5 km) compared to otters released in unoccupied areas (4.2 km). However, there was no difference in movements between males (5.1 km) and females (8.3 km). Thus, the movement pattern among the released otters depended on the presence or absence of other otters in the releasing area (Sjöåsen 1997).

The maximum linear distance of movements among the 36 released otter was between three and 39 km and there was no difference between sexes (Sjöåsen 1997). These figures include also those otters that died soon after release. If these are excluded the maximum linear distance of movements from the release site increased to between eleven and 39 km. However, one male was found drowned in fishing gear 76 km linear distance from the release site 2.5 years after released. The actual distance this male had travelled was aproximately 180 km. The long distance moved by the male is interesting from a conservation perspective, showing that otters are capable to move long distances to recolonize areas far away from the release (native) area.

Interactions

Interactions between released otters were observed at several occasions (Sjöåsen 1997). For example a female (F2) released in 1989 established a home range in Lake Uren. In 1990 two other females were released in the same lake - F12 was released in the beginning of March, F16 in the middle of April.

Soon after the release, F12 became resident in a small lake (Lake Månsjön), located 500 metres up-streams Lake Uren. In March and April, F12 was repeatedly visited by the established F2. On three occasions, F12 responded to the presence of F2 and moved south over land to Lake Långhalsen. However, on each occasion F12 returned. On the night between 26-27 April, both F2 and F12 were located on the west shore of Lake Månsjön. At midnight F12 moved south, crossed between Lake Månsjön and Lake Långhalsen, and travelled further southward on Lake Långhalsen. After that night F12 never visited Lake

Månsjön again. Instead she established a home range in the southern part of Lake Långhalsen.

F16 released in the north-west part of Lake Uren, stayed in that area for more than a month (Sjöåsen 1997). Her activities were restricted to a very small area. At the end of May she travelled upstream following a ditch. Three days later she was found dead, the body was emaciated. During the time F16 was present in north-west Lake Uren, she was repeatedly visited by F2. The interaction pattern of F2 on F16 was similar to that of F2 and F12. However, F16 did not show the same "strength" compared to F12, and my conclusion is that F16 most probably died because of the interaction from F2.

This example of interactions between individuals does emphasise the importance to have a good knowledge about the otter presence in an area before new otters are released in that area.

Establishment

Sixteen out of the 36 released otters were recorded to have established home ranges (Sjöåsen 1997). Establishment occurred mainly in unoccupied areas, but two males established their home ranges within an area occupied by a female. Except for two males that established home ranges with extensive overlap (the same two males as above), there were no overlapping home ranges irrespective of sex. Otters released in occupied areas usually established their home ranges in the first vacant adjacent area suitable for otters.

During the period between July and December the first year after release, the home range size of established otters did not differ between males (n = 6, 35.7 km) and females (n = 7, 44.0 km, Sjöåsen unpubl.). During the first six months of the following year (January to June) males expanded their home ranges (n = 6, 63.4 km), while no such expansion was observed among the females (n = 7, 49.8 km). Thus, females had the same home range size both before and during the breeding season, indicating that they have feeding home ranges. The home range expansion among the males could indicate a search behaviour for mates.

Habitat Utilisation

One established female showed a seasonal migration between two bordering areas (Sjöåsen 1997). During the summer she was resident in a lake, but when

it become ice covered, she moved down-streams to a river and estuary. Next spring following the ice break-up she moved back to the lake.

This shift from using lakes during the summer to rivers and streams during the winter was observed also among other otters, but these otters had home ranges covering both types of habitats. Thus, open water seems to be of great importance for the otter in areas with lakes covered by ice during the winter.

Activity Pattern

More than 10,600 observations confirmed the otters in this study showed nocturnal activity irrespective of season (Sjöåsen unpubl.). For example during the short summer nights on this latitude (N 59°), the otter activity was most intense between 8 o'clock in the evening and 4 o'clock in the morning, while the period of activity was much longer during the winter. However, during the summer the activity per hour was higher than during the winter.

