THE NEVER ENDING STORY

I remember the sunny morning when the participants of the VIIth International Otter Colloquium walked from the hotel to Trebon. Robert asked me whether I would like to join the group of editors, Jan Nel, himself and one more, at that time. I told him that I do not see any chance to do this in addition to my job and my voluntarily editorship of the IUCN OSG Bulletin. Robert – you convinced me to join the group as only 25% of the work had to be done by me as we were four. This assumption was a big mistake as I found out later. We shared the submitted manuscripts and were supposed to send the package of 25% to the reviewers and collate the answers. After a year when Robert, Jan and I had 75% of the manuscripts back from the reviewers we found out that our fourth colleague had not even started and even worse, was no longer interested.

So Robert and I took over the responsibility for these manuscripts. Then a lot of things happened, and the project seemed to become a never-ending story! Actually for various reasons not much was done for a while. It was at the Otter and Toxicological Conference on the Island of Skye (September 2000) that Jim Conroy asked me what was happening about the proceedings. Somehow this was my second mistake as I said, *O.K. lets do something.* I agreed to complete the editing and Jim was ready to do the corrections of the all manuscripts in respect to the language.

This was the status about 18 months ago and now finally you receive the Proceedings. I will not elaborate on what happened in these months, like PCs that crashed during this project, e-mails that were lost, authors that submitted six versions of the same manuscript within two days and reacted angrily when they got the wrong one returned for proof reading, lost slides, lost manuscripts, wrong e-mail addresses, and much more. But I also would like to apologize for some angry e-mails I sent when I lost the sight on the versions of manuscripts, and where it was my mistake.

Jim - I want to express my sincere thank to you as without you I would never have finished it! Robert - thanks for still going on when it was not easy for you. Jan – thanks a lot for the job that you have down far south!

After all this, I have to state, that in the future Proceedings of the Otter Colloquium must be produced immediately after the meeting (at least within 12 months) or not at all.

Nobody should ever, ever ask me again to help him/her in this job. I will most definitely decline.

To be honest this was a very frustrating job that I will never take over!

PREFACE

The VIIth International Otter Colloquium was held in Trebon, Czech Republic, from March 14 to 19, 1998, under the theme 'Otter Conservation - an example for a sustainable use of wetlands by man'.

The organization of the Colloquium was a joint effort of the IUCN Otter Specialist Group, the Czech environmental organization ENVI, and the German Aktion Fischotterschutz. The Colloquium was attended by 131 participants from 31 countries and included representative from all continents but Australia. There were 46 lectures and 49 posters concerning all species of otters.

The Colloquium really was a time for both hard work and good meetings. The first day included the meeting of the IUCN/SSC Otter Specialist Group (OSG), which included a presentation of Dr. Mariano Gimenez-Dixon (IUCN headquarters) commemorating the 50th anniversary of the IUCN and the role of the Species Survival Commission. Two of the main outcomes of the OSG meeting were the election of Claus Reuther as chairperson of the OSG, succeeding Padma de Silva, and the proposal for a revision of the Otter Action Plan (OAP).

Both at the OSG meeting and during the Colloquium, much time was spent discussing the OAP. The previous plan was ten years old and needed updating. Much has changed in those intervening years; progress having been made in several fields. There is, however, no room for relaxation and several otter populations and otter species around the world continue to be increasingly threatened.

Another result of the Colloquium was the formation of the Reintroduction Advisory Committee (RAC) for Europe, which will develop criteria for otter reintroduction projects. Other results included the initiative to set-up a website for the OSG.

As to the region where the conference took place, the Trebon Biosphere Reserve well fits the theme of the meeting. The region harbors a healthy population of Eurasian otters, which survives due to the presence of 500 fishponds (7,000 ha) within the Reserve, with an average annual harvest of fish (mainly carp) of 2,800 tonnes. Most of the fishponds of Trebon originated in the 14-16th century and have developed into shallow, semi-natural lakes. The complex of ponds is now listed as a Ramsar Site. With respect to this, recommendations of the Colloquium included that it should be accepted that otters do cause damages in fish farming areas, methods have to be found to minimize conflicts about this, and also that the Ramsar Convention Bureau be asked to include the presence of an otter population as one of the criteria for designating Ramsar sites.

The local organizers of the Colloquium and the editors are grateful for the continuing trust the OSG has had in us to complete the job. As to my co-

editors, Jan and Arno were always reliable and quick in doing their part. Jim, thanks - you jumped in to help us out when needed.

Financial support for specific participants to attend the Colloquium and for publishing these Proceedings were received from the International Fund for Animal Welfare, the Czech Rozmberk Society, Aktion Fischotterschutz and the Philadelphia Zoological Garden.

Finally, we would like to express our great appreciation for a group of people who never receive thanks but upon whom we depend so much. It is time to mention all those spouses, children, and friends who were often kept waiting for a long time because we needed just a few minutes more to finish our reports, articles or whatever, or went out into the night waiting for hours at a time to catch that one rare glimpse of an otter.

On behalf of the editors,

Robert Dulfer

WHY OTTER PEOPLE FROM ALL OVER THE WORLD DID COME TO THE CZECH REPUBLIC

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Environmental protection still concerns the basic needs of mankind. IUCN (International Union for Conservation of Nature and Natural Resources), the 'World Conservation Union', based in Gland/Switzerland, is one of the most important international organisations in this field.

IUCN's vision sounds simple but nevertheless is very ambitious: "*A just world that values and conserves nature.*" This is also true for the mission aiming at this vision: *"To influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable*."

IUCN was created in 1948. It is the world's largest conservation-related organisation, bringing together 76 states, 111 government agencies, 720 Non-Governmental Organisations (NGO), 35 affiliates, and some 10,000 scientists and experts from more than 180 countries in a unique world-wide partnership.

Work of IUCN is organised by six Commissions, which are established by the General Assembly:
- CEM - Commission on Ecosystem Management (~ 250 members)
- CEC - Commission on Education and Communication (~ 600 members)
- CEESP - Commission on Environmental, Economic and Social Policy (~ 350 members)
- CEL - Commission on Environmental Law (CEL) (~ 550 members)
- WCPA - World Commission on Protected Areas (~ 1,300 members)
- SSC - Species Survival Commission (~ 6,800 members)

The Species Survival Commission (SSC) is the largest commission of IUCN. Its vision is: "*A world that values and conserves present levels of biodiversity, within species, between species and of ecosystems*". Its goal is described as: "*The extinction crisis and massive loss in biodiversity are universally adopted as a shared responsibility, resulting in action to reduce this loss of diversity within species, between species and of ecosystems*".

The administration of SSC is carried out by the Chair with a Steering/Executive Committee, which has 15 members, providing a geographical and interdisciplinary balance, each responsible for providing direction to a portion of the extended network of Specialist Groups and Task Forces.

SSC maintains a network of over 100 Specialist Groups, which include scientists, conservation professionals and dedicated lay conservationists. These Groups are organized to provide broad coverage of taxonomic groups of animals and plants, as well as important inter-disciplinary conservation methodologies. Specialist Groups constitute the main work unit of SSC, providing the expertise, breadth, and commitment that drives SSC and makes its achievements possible.

One of these Specialist Groups is the IUCN/SSC Otter Specialist Group (OSG). Members of the group are appointed by the Chair of the group for a three year period at a time. Until 1998 the group was chaired by Prof. Padma Kumari de Silva from Sri Lanka. In this task she was assisted by six co-ordinators concerned with special regions or themes of importance to otter conservation. The basis for the working of this Specialist Group is the so called 'Otter Action Plan', which was published in 1990.