Concerning the entire 24-hours period the activity among the otters was approximately 40 % of the time and there was no difference in activity between spring, summer, autumn and winter.

Conclusions

From a conservation perspective, what are the conclusions based on the results from the otter reintroduction project in Sweden? The implication of translocating otters is to deal with animals transported from one area and released into a new unfamiliar area. The behaviour of these otters may differ from one individual to another, but in general are to a great extent influenced by the situation in the reintroduction area.

This study has led to new understandings on how released otters behave. Individuals released in areas occupied by conspecifics often traveled more widely than animals released in unoccupied areas. Otters released in occupied areas appeared to move to the first suitable vacant area for establishment. Although they moved from occupied areas, several established their home ranges adjacent to the home range of the resident otter. However, there where individuals who did not follow this pattern and moved further from the release site and were lost from radio contact. The fate of these otters is unknown, but we know that areas outside the study area, absent of otters before the project started, have been recolonised during the last five years. It is probable that otters from the reintroduction project have recolonised these areas.

It is reasonable to conclude that the primary explanation for the movement and establishment pattern of released female otters was competition for resources (food and good habitats). Also in subadult males competition for resources was of significance, but not as obvious as in females. When males become adults, competition for mates was probably a more important factor than competition for food. Thus, females seem to be more careful than males to choose an area with high food production for establishment, probably because of the importance to raise young in an area of good quality.

Interactions from conspecifics and habitat quality appear to be important factors to explain movement and establishment patterns of released animals. Consequently, the knowledge of the otter presence in a potential area for reintroduction is of fundamental importance. It is also important to make sure that the habitat quality, measured as fish production, shelter, etc. is high.

Considering the experiences from this study, otter reintroduction should be carried out in different ways depending on the circumstances in the area. If no otters are present in an area, releases should concentrate on areas where the habitat quality is judged to be good. If otters already are present in the release area, it is important to avoid aggressions from residents that could result in stress and alternatively death among the released otters. In this case an otter should be released on the peripheral area of the existing population. My suggestion is to release the otters approximately 10 km from areas occupied by other otters.

Finally, from a conservation perspective, reintroduction is clearly possible to augment a population provided that environmental and habitat problems that caused the original decline of the population have been identified and removed (IUCN 1987). However, radio tracking is not enough to get satisfactory information about the development of a population in an area. Therefore it is necessary to have a following-up phase with consecutive surveys of otter signs in the area - every third year for a 10-years period as a suggestion.

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References

Bignert, A, Jensen, S., Olsson, M., Persson, W., Roos, A., Alsberg, T., Eriksson, U., Häggberg, L., Litzén, K., Zakrisson, S. & Åslund, K. 1995. Time Series of Contaminents in the marine environment along the Swedish coasts. In: Yvervakning av miljögifter i levande organismer, Rapport 4314. (eds A. Bignert, T. Odsjö & M. Olsson). PMK, Naturvårdsverket (Swedish Environmental Protection Agency).

Chanin, P. 1985. The Natural History of Otters. Croom Helm, London.

Chanin, P.R.F. & Jefferies, D.J. 1978. The decline of the otter *Lutra lutra* in Britain: an analysis of hunting records and discussion of causes. Biol. J. Linn. Soc., 10, 305-328.

Erlinge, S. 1966. Food habits of the fish otter *Lutra lutra* L. south Swedish habitats. Viltrevy, 4, 371-443.

Erlinge, S. 1967. Home range of the otter *Lutra lutra* in Southern Sweden. Oikos, 18, 186-209.

Erlinge, S. 1968a. Territoriality of the otter *Lutra lutra* L. Oikos, 19, 81-98.

Erlinge, S. 1968b. Food studies on captive otters *Lutra lutra* L. Oikos, 19, 259-270.

Erlinge, S. 1972. The situation of the otter population in Sweden. Viltrevy, 8, 379-397.

Erlinge, S. & Nilsson, T. 1978. Nedslående inventeringsresultat: uttern forsätter att minska - bara 1000- 1500 uttrar kvar. Svensk Jakt, 3, 154-156.