In addition to personal communications, the Group has two main platforms to facilitate exchange of information. One concerns the publication of the 'Otter Specialist Group Bulletin' which is published twice a year by Dr. Arno Gutleb (Austria/The Netherlands) and which gives the opportunity to present the latest scientific results as well as identify the problems of and solutions for otter conservation world wide. The second is the International Otter Colloquium (IOC).

When I organised the first International Otter Colloquium in Göttingen (Germany) in 1979 and founded this conference series I did not expect that it would develop into such an important tool for otter conservation. IOC-I brought together nearly 100 people from 14 - mainly European - countries (REUTHER and FESTETICS 1980). The first step to become a world wide meeting was taken at IOC-II, which was held in Norwich (United Kingdom) in 1981 and organised by Philip Wayre (JESSOP 1983/1984). Among the some 50 participants from eight countries for the first time conservationists from U.S.A. and Asia could be welcomed there. IOC-III, held in Strassbourg (France) at the Council of Europe in 1983 and organised by Nicole Duplaix and Christian Kempf, brought together 121 participants from 23 countries - for the first time also Africa was represented at this colloquium. When IOC-IV was held in Santa Cruz (U.S.A) in 1985, Pat Foster-Turley, Chair of OSG at that time and organiser of this colloquium, could welcome 83 participants from 15 countries - for the first time also including Latin America. At this meeting it was decided to alter the interval of the colloquium from two to four years. More than 130 participants from 36 countries attended IOC-V, held at the Otter Centre in Hankensbüttel (Germany) and covering all continents hosting otters (REUTHER and RÖCHERT 1991). It was at this conference that the plan arose to have the next colloquium in Latin America. Because of several circumstances this intention was not practicable. Due to the courage of David Rowe-Rowe it was possible to shift IOC-VI at the last minute to Pietermaritzburg (South Africa). 60 scientists and conservationists representing 22 countries attended this event (REUTHER and ROWE-ROWE 1995). Again it was intended to have the next IOC in 1997 in Latin America. However, as a result of organizational problems, it was decided by the coordinators of OSG in November 1996 to change this plan and to hold the next colloquium in Europe. In early summer 1997 the final decision was made for Trebon, in the Czech Republic. Then it was too late to keep the colloquium within the customary four-years interval and so it had to be postponed to the spring of 1998. One of the preconditions for this decision was the stroke of luck that Robert Dulfer agreed to take over most of the organisational work, supported by ENVI, a Czech conservation institution, and by the German Aktion Fischotterschutz.

The decision to settle on Trebon was made not only because of the fact that most members of OSG are Europeans, and that there are interesting projects on otters being carried out in this place. It was also felt that Trebon offered a splendid place to focus the interests of otter specialists as well as those of the general public on the conflict between otter conservation and activities of man. Otters are an excellent symbol for all the wetlands throughout the world, except the Polar and the Australasian regions. They are the top predators whose only enemy is man. Otters are being threatened not only by such human activities as hunting, poaching, use of pesticides and spilling of oil, etc., but more importantly they are being endangered by the destruction of their habitats.

While looking for possibilities to ensure the long-term survival of the 13 species of otters across their geographic distribution, the specialists came to realize that the mere establishment of protected areas alone will not be enough. Otters inhabit a variety of wetlands and they, being top carnivores, need large territorial space. It seems unrealistic to protect so many species and so large areas to ensure the genetic continuity between populations. We need to find measures to ensure the survival of otters that are outside the protected areas as well. This will be the greatest challenge facing all otter specialists in the years to come. We need to develop strategies that would promote the co-existence of humans and otters. This objective goes well with the principles enunciated at the 1992 Rio World Summit - for a Sustainable Development.

Discussions on how these principles could be integrated into activities commensurate with otter survival and conservation were planned to be one of the main topics at the Trebon colloquium. Therefore the motto of this meeting was: "*Otter conservation - an example for a sustainable use of wetlands by man*".

Trebon seemed to be a good place to develop feasible strategies for otter conservation. The region is dominated by the fish-pond industry and is one of the areas in Europe that holds viable populations of otters. The conflicts between economy and ecology are evident here. It was expected that most of the otter specialists from throughout the world attending IOC-VII would have similar problems in the minds. Therefore, Trebon should offer a good venue for a frank and fruitful exchange of views, based on years of experience in conserving and managing otters. It was hoped that the results from this colloquium would be beneficial to both parties: guests from all over the world, and the hosts in the Czech Republic.

These expectations were not disappointed. One hundred and thirty one participants from 34 countries attended IOC-VII. Presentations, discussions and workshops covered all otter species, all geographical regions and a wide variety of themes connected with otter conservation and nature conservation in general. Numerous recommendations were one of the visible outcomes of this meeting. They will form part of the basis for the work of OSG for the years after Trebon.

When I accepted at this Trebon colloquium to take over the chairmanship for OSG I announced three main goals for the work of this group for the period until the next IOC:

I. the preparation of a manifesto for the OSG, defining the fundamental goals of otter protection and the preconditions for a sustainable co-existence of otters and man on the basis of suitable habitats,
II. the revision of the global Otter Action Plan,
III. the establishment of an information network within OSG as well as between the OSG and specialists or institutions outside the otter world.

The basis for these three tasks was formed in Trebon.

If such an event happens in a collegial, cordial and familiar atmosphere and results in so many fruitful discussions and path-breaking decisions this is a proof for a good preparation and organisation work. The credit for this goes especially to Robert Dulfer and Marie Prchalova who were responsible for most of the work behind the scenes before and during the colloquium. However, all the Czech hosts merit a warm thanks for their hospitality.

An important outcome of such an event are always the proceedings. They not only reflect the programme and the contents of the colloquium. They also reflect the state of our knowledge and the needs for further studies or activities. It is always difficult to find people who are prepared to take over the responsibility for the editorship of such proceedings. As more we have to thank Robert Dulfer, Arno Gutleb, Jan Nel and Jim Conroy that they ensured the publication of these proceedings of the VII. International Otter Colloquium held in March 1998 in Trebon/Czech Republic.

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THE DIET OF *Lutra canadensis* IN THE UPPER COLORADO RIVER SYSTEM

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Abstract: The North American river otter was reintroduced into the headwaters of the Colorado River in Rocky Mountain National Park between 1978 and 1984, after it was extirpated from the Park and declared a Colorado state endangered species. Estimates from biannual winter otter surveys since 1992 indicate that 15 to 17 individuals inhabit this portion of the river system. This population became the concentration for the current project, which began in 1992 and continued for five years. Its purpose was to collect and analyze scats (faeces) to determine the species' diet. Thirty-six percent of the diet consisted of prey from the Catostomidae, 23% from the Salmonidae, 34% crayfish and 7% other fish families and invertebrates. Seasonal trends showed crayfish dominated in the diet during the summer months and the non-game Catostomidae was evenly distributed throughout the seasons.

INTRODUCTION

The food habits of the North American river otter (*Lutra canadensis*) have been studied in a number of locations throughout North America. They were summarized by TOWEILL and TABOR (1982) and later by MELQUIST and DRONKERT (1987), with more recent studies having been conducted by SERFASS et al. (1990) and MACK (1994). The current project will add additional information about the otter's diet for a different segment of the continent.

STUDY AREA

The study area comprised a 26 km stretch of the headwaters of the Colorado River, its tributaries and major drainages in Rocky Mountain National Park, and waterways in adjacent sections of the Arapaho National Forest in the state of Colorado, west-central part of the United States (40^0 30′ N; 106^0 W). The terrain was mountainous with valley habitat ranging in elevations from 2530 to 2750m. The riparian vegetation along this portion of the Colorado River is classified as shrub/grass with the main shrub being willow (*Salix* spp.) and lesser amounts of alder (*Alnus tenuifolii*) and dog birch (*Betula glandulosa*) plus many associated grasses (MACK, 1985). There were stretches in the study area of lodgepole pine (*Pinus contorta*) with either sparse or dense understory components. The temperatures during trekking ranged from -25 to +25^o C.