Hook, O. & Johnels, A. 1972. The breeding and distribution of the grey seal (*Halichoerus grypus* Fab.) in the Baltic Sea, with observations on other seals of the area. Proc. R. Soc. London. B, 182, 37-58.

IUCN. 1987. The IUCN position statement on translocation of living organisms. Introduction, re-introduction and re- stocking. IUCN, Gland, Switzerland.

Jensen, S. 1972. The PCB story. Ambio, 1, 123-131.

Jensen, S., Kihlström, J.E., Olsson, M., Lundberg, C. & Örberg, J. 1977. Effects of PCB and DDT on mink (*Mustela vison*) during the reproductive season. Ambio, 6, 239.

Kruuk, H. 1995. Wild otter. O.U.P. Oxford.

Kruuk, H. & Conroy, J.W.H. 1991. Mortality of otters (*Lutra lutra*) in Shetland. J. Appl. Ecol., 28, 83-94.

Macdonald, S.M. & Mason, C.F. 1994. Status and conservation needs of the otter (*Lutra lutra*) in the Western Palearctic. Convention on the conservation of European wildlife and natural habitats. Council of Europe. Strasbourg.

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

Olsson, M. & Reutergård, L. 1986. DDT and PCB pollution trends in the Swedish aquatic environment. Ambio, 15, 103-109.

Olsson, M. & Sandegren, F. 1983. The otter situation in Sweden and the Småland-Södermanland surveys of 1983 Proc. International Otter Symposium, Strasbourg, 3rd.

Olsson, M. & Sandegren, F. 1984. Varför minskar uttern? Svensk Jakt, 2, 86-89 (in Swedish).

Olsson, M., Karlsson, B. & Ahnlund, E. 1992. Seals and seal protection: a presentation of a Swedish research project. Ambio, 8, 494-496.

Olsson, M. Sjöåsen, T. & Sandgren, F. 1989. Utterinventering Norrland 1986-87. Viltnytt, 27, 30-39. (in Swedish).

Pollock, K.H., Winterstein, S.R. & Conroy, M.J. 1989a. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics, 45, 99-109.

Pollock, K.H., Winterstein, S.R., Bunck, C.M. & Curtis, P.D. 1989b. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management, 53, 7-15.

Reuther, C. & Festetics, A. 1980. Der Fischotter in Europa - Verbreitung, Bedrohung, Erhaltung. Selbstverlag, Oderhaus & Göttingen. (in German).

Sandegren, F., Olsson, M. & Reutergårdh, L. 1980. Der Rückgang der Fischotterpopulation in Schweden. In Der Fischotter in Europa - Verbreitung, Bedrohung, Erhaltung, (eds C. Reuther & A. Festetics), 107-113. Selbstverlag, Oderhaus & Göttingen. (in German).

Sjöåsen, T. 1996. Survivorship of captive-bred and wild- caught reintroduced European otters *Lutra lutra* in Sweden. Biol. Conserv., 76, 161-165.

Sjöåsen, T. 1997. Movements and establishment of reintroduced European otters (*Lutra lutra*). J. Appl. Ecol. 34, 1070-1080.

Sjöåsen, T. & Sandegren, F. 1992. Reintroduction of Eurasian otters (*Lutra lutra*) in southern Sweden 1987-1992: a project in progress. Habitat 7. Otterschutz in Deutschland, (ed C. Reuther) 143-146. Hankensbüttel, Germany.

Sjöasen T., Ozolins, J., Greyerz, E. and Olsson, M. 1997. The otter (*Lutra lutra*) situation in Latvia and Sweden related to PCB and DDT levels. Ambio 26 (4), 196-201.