The most abundant fish found in the upper Colorado River and its drainages are represented by four families: Salmonidae - five species; Catostomidae - two species; Cyprinidae - one species; and Cottidae - one species (MACK, 1985). There are various other vertebrates and invertebrates, including crayfish, which are found in at least the southern portion of the study site.

MATERIALS AND METHODS

The study was conducted by walking the study site throughout the seasons. Telemetry was not used. A total of 1652 field hours were spent in the study area. Scats (faeces) were collected where found during the survey from April into December for 1993 through 1996. Scats were rarely found during the winter months (21 December - 20 March) due to snow conditions, so this season was under-represented and is therefore not included in the results. The three seasons when scats were collected and analyzed were: spring (21 March - 20 June), summer (21 June - 20 September) and autumn (21 September - 20 December). There were two portions of the study area where scats were found most often, one in the main river system, the other an adjacent system of Monarch Lake and Arapaho Creek. When collecting, each scat was bagged individually and labeled with date, location, condition of scat, terrain, weather, and substrate where found. The contents were air-dried, then cleaned with a solution of water and dental cleaner, washed through a sieve and placed in individual containers. Fish were classified by family using vertebra, jaws, pharyngeal arch, and scales, which followed information from CONROY et al. (1993) and the author's fish collection. Crayfish exoskeletons and the general category of insects were easily identified. When there was evidence of more than one category of prey in an individual scat, all items from each prey were separated. Then the relative frequency of each prey category (i.e. the total number of occurrences of all prey items) was compared to the total number of items for all prey categories. The percentages totalled 100%.

RESULTS

Ninety-eight scats collected from eight different locations over the four year period were analyzed (26 were collected during the spring, 42 during the summer and 30 during the autumn). Fifty-one percent of the scats came from the Colorado River system and 49% from the adjacent system. Fifty percent were found on boulders, either in the water or on the shoreline; 41% were found on the ground up to 9m inland; and nine percent were found on logs or log-jams jutted out into the water. Otter trails led to those found inland.

Species from two families of fish dominated the river otters' diet, Catostomidae and Salmonidae. Thirty-six percent of the prey items were from Catostomidae, 23% from Salmonidae, 7% from the other fish families and insects, and 34% from crayfish. There were no bird, mammal or amphibian bones found in the collected scat (Fig. 1).

Seasonal trends of prey in the otter's diet were: spring - Catostomidae 11%, Salmonidae 13%, Other 3%; summer - Catostomidae 11%, Salmonidae 4%, Crayfish 26%, Other 2%; and autumn - Catostomidae 14%, Salmonidae 6%, Crayfish 8%, and Other 2% (Fig. 2). (The percentages for each season and prey item are based on the total number of analyzed scats.)

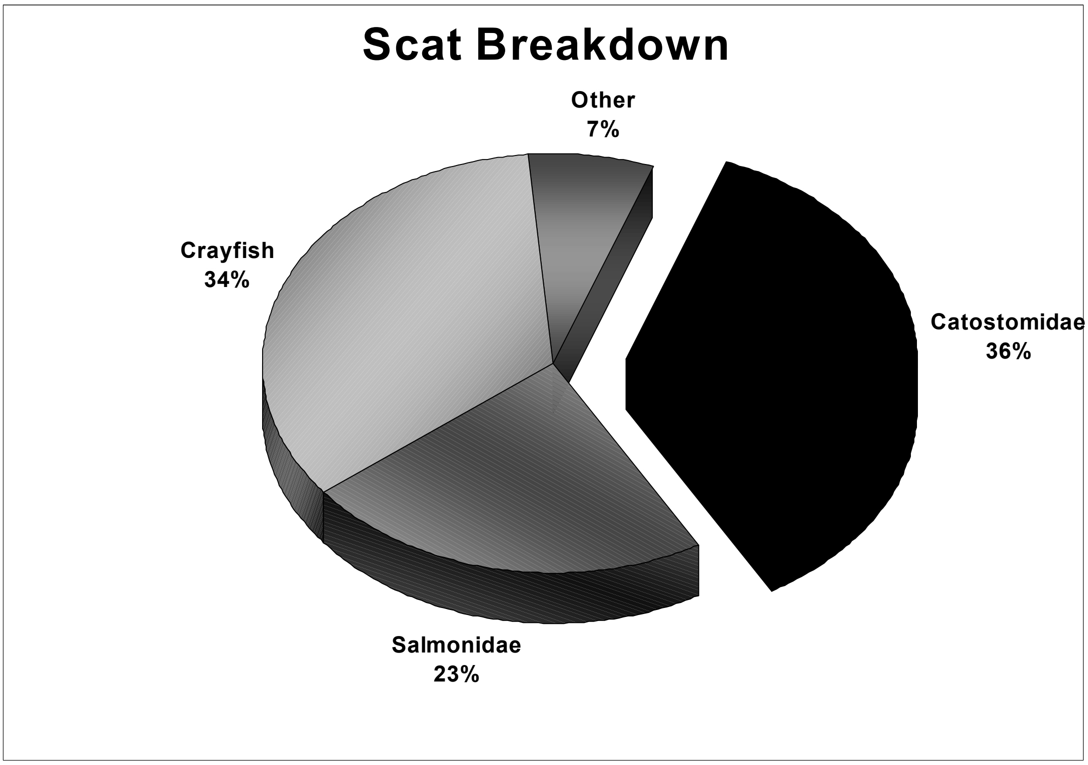

Figure 1. The diet of river otters in the upper Colorado River basin for the years 1993 – 1996. The percentages are based on a relative frequency analysis of 98 scats.

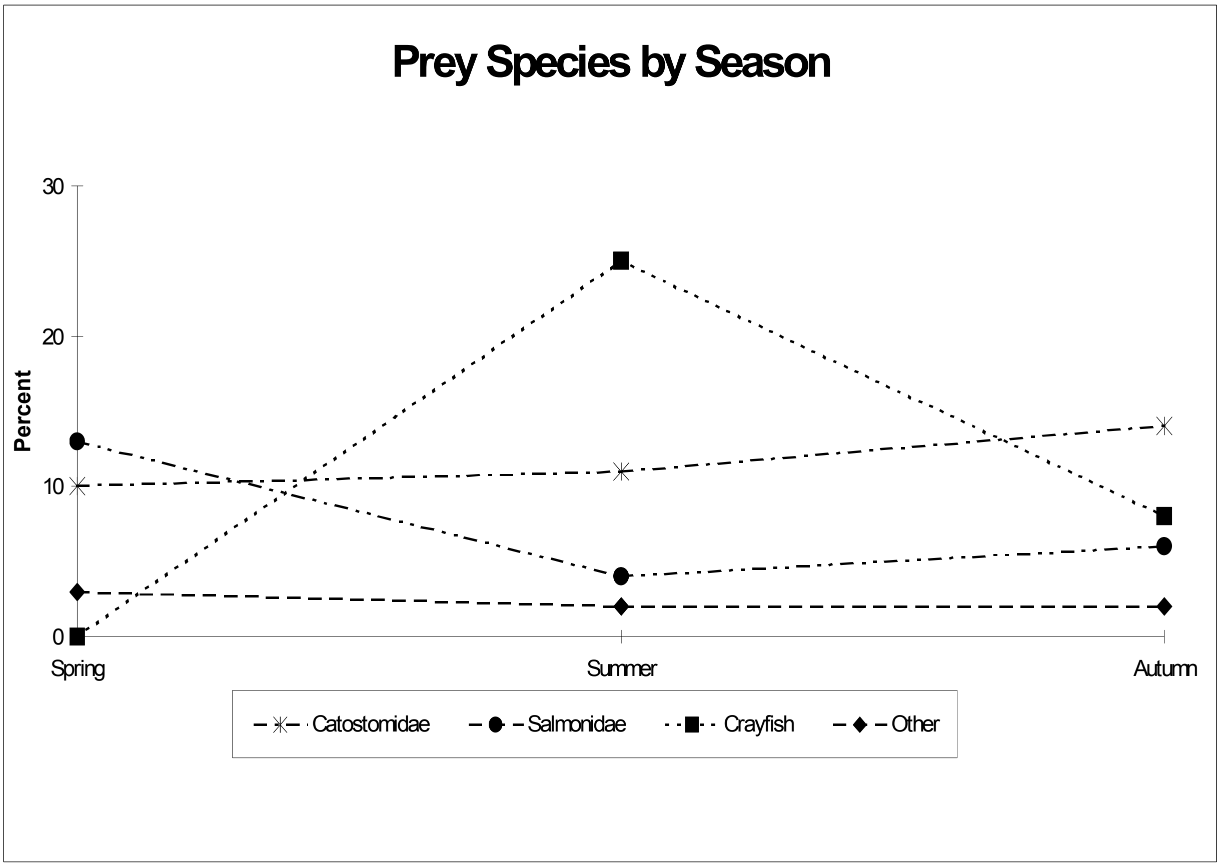

Figure 2. Seasonal trends in the diet of river otters in the upper Colorado River basin for the years 1993 – 1996. Percentages of each category and each season are based on the total number of analyzed scats.

CONCLUSIONS

1. The results of the survey of the upper Colorado River system showed that 15 to 17 river otters may eventually be present in the study area.

2. Fish were the major component of the river otter's diet, with crayfish dominant during the summer months. These findings are consistent with other otter food habit studies conducted in North America (TOWEILL and TABOR, 1982). The non-game fish species from the Catostomidae family dominated the otter's diet. This substantiates findings from other areas of the country that otters primarily take the slower moving forage fish species, such as Catostomidae, compared to the faster moving game species, such as Salmonidae (TOWEILL and TABOR, 1982; MELQUIST and DRONKERT, 1987; SERFASS et al., 1990; MACK, 1994).

Acknowledgements - I thank the staff and volunteers in the West Unit of Rocky Mountain National Park for their help in the survey, and, especially Jim Capps, District Interpreter, for his assistance and encouragement. I extend a special thank you to David Berg for all his support.

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REQUIREMENTS OF THE CAPE CLAWLESS OTTER (*Aonyx capensis*) AND THE SPOTTED-NECKED OTTER (*Lutra maculicollis*) IN THE NATAL DRAKENSBERG (SOUTH AFRICA)

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Abstract: Factors affecting the presence of two coexisting species of otter, the Cape clawless otter and the spotted-necked otter were studied in protected and unprotected areas of the Natal Drakensberg. Area requirements (in terms of length of river per individual), habitat characteristics and prey availability, were investigated. Otter diets were investigated by the analysis of scats. The Cape clawless otter’s diet comprised primarily crabs, supplemented with amphibians, insects and fish in low numbers. They preyed on a smaller variety of food items than the spotted-necked otters. The Cape clawless otter appeared to be more specialised and demanding, owing to its morphological adaptations. The spotted-necked otter fed on fish and crabs as primary food items, with frogs and insects taken in substitution of the fish diet in winter. They were more opportunistic and adaptable to many food resource conditions than the Cape clawless otter. However, being more piscivorous than the Cape clawless otter, they were also closer linked to habitats characterised by presence of water occurring all year around, where the food availability was more constant during the year. Both species selected riverine habitat characterised by rocks and dense bushy vegetation. Protected areas, characterised by dense vegetation cover, little environmental degradation and low levels of human disturbance, were the areas in which a greater number of Cape clawless otters and spotted-necked otters occurred. Food resources appeared to be particularly important for the presence of the spotted-necked otter, as the species was more concentrated where fish availability (trout) was high.

INTRODUCTION

Current information on the distribution and status of the two species of otters occurring in South Africa (ROWE-ROWE, 1992) indicates that both species, the Cape clawless otter (*Aonyx capensis*) and the spotted-necked otter *(Lutra maculicollis*), have declined in Kwa-Zulu Natal during the past 15 years when compared with data from earlier distribution records (ROWE-ROWE, 1977). In South Africa, the spotted-necked otter is the rarer species, being confined to fragmented inland waters in the eastern part of the country, whereas the Cape clawless otter is more common, but is also restricted to the eastern half of the country and along the south coast. Although Cape clawless otters have been reported from 50% of Kwa-Zulu Natal's protected areas and spotted-necked otters from 20%, many of these protected areas are small, and in many, the occurrence of otters is temporary (ROWE-ROWE et al., 1994).

The specific aims of this project were to identify habitat and prey availability, and the ecological requirements of each otter species, with particular reference to the length of stream necessary to support an individual. Such information is essential to provide management recommendations to benefit otter populations and their habitat, both within and outside protected areas of the Natal Drakensberg.

STUDY AREAS

The study was conducted in three areas (Cobham, Loteni and Kamberg Nature Reserves), which form part of the 240,000 ha Natal Drakensberg Park in western KwaZulu-Natal (South Africa), and in adjacent farmland.

All the areas occurred in the highland bioclimatic region, where, in the protected areas, the environment was represented by natural riverine habitat with dense vegetation cover along the river banks. In Kamberg Nature Reserve the upper section of the river (Gladstone's nose) included a fishing resort and a trout hatchery, and was characterised by the presence of six dams and adjacent swamps, whilst oxbows lakes and swamps characterised the lower section (Stillerust). The unprotected area, situated between these two sections, consisted of a single large farm (Riverside farm) and a village (Tendele). The habitat was represented by monoculture for pastures, dairy cattle and subsistence farming.

METHODS

To study the habitat requirements and the feeding ecology of both species of otter, data were collected monthly from March 1993 to February 1994 by surveying 5 km stretches of river banks in each study area within 10 m from the water's edge. The survey methods followed standard procedures (e.g. MASON and MACDONALD, 1986; JENKINS and BORROWS, 1980; KRUUK et al., 1986) and positive identification of a species' presence was based on descriptions and data published by ROWE-ROWE (1992).

The use of the habitat by the Cape clawless otter and the spotted-necked otter was studied considering the habitat features of the river banks where signs of presence of each species of otter occurred (e.g. sprainting sites, rolling places, resting sites, holts). The chi-square analysis and the Bonferroni confidence intervals were used to test for the selection or avoidance of the habitat types considered (dense vegetation cover, short grass, alluvium, and emerging rocks associated to bush). Other environmental characteristics examined were the factors affecting the presence of the otters in relation to habitat quality, such as human disturbance and environmental degradation. The density of otter sites and number of individuals for each study area were estimated by counting otter signs of presence, through direct observations of the animals, and considering the size and number of scats and tracks found during each survey session (CARUGATI, 1995). Diet was investigated by analysing the faeces following standard procedures (WEBB, 1976). To generalise the results the five study areas were pooled into two groups: protected and unprotected areas.