MORTALITY OF OTTERS (*LUTRA LUTRA*) IN AUSTRIA WITH SPECIAL REFERENCE TO EVIDENCE FOR POACHING

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Key words: Lutra lutra, mortality, illegal killing, fish pond, Austria

In 1989 WWF Austria initiated a project to collect the carcasses of otters found dead in Austria. The aim of this program is to get information on causes of death, potential dangerous places along streets and to obtain the carcasses for further scientific research. On all these carcasses necropsies and thereafter x-ray, histopathoplogy, bacteriology, virology and patasitology were conducted. These findings were published on a regular basis (Gutleb 1994a,b) and some results were provided to those interested on specific data (Sainsbury *et al.* 1995; in press; Miller *et al.* 1995a,b). In the last months data sheets about all dead otters were sent to persons working in the field in Austriathus improving the flow of information.

The total number of verified cases of dead otters is 51 (1968 -1995). There is an remarkable increase of dead otters found which might reflect both the fact of increasing otter numbers in Austria (Kranz 1995) as well as increasing scientific and public interest in the species, which may favour the flow of information. Causes of death are given in table 1. About 80 % of all otters found were killed by cars, which is in the same range as data of Braun (1988), Kruuk & Conroy (1991), Skaren (1992), Stubbe *et al.* 1993) and Zinke (1991) for other areas in Europe.

Table 1: Causes of death of the otter (*Lutra lutra*) in Austria (n=51; 1968-1996)

cause of death	n
traffic accidents	42
slain	3
dog	1
fish net	1
distemper	2
unknown	2

The results of the necropsies revealed two cases of attemptst to kill otters illegally. A "muskrat" was killed by a farmer inside the farm yard. The man claimed his fear from rabies as his reason to kill the animal. He passed the carcass to his neighbour, who gave it to a member of the hunting authority who finally identified the animal as an otter. Rabies could be excluded by immunohistology though the otter had no suppurative encephalitis. In the x-ray it was found that this old male (9 years) had been wounded twice by lead pellets of different size (Gutleb *et al.* 1995). In another case, a male otter was found dead next to a street but no skeletal alterations were found. In the x-ray lead pellets were seen but necropsy showed that the animal was not freshly wounded as the skin showed no lesions due to gun shots (Gutleb *et al.* 1995).

In the literature there is information on some similar cases on animals which were also wounded by shooting before being killed by a car. Two otters were found dead with lead pellets in Denmark (Madsen 1994), one animal in Germany (Zinke 1994) and one in the Czech Republic (Toman 1995). In all these animals the lead pellets lay in the tissue without any reaction thus giving evidence that the animals had been wounded a long period before being killed by a car.

In contrary to data for Germany (Stubbe *et al.* 1993), Finland (Skarén 1993) and the Czech Republic (Toman, pers. comm. and own observ.) no cases on otters killed in traps are presently known from Austria. Nevertheless there is strong evidence that otters are killed in different sorts of traps in Austria, too. Four leghold traps were found in an area of 36 km^2 during a survey of 139 fish ponds in Lower Austria in 1993 (Kranz 1994). Additionally another type of trap has been used in the Waldviertel (northern Lower Austria) recently. Pipes with a diameter of approximately 20 cm and a length of more than 100 cm which are closed at the end and filled with water are positioned in the ponds to keep an entrance through the ice in winter. Otters are suspected to use the pipe to get into the water. After having entered the pipe they cannot turn around and get drowned therein. Until now we cannot verify if this kind of trap was used successfully but it might pose a serious threat to otters.

The otter is fully protected by hunting law in all provinces of Austria since 1950 (Reuther 1980). Nevertheless our results of the necropsies revealed that at least some animals are killed illegally. The problem of fish loss in ponds in the Waldviertel is a well reported phenomenon (Bodner, 1994, 1995) and the acceptance of the otter in some parts of the local population is low. If the problem of fish loss in fish pond areas is not solved even an increase in numbers of illegaly killed otters has to be expected.

References

Bodner, M. 1994. Fischotter und Teichwirtschaft - vorläufige Ergebnisse des WWF-Projektes. Forschungsbericht Fischotter 2, 6-11.

Bodner, M. 1995. Fish loss in Austrian fish-ponds as a result of otter (*Lutra lutra*) predation. IUCN Otter Specialist Group Bulletin 12, 3-10.