RESULTS

DISTRIBUTION

In protected areas signs of presence of otters were found in 121 sites for the Cape clawless otters and 86 for the spotted-necked otters. Only 11 positive sites of Cape clawless otters were found in the unprotected areas, while for spotted-necked otters no signs were recorded. In protected areas the Cape clawless otter and the spotted-necked otter selected natural riverine habitat consisting of river banks covered by tall grass, bush, shrub and reed, or emerging rocks covered by dense vegetation (Table 1).

Table 1. Bonferroni confidence intervals for the habitat selection of the sprainting sites of the Cape clawless otter (n=102) and spotted-necked otter (n=66).

Cape clawless otter							
River banks type	A	Pa	O	E	Pu	Bonferroni Confidence Intervals	
Dense vegetation	22684	0.61	49	61.71	0.48	0.33 < Pa < 0.63	ns
Short grass	9501	0.25	10	25.85	0.10	0.02 < Pa < 0.19	--
Alluvium	3105	0.08	9	8.45	0.09	0.05 < Pa < 0.17	ns
Emerging rocks and bush	2205	0.06	34	6.00	0.33	0.19 < Pa < 0.47	ns
Total	37495	1	102	102	1		
Spotted-necked otter							
River banks type	A	Pa	O	E	Pu	Bonferroni Confidence Intervals	
Dense vegetation	22684	0.61	36	39.93	0.54	0.37 < Pa < 0.73	ns
Short grass	9501	0.25	3	16.72	0.05	0.03 < Pa < 0.13	--
Alluvium	3105	0.08	7	5.47	0.11	0.05 < Pa < 0.22	ns
Emerging rocks and bush	2205	0.06	20	3.88	0.30	0.13 < Pa < 0.47	+
Total	37495	1	66	66	1		

A: availability of river bank type; Pa: Proportion of availability; O: Number of sites found in each river bank type; E: expected number of signs; Pu: proportional use of banks type

Sites with stones, gravel and short grass were used less frequently than other grounds. No significant differences were observed between the two species in the proportional use of the bank types. In unprotected areas all the sites were found in stretches of river bank covered by dense vegetation.

The main causes of habitat degradation, recorded mainly in the village area, were the presence of solid rubbish in the river and along the banks, traces of foam and oil in the water and open sewage flowing directly into the river. The lack of vegetation cover was caused by agricultural practices as well as by the presence of cattle trampling the vegetation to the river's edge. The major causes of disturbance were the presence of dwellings, people constantly using the river and roads running close to the river. Seasonally, in protected areas, the massive presence of tourists along the river banks was also disruptive for the otters, mainly when people stationed all day long near by sites frequented by the two species (such as resting places). Planted pastures and monocultures reducing the landscape diversity (Shannon-Weaver index

H=0.2), combined with a high level of habitat degradation and different forms of disturbance were identified as the features affecting negatively the presence of otters.

To favour wild and domestic grazers, high-veld grasslands are burned in large patches at least once a year (mainly during winter months). Another cause of disturbance to otters was the burning of the vegetation right to the river's edge. The river banks of protected areas were burned from July to October. The worse effect was registered in October 1993 at Kamberg Nature Reserve (Stillerust section) when more than half of the study area (including both river banks for a length of about 3 km) was burned. The number of sites of presence of both otter species decreased from 26 to nine sites. The higher decrease was recorded for the Cape clawless otter (from 10 to 3 sites). The density estimation of otter sites and number of individuals for each study area are presented in Table 2.

Table 2. Numbers of spraint sites of Cape clawless and spotted-necked otters recorded in each study area. Main spraint sites represent the sites used more than three times. The density is expressed as number of spraint site and number of otters occurring along 1 km of river bank.

Cape clawless otter				
Study areas	N. of sites	N. of main sites	site density/km	otter density/km
Cobham	27	9	5.4	0.3
Loteni	41	17	8.9	0.6
Stillerust	27	10	5.8	0.6
Gladstone’s nose	26	8	5.4	0.4
Unprotected area	11	5	1.8	0.4
Spotted-necked otter				
Study areas	N. of sites	N. of main sites	site density/km	otter density/km
Cobham	12	2	2.5	0.2
Loteni	19	2	4	0.4
Stillerust	23	8	5	0.7
Gladstone’s nose	31	5	6.5	1
Unprotected area	0	0	0	0

Numbers of individual per km were extrapolated by combining the outcomes of the different methods applied, such as scat and track size, number of scats and sprainting sites, as well as direct observation on the animals (CARUGATI, 1995). The highest number of sites and number of individuals of Cape clawless otter per km was recorded at Loteni and Stillersut areas. Spotted-necked otter density was higher at Gladstone’s nose area.

DIET

The diet of the two species of otter was investigated by the analysis of 735 scats of Cape clawless otter and 516 scats of spotted-necked otter. Diet composition is shown in Table 3, presented numerically and as relative frequency of occurrence (RF%) of each prey item.

The Cape clawless otter was primarily a crab eater, supplemented with amphibians, insects and fish in low numbers. The spotted-necked otter was a fish eater, supplemented by crabs and amphibians (similarly represented with 25% of RF), and insects. Minor items for both species of otter were mainly small mammals and waterside birds. Significant differences in the use of prey categories between the two species of otter (χ^2= 339.11: P<<0.001: $n_{1,2}$=7;

df=6) were found. Niche breadth was wider for the spotted-necked otter (Levin's B =0.72), than the Cape clawless otter (Levin's B =0.47).

Table 3. Summary of food items recorded in scats of cape clawless otter and spotted-necked otter. Collection of scats took place between March 1993 and February 1994

	Cape clawless otter				**Spotted-necked otter**	
	Unprotected areas		Protected areas			
Prey items	n=79		n=656		n=516	
	Actual	RF%	Actual	RF%	Actual	RF%
CRAB	68	48	597	58	222	25
FISH	3	2	109	11	330	37
Barb (*Barbus spp*.)	1	1	15	1	115	13
Scaly fish (*Barbus natalensis*)	-	-	7	1	13	1
Trout (*Salmo trutta - Oncorhyncus mykiss)*	2	1	79	8	192	22
Fish unidentified	-	-	8	1	6	1
AMPHIBIANS	44	31	147	14	221	25
Frog (*Rana* spp.)	21	15	101	10	179	20
Clawed toad (*Xenopus laevis)*	16	11	17	2	15	2
Amphibians unidentified	7	5	29	3	27	3
INSECTS	25	17	134	13	95	11
Coleoptera	3	2	12	1	22	2
Odonata (larval)	22	15	122	12	73	8
OTHER	-	-	32	3	20	3
Dung	-	-	31	2.99	6	1
Other vertebrates (reptiles, birds, mammals)	-	-	1	0.01	14	2

DISCUSSION

The large number of signs of each otter species was associated with high levels of habitat variety, dense vegetation cover on river banks, food availability and low levels of disturbance and habitat degradation.

Cover, in the form of unburned and undisturbed grass or bush, on at least one bank of the river, appeared to be particularly important for both otter species. D'INZILLO CARRANZA (1997) mentions that spotted-necked otters spend 60% of their time on land, a figure, which might be similar for the Cape clawless otter. The presence of dense vegetation, in terms of thick underbush, is very important in providing shelter during periods of "inactivity". Veld burning appeared to have a marked negative effect on otters. This practice is common in both protected an unprotected areas; the impact of fires is temporary but important in maintaining the high-veld ecosystem. However, fires may remove critical resources, such as underbush, needed by otters. It is thus recommended that along the major rivers of the Natal Drakensberg Park, both banks are not burnt during the same year. If the larger rivers are used as firebreaks between burning blocks, the biennial burning of the opposite banks should be practised.

In the unprotected areas, the extensive monoculture, the exploitation of the land to the river's edge, the absence of vegetation covering the river banks and general environmental degradation seem to be the main negative factors affecting the presence of otters. Differences in the occurrence of the two species of otter were evident even within the protected areas. Cape clawless otters occurred widely throughout the protected areas, whereas the spotted-necked otters, were numerous where the availability of the food resources (mainly trout) was highest, such as at the trout hatchery of Gladstone's nose.

The different feeding habits of the two species, described also by ROWE-ROWE (1977), likely play an important role in habitat partitioning. Cape clawless otter, which has particular morphological adaptations, is a crab eater. It is more specialised and has a narrower trophic niche breadth than the spotted-necked otter. Due to this peculiarity the Cape clawless otter might be the more vulnerable species. Nevertheless, the spotted-necked otter, being mostly piscivorous, is linked to habitat characterised by continuous presence of water, where food availability is more predictable during the year.

The availability of different kinds of food is an important factor influencing otter feeding habits and their presence in the area (CARUGATI, 1995).

Protected areas, characterised by dense vegetation cover, scarce environmental degradation and low levels of human disturbance, were the areas in which larger number of Cape clawless and spotted-necked otters occurred. A proper management of the stretches of river flowing through unprotected areas, such as protecting the river banks from cattle trampling, improving vegetation cover, limiting human disturbance, avoiding pollutant sources in rivers, would amplify the suitable habitat for otters and serve as corridor between the areas where they occur.

Acknowledgements - I thank with particular emphasis, for the great enthusiasm, support and useful comments provided during the compilation of the entire research Dr Dave Rowe-Rowe (of the Natal Parks Board) project co-ordinator. Particular acknowledgements are addressed to the Endangered Wildlife Trust of South Africa and the University of Natal having financially supported the research. The Natal Parks Board provided for the accommodation and the facilities in the field.
I also would like to thank the Department of National Education in Pretoria and the Italian Bureau of International Affairs having granted me the opportunity to come in South Africa and to conduct this project.

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HABITAT, PREY AND AREA REQUIREMENTS OF OTTERS (*Aonyx capensis*) AND (*Lutra maculicollis*) IN THE NATAL DRAKENSBERG (SOUTH AFRICA)

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Abstract: Factors affecting the presence of two coexisting species of otter (*Aonyx capensis* and *Lutra maculicollis*) were studied in protected and unprotected areas of the Natal Drakensberg Park. The aim of the project was to identify those sections of the Park, that can be managed to benefit each otter species both within protected and unprotected areas. Area requirements (in terms of length of river per individual), habitat characteristics and prey availability, which influence the abundance of otters, were investigated. Both otter species selected riverine habitat characterised by rocks and dense bushy vegetation, whereas stones, gravel and short grass, were used less frequently. Most of the holts and resting sites were found where dense vegetation occurred. Otter diets were investigated by the analysis of scats. The Cape clawless otters diet comprised primarily of crabs, supplemented with amphibians, insects and fish in low numbers. They preyed on a smaller variety of food items than the spotted-necked otters. The Cape clawless otter appeared to be more specialised and demanding, owing to its morphological adaptations. The spotted-necked otter fed on fish and crabs, as primary food items, with frogs and insects taken in substitution of the fish diet in winter. They were more opportunistic and adaptable to many food resource conditions than the Cape clawless otter. However being more piscivorous than the Cape clawless otter, they were also closer linked to habitats characterised by permanent water, where the food availability was more constant during the year. Protected areas, characterised by dense vegetation cover, little environmental degradation and low levels of human disturbance were the areas in which a greater number of Cape clawless otter and spotted-necked otter occurred. Food resources appeared to be particularly important for the presence of the spotted-necked otter, as the species was more concentrated where fish availability (trout) was abundant.

INTRODUCTION

Current information on the distribution and status of the two species of South African otters (ROWE-ROWE, 1992) indicates that both species, the Cape clawless otter (*Aonyx capensis*) and the spotted-necked otter *(Lutra maculicollis*), have declined in Kwa-Zulu Natal during the past 15 to 20 years relative to earlier distributional records (ROWE-ROWE, 1977). In South Africa, the spotted-necked otter is the rarer species, being confined to fragmented inland waters in the eastern part of the country, whereas the Cape clawless otter is more common, but is also restricted to the eastern half of the country and along the south coast. Although Cape clawless otters have been reported from 50% of Kwa-Zulu Natal's protected areas and spotted-necked otters from 20%, many of these protected areas are likely to be small, and in many otters occur only temporary (ROWE-ROWE et al., 1994).

The specific aims of this project were to identify the ecological requirements of otters, particularly habitat and prey availability, and the length of stream per individual. Such information is essential to provide management recommendations to benefit otter populations and their habitat, both within and outside protected areas of the Natal Drakensberg.

STUDY AREAS

The study was conducted in three areas, which form part of the 240 000 ha Natal Drakensberg Park in western KwaZulu-Natal, and adjacent farmland. In the park data were collected from 5 km stretches of the Polela and Loteni rivers at Cobham and Loteni Nature Reserves, and from 15 km of the Mooi River separated in three different sections of 5 km each. The upper and lower section of the Mooi River were part of Kamberg Nature Reserve. The upper section (Gladstone's nose) included a fishing resort and a trout hatchery, and was characterised by the presence of 6 dams and adjacent swamps, whilst oxbows lakes and swamps characterised the lower section (Stillerust).
The river flowed through an unprotected area (farmland and village) situated in between the two over mentioned sections.

METHODS

In order to study the feeding ecology, the habitat characteristics and the features of the sites frequented by the otter (e.g. sprainting sites, rolling places, resting sites, holts), data were collected monthly from March 1993 to February 1994 by surveying the river banks within 10 m from the water's edge. Other environmental characteristics considered were the factors affecting the presence of the otters, in relation to habitat quality (e.g. human disturbance and environmental degradation). To generalise the results the five study areas were pooled in to two groups: protected and unprotected areas.

RESULTS

In the protected areas the presence of Cape clawless otters was recorded at 121 sites, while spotted-necked otters were recorded at 86. Only 11 sites of presence of Cape clawless otters were found in the unprotected areas, while spotted-necked otters were never recorded. The density of otter sites and number for each study area are presented in Table 1. Data have been estimated by using signs of presence, (e.g. size and numbers of scats and tracks, rolling and resting places) and direct observations of animals.

In protected areas the Cape clawless otter and the spotted-necked otter selected natural riverine habitat consisting of river banks covered by tall grass, bush, shrub and reed, or emerging rocks covered by dense vegetation. The chi-square analysis and the Bonferroni confidence intervals were used to test for the selection or avoidance of habitat types (Table 2). No significant differences were observed between the two species in the proportional use of the bank types.

In unprotected areas all the otter sites were found in the limited stretches of river bank covered by dense vegetation.