Braun, A.-J. 1988. The otter in Brittany. IUCN Otter Specialist Group Bulletin, 3, 5-8.

Gutleb A.C. 1994a. Todesursachenforschung Fischotter. Grundlage für ein Schutzkonzept von *Lutra lutra* L. 1758 - Bericht für die Jahre 1990 - 1992. Forschungsbericht Fischotter 2, 12-25.

Gutleb A.C. 1994b. Todesursachenforschung Fischotter. Bericht an das WWF Forschungsinstitut.

Gutleb, A.C., Henninger, W., Loupal, G., Kranz, A. 1995. Evidence for illegal attempts to kill otters (*Lutra lutra*) in Austria. IUCN Otter Specialist Group Bulletin 11, 13-15.

Gutleb, A.C., Loupal, G., Henninger, W. 1997: Pseudarthrose des Os penis eines Fischotters (*Lutra lutra*). Proceedings 14. Marderkolloquium, Kouty, Tschechische Republik, 20-21.

Kranz, A. 1994. Otters increasing, threats increasing. IUCN Otter Specialist Group Bulletin 10, 28-30.

Kranz, A. 1995. Verbreitung der bayerisch-böhmisch-\österreichischen Otterpopulationen (*Lutra lutra*) 1994 in Österreich. Boku-Berichte 9, 1-25.

Kruuk, H., Conroy, J.W.H. 1991. Mortality of otters (*Lutra lutra*) in Shetland. J. Appl. Ecol., 28, 83-94.

Madsen, A.B., Kanstrup, N., Sögaard, B. 1994. Lead pellets in Danish otters *Lutra lutra*. In: Council of Europe (eds.): Otters - an action plan for their conservation. IUCN, Gland Switzerland, 29-40.

Miller, I., Gutleb, A.C., Kranz, A., Gemeiner, M. 1995a: Forensics on wild animals: differentiation between otter and pheasant blood using electrophoretic methods. Electrophoresis 16, 865 - 868.

Miller, I., Gutleb, A.C., Gemeiner, M. 1995b: Two-dimensional electrophoresis for the study of blood/serum proteins of the otter, an endangered species. Electrophoresis 16, 1193 - 1198.

Reuther, C. 1980: Zur Situation des Fischotters in Europa. In: Reuther, C., Festetics, A. (Hrsg.): Der Fischotter in Europa. Selbstverlag, Oderhaus und Göttingen.

Sainsbury, A.W., Bennett, P.M., Kirkwood, J.K. 1995. The welfare of free-living wild animals in Europe: harm caused by human activities. Animal Welfare 4, 183-206.

Skarén, U. 1992. Analysis of one hundred ottes killed by accidents in Central Finland. IUCN Otter Specialist Group Bulletin 7, 9-12.

Stubbe, M., Heidecke, D., Dolch, D., Teubner, J., Labes, R., Ansorge, H., Mau, H., Blanke, D. 1993. Monitoring Fischotter 1985 - 1991. Tiere im Konflikt 1, 11-59.

Toman, A. 1995. Ilegálni lov vydry rícní. Bull. Vydra 5, 67-69.

Zinke, O. 1991. Ein aktueller Nachweis illegaler Bejagung des Fischotters. Veröff. d. Museums d. Westlausitz, 17, 90-92.

OTTERS AND FISHERIES IN CENTRAL EUROPE WHAT IS THE PROBLEM

Andreas KRANZ, Ales TOMAN and Kevin ROCHE

In northern Austria and the south of the Czech Republic, otters have become a conflict species of major concern. On the one hand they are considered to be a pest at commercial fish ponds and stocked rivers and, on the other hand, otters are still a high priority species for conservationists.

As a consequence of this conflict, otters are killed illegally, both in Austria and in the Czech Republic. Three out of eight radio-tagged otters were killed by poachers, and traps are frequently found in the field. The actual annual loss due to poaching is estimated to exceed 100 individuals in southern Bohemia. Though poaching does not seem to have had a major effect on the population in the recent past, with the worsening economic situation of fish farmers in this region, illegal killing may be expected to increase and begin cause problems for the population in the very near future.