Table 1. Density of otter sites

Study areas	N. of sites	N. of main sites	site density/km	otter density/km
Cape clawless otter				
Cobham	27	9	5.4	0.3
Loteni	41	17	8.9	0.6
Stillerust	27	10	5.8	0.6
Gladstone's nose	26	8	5.4	0.4
Farmaland	11	5	1.8	0.4
Spotted-necked otter				
Study areas	N. of sites	N. of main sites	site density/km	otter density/km
Cobham	12	2	2.5	0.2
Loteni	19	2	4	0.4
Stillerust	23	8	5	0.7
Gladstone's nose	31	5	6.5	1

Table 2. Habitat types

River banks type	Avail-ability	Proportion of availability	Observed	Expected	Proportion of use	Bonferroni Confidence Intervals
Cape clawless otter						
Dense vegetation	22684	0.61	49	61.71	0.48	$0.33 < P < 0.63$ ns
Short grass	9501	0.25	10	25.85	0.10	$0.02 < P < 0.19$ -
Alluvium	3105	0.08	9	8.45	0.09	$0.05 < P < 0.17$ ns
Emerging rocks and bush	2205	0.06	34	6.00	0.33	$0.19 < P < 0.47$ ns
Total	37495	1	102	102	1	
Spotted-necked otter						
River banks type	Availability	Proportion of availability	Observed	Expected	Prooportion of use	Bonferroni Confidence Intervals
Dense vegetation	12	0.61	36	39.93	0.54	$0.37 < P < 0.73$ ns
Short grass	19	0.25	3	16.72	0.05	$-0.03 < P < 0.13$ -
Alluvium	23	0.08	7	5.47	0.11	$-0.05 < P < 0.22$ ns
Emerging rocks and bush	31	0.06	20	3.88	0.30	$0.13 < P < 0.47$ +
Total	37495	1	66	66	1	

The main causes of habitat degradation were the presence of solid rubbish in the river and along the banks, traces of foam and oil in the water and open sewage flowing directly into the river. The lack of vegetation cover was caused by agricultural practice as well as by the presence of cattle trampling the vegetation to the river's edge; whilst the major causes of disturbance were the presence of dwellings, people using the river constantly and roads running close to the river. Seasonally, in protected areas, the presence of tourists along the river banks was also disruptive for the otters.

Planted pastures and monocultures reducing the landscape diversity (Shannon-Weaver index H=0.2), and combined to high level of habitat degradation and sources of disturbance were identified as the features affecting negatively the presence of otters.

Another cause of disturbance to otters was the burning of the vegetation to the river's edge. The river banks of protected areas were burned from July to October. The worse effect was registered in October 1993 at Kamberg Nature Reserve (Stillerust lower section) when more than half of the study area (including both river banks for a length of about 3 km) was burned. The number of sites of presence of both otter species decreased from 26 to 9 sites. The higher dicrease was recorded for the Cape clawless otter (from 10 to 3 sites).

The diet of the two species of otter was investigated by the analysis of 735 scats of Cape clawless otter and 516 scats of spotted-necked otter, following standard procedure of previous authors (e.g. WEBB, 1976).

Diet composition is shown in Table 3, presented numerically and as relative frequency of occurrence (RF%) of each prey item.

Table 3. Diet composition

	Cape clawless otter				**Spotted-necked otter**	
	Unprotected areas		Protected areas			
Prey items	n=79		n=656		n=516	
	Actual	RF%	Actual	RF%	Actual	RF%
CRAB	68	48	597	58	222	25
FISH	3	2	109	11	330	37
Barb (*Barbus spp*.)	1	1	15	1	115	13
Scaly fish (*Barbus natalensis*)	-	-	7	1	13	1
Trout (*Salmo trutta - Oncorhyncus mykiss)*	2	1	79	8	192	22
Fish unidentified	-	-	8	1	6	1
AMPHIBIANS	44	31	147	14	221	25
Frog (*Rana* spp.)	21	15	101	10	179	20
Clawed toad (*Xenopus laevis)*	16	11	17	2	15	2
Amphibians unidentified	7	5	29	3	27	3
INSECTS	25	17	134	13	95	11
Coleoptera	3	2	12	1	22	2
Odonata (larval)	22	15	122	12	73	8
OTHER	-	-	32	3	20	3
Dung	-	-	31	2.99	6	1
Other vertebrates (reptiles, birds, mammals)	-	-	1	0.01	14	2

The Cape clawless otter was primarily a crab eater: its diet comprised predominately crabs, supplemented with amphibians, insects and fish in low numbers. The spotted-necked otter was a fish eater. Fish was the primary food item followed by crabs and amphibians (similarly represented with 25% of RF), and insects. Minor items for both species of otter were mainly small mammals and waterside birds.

The Chi-square analysis was used to test for significant differences in the use of prey species categories (χ^2=339.11; *P*<<0.001; $n_{1,2}$=7; df=6)

Niche breadth was wider for the spotted-necked otter (Levin's B = 0.72), than the Cape clawless otter (Levin's B =0.47). The species was more generalist, using more resources than the Cape clawless otter, which might be considered more of a specialist species.

DISCUSSION

The greater amount of sign of presence of each otter species was associated with high levels of habitat variety, dense vegetation cover on river banks, food availability and low levels of disturbance and habitat degradation.

Cover, in the form of unburnt and undisturbed grass or bush, on at least one bank of the river, appeared to be particularly important for both otter species. Spotted-necked otters spend 60% of their time on land (D'INZILLO CARRANZA, 1996), similarly might do Cape clawless otter. The presence of dense vegetation, in terms of thick underbush, is very important in providing shelter during periods of "inactivity". Veld burning appeared to have a marked negative effect on otters. In order to favour wild and domestic grazers, high-veld grasslands are burned in large patches at least once a year (mainly during winter months). This practice is common in both protected an unprotected areas; the impact of fires is temporary but important in maintaining the high-veld ecosystem (NAANI, 1969). However, fires may remove critical resources, such as underbush, needed by otters. It is thus recommended that along the major rivers of the Natal Drakensberg Park, both banks are not burnt during the same year. If the larger rivers are used as firebreaks between burning blocks, the biennial burning of the opposite banks should be practised.

In the unprotected areas, the extensive monoculture, the exploitation of the land to the river's edge, the absence of vegetation covering the river banks and general environmental degradation were the main negative factors affecting the presence of otters. Though, differences in the occurrence of the two species of otter was evident even within the protected areas. Whilst, Cape clawless otters occurred widely throughout the protected areas, spotted-necked otters were numerous where the availability of the food resources (mainly trout) was highest.

The different feeding habits of the two species, described also by ROWE-ROWE (1977) likely play an important role in habitat partitioning. Cape clawless otter, which has particular morphological adaptations is a crab eater. It is more specialised and has a narrower trophic niche breadth than the spotted-necked otter, appears to be the more vulnerable species. Nevertheless, the spotted-necked otter, being mostly piscivorous, is linked to habitat characterised by permanent water, where food availability is more predictable during the year.

The availability of different kinds of food is an important factor influencing otter feeding habits and their presence in the area.

Prey availability is the primary factor affecting the abundance of both species in the Natal Drakensberg. Protected areas, characterised by dense vegetation cover, scarce environmental degradation and low levels of human disturbance, were the areas in which larger number of Cape clawless and spotted-necked otters occurred. A proper management of the stretches of river flowing through unprotected areas, would amplify the suitable habitat for otters and serve as corridor between the areas where they occur.

Acknowledgements - I thank with particular emphasis, for the great enthusiasm, support and useful comments provided during the compilation of the entire research Dr. Dave Rowe-Rowe (of the Natal Parks Board) project co-ordinator. Particular acknowledgements are addressed to the Endangered Wildlife Trust of South Africa and the University of Natal having financially supported the research. The Natal Parks Board provided for the accommodation and the facilities in the field. I also would like to thank the Department of National Education in Pretoria and the Italian Bureau of International Affairs having granted me the opportunity to come in South Africa and to conduct this project.

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THE STATUS OF THE EURASIAN OTTER (*Lutra lutra*)

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INTRODUCTION

The Eurasian otter (*Lutra lutra*) has been described as having *one of the widest distributions of all Palearctic mammals* (CORBET, 1966). Its range originally extended from Portugal in the west to Japan in the east, and from northern Europe and Asia, to the southern shores of the Mediterranean. In Asia, it is found as far south as Indonesia (FOSTER-TURLEY and SANTIAPILLAI, 1990; CONROY et al., 1996).