Reasons for the Conflict

- An increase in otter numbers.
- A different perception of levels and causes of damage by both conservationists and fisheries. Fish disappear, but that does not necessarily mean that they were eaten by otters. Relatively little is known of the true losses due to other fisheaters, such as mink, cormorants or herons, and even man, in the form of poachers. Further, many losses may be due to disease an poor water quality, e.g. fluctuations in pH, low o^2 or pollution, inparticular during the cold season (lethal stress to overwintering carp).
- A drop in fish prices, particularly as economic markets have become more open after 1989. Hungary, Poland and the Czech Republic all compete to export cheap fish (carp) to the European Community.
- Compensation payments for fish losses in ponds of northern Austria have tended to encourage an increase in the number and amount of claims. Otter damage is, by definition of this system of voluntary compensation payments, "any fish loss which cannot be explained by other reasons" (such as bad water quality, diseases etc.). The only connection with otters required is some evidence of presence, such as otter tracks or excrements; and potential other reasons are usually not checked consequently enough.
- The small size of many fish farming enterprises, particularly in Austria, results in an increased risk of high relative damage.
- Low experience in fish farming of new pond owners, both in Austria and in the Czech Republic. Following the political and economic changes in the former socialist countries since 1989, many ponds were returned to their former owners. However, many of these new fish farmers had little knowledge, or sometimes interest, in fish farming, resulting in many mistakes. Otters are often a convenient 'scapegoat' for such mistakes.
- In Austria, many pond owners seem to consider carp more as a pet than as a commercial product. This often results in inappropriate stocking levels that can lead to an increase in disease or even act as an extraordinary attractant to predators.
- Sport anglers on rivers are no longer used to competition. As otter numbers increase in rivers, and as otters tend to be the more efficient hunters, they may consume a considerable amount of the annual productivity (or stocked fish), which would otherwise be available for the sportsman.

How to Reduce Future Conflicts?

Fish in ponds may be considered as domestic animals and hence, they are the property of their owners. Fish in rivers, whether wild or stocked, however, cannot be said to be the property of those who have the right to fish there, though the right to fish has some value. When there are less fish due to otter predation, the value of the river will go down. Otters eat fish and, whether from fish ponds or rivers, conflicts are bound to occur when their is some financial loss.

However, as has been seen in Austria, financial compensation for fish losses is a dangerous road to follow. Any compensation payments directly to the fisheries must be avoided, at least in rivers. In ponds, if inevitable, the basis of any compensation payments for theoretical fish loss (damages) must be based upon the estimated number of otters, their daily food requirements and their diet composition (Czech compensation model and Saxon compensation practice), but not on fish losses of unknown causes.

Rather than pay such compensation payments, however, we would recommend that payments could be made towards habitat improvement for fish (spawning grounds, fish ladders, fish restocking), thereby improving the otters natural food sources and possibly reducing predation on species with economic value. Such measures not only take the edge from the conflict but also result in considerable benefits for the entire ecosystem. In addition, a public relations campaign, aimed particularly at the young but also to fish farmers and decision makers, should inform people about the otter, its status and possible means of reducing potential conflicts. As often as not, it is not the fault of the otter that conflict arises. Rather, it is human management practices, or ignorance of the habits of these animals, which creates, from an otter's point of view, nothing other than ideal feeding places.

It is clear that if the political decisions needed for otter management measures (such as translocation programmes or compensation schemes, etc.) are to be realistic and successful more knowledge is required in some areas than is available at present. There is a need for:

- identifying causes of fish mortality, in particular of overwintering carp
- quantifying otter numbers on a larger scale in river and pond areas
- a human dimensions study to identify the attitudes, wishes and knowledge of people in general, and of fish farmers and anglers in particular.

Indeed, this last point should be the basis for political decisions, not the agitation of pressure groups.

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