Over the past 40 years there have been marked declines in the number of animals throughout much of the otter's range, particularly in Western Europe, and concern expressed for the survival of the species in several countries.

THE OTTER IN EUROPE

The British Isles

The otter was once widespread throughout the British Isles, and this is reflected by its inclusion in many early natural history books, the fact that bounties were paid on them and that hunts were organised as a sport and as a means of control, with in some areas, dramatic effects.

Populations appear to have been still relatively healthy in the early 1950s (STEPHENS, 1957), but shortly afterwards the situation changed. There was a serious decline in numbers, which started suddenly about 1957/58, and occurred simultaneously throughout much of England, Wales and the Scottish borders. CHANIN and JEFFERIES (1979) reviewed the situation and concluded that the factor most likely to have been responsible for these events, were the introduction in 1956 of the organochlorine groups of insecticides, in particular dieldrin.

Detailed monitoring programmes have shown that following the decline in otter numbers over large areas of the UK, there has been, since in the late 1970s, a slow expansion of the animals' ranges particularly over the last 20 years (Table 1). These have centred on those otter strongholds which survived the population crashes of the late 1950s. There are, however, still large areas, particularly of central and southern England, where the species is still absent, or very rare; but even in some of these there are occasional reports of otters being seen, suggesting a continuing expansion of the species range.

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JEFFERIES (1997) reviewed the findings of the three national otter surveys, and concluded that should the current rate of recovery be maintained, a level of 75% occupation over all of Britain may be achieved by 2010, just over half a century following the population crash.

Table 1. Results of the three national surveys of England, Wales and Scotland

Country / Year visited	No sites	No positive	% positive	Reference
England				
1977-79	2,940	170	5.8	LENTON et al. (1980)
1984-86	3,188	286	9.0	STRACHAN et al. (1990)
1991-93	3,188	706	22.2	STRACHAN and JEFFERIES (1996)
Wales				
1977-78	1,030	210	20.4	CRAWFORD et al. (1979)
1984-85	1,097	421	38.4	ANDREWS and CRAWFORD (1986)
1991	1,102	579	52.5	ANDREWS et al. (1993)
Scotland				
1977-79	4,636	3,385	73.0	GREEN and GREEN (1980)
1984-85[1]	2,650	1,717	64.7	GREEN and GREEN (1987)
1977-79	2,650	1,511	57.0	GREEN and GREEN (1987)[1]
1991-94	3,706	3,245	88.0	GREEN and GREEN (1997)
1977-79	2,538	1,726	68.0	GREEN and GREEN (1997)[2]
Ireland				
1980-81	2,373	2,177	91.7	CHAPMAN and CHAPMAN (1982)

1 Only areas, which showed sub-optimal distribution in 1977-79 were surveyed
2 Data for the sites, which were surveyed in 1984-85

Shortly after the decline of the otter was reported in Britain, similar declines were recorded throughout much of Western Europe. (MACDONALD and MASON, 1990)

WESTERN EUROPE

Portugal, Spain, France, Belgium, Netherlands, Luxembourg, Switzerland, Germany, Austria, Liechenstein

The otter is widespread and thriving throughout much of **Portugal,** with animals being found both on the coast and in freshwater habitats (TRINDADE, 1994; SANTOS REIS et al., 1996). The animals are most common in the northeast and southwest parts of the country and least common in the central area. Portugal could, therefore, hold one of the most important otter populations in Western Europe.

There is no evidence to suggest that the population is currently under threat, although SANTOS REIS (1994) identified a new potential danger, periods without rain, resulting in many watercourses becoming dry in the summer.

The species has been fully protected since 1974, but still subject to illegal hunting.

It was thought that there had been a marked decline in otter numbers in **Spain** since the mid 1960s (BLAS-ARITO, 1978). In the early 1980s, however, it was still widely distributed in the west, but by the end of that decade was considered threatened in the east, and restricted in the central region (DELIBES, 1990).

A spraint survey of 3,966 sites throughout the country in 1984-85 found evidence of otters at just 1,327 (33.5%) (DELIBES, 1990). Signs of otters were most frequent in the north and northwest of the country: Galicia and Asturias, and in west central Spain on the borders of Portugal, where there is also a healthy population (SANTOS REIS et al., 1996). Fewest signs were found in the east, southeast and central part of the country.

Recent surveys have shown a recovery in five regions - Cataluña, Aragón, Asturias, Galicia and Western Andalucía, but there has been a decline in others including Navarra, the Basque country, Rioja and to the north of Castilla-León. Increases have also been reported from both the coastal and subalpine areas of the Pyrennes (RUIZ-OLMO, 1994).

There is, however, concern that damming of streams, particularly in the Mediterranean part of the country, will have an adverse effect on otter numbers (PEREZ and LACOMBA, 1991).

At the beginning of the 20th century, the otter was found in every region of **France** except Corsica, and remained common throughout the country until about 1930 (ROSOUX et al., 1996). Over the next two decades a decline occurred and since the 1950s the species has disappeared from 47 of the 95 French Departments. Otters are widespread in the area west of Brittany, south to the Pyrennes and in the Massif Central, but are absent from much of the north and east of the country (ROSOUX et al., 1996). There has been a recolonisation, in the area around the Massif Central, which started around 1984. The number of Departments without otters, however, continued to increase over the past 40 years, from 21 in the period 1930-1950 to 47 in the most recent survey (1989-1993). Brittany is now thought to contain about 25% of the country's otters (LAFONTAINE, 1993).

The otter was once common in **Belgium**. At the turn of the century around 300 individuals a year were killed. During the 1960s numbers declined at most locations, and by the 1980s, only a few small relic populations were left (CRIEL, 1984, 1989). In the northern part of the country (Flanders), the species became extinct, although recently there have been occasional signs of animals. In the southern part of the country (Wallonie), a few animals continued to survive (VAN DEN BERG, 1998). OVERAL (1995) recorded a small, but viable, population on the Haute-Sûre, along the border between Luxembourg and Belgium.

The current state of the majority of Belgian rivers, heavily polluted and with few fish, means that they are unsuitable for otters (LIBOIS and HALLET, 1996). The species is fully protected in Belgium, and is listed in the Red Data Book (K. van den BERG, pers. comm.)

As early as 1940, the otter population in **The Netherlands** was thought to have reached an all time low of between 30 and 50 animals (BROUWER, 1940, 1942), and legislation was enacted to protect the species. By 1962 however, there had been a significant increase with an estimated 300 individuals distributed in five areas (van WIJNGAARDEN and van de PEPPEL, 1970). As late as 1983, the species was considered to be widely distributed (VEEN, 1984). However, by 1988 otters were restricted to a few isolated areas

(NOLET and MARTENS, 1989), and is thought to have become extinct shortly after this (WINTER, 1993). In recent years, signs of animals have been reported from some parts of the country (DULFER et al., 1993).

The species is also thought extinct in **Luxembourg.** They were, however, found throughout the country in the 19th century. Pressures from hunters and fishing interests resulted in the population being dramatically reduced. Although hunting ceased in the mid 1950s, and the species protected in 1972, the population continued to decline and were last seen in 1995 in La Haute-Sûre region (SCHMIDT and ADAM, 1992; GROUPE LOUTRE LUXEMBOURG, 1997).

In the early 1950s it was thought that there were 40-60 individuals in central and northern parts of **Switzerland** (KREBSER, 1959), the species is now considered extinct (WEBER et al., 1991).

In **Germany**, where the otter is fully protected by hunting law, the species is highly endangered in the old Federal Republic, with otters being rare or extinct in many of the federal states. Over 20 years ago, HÖDL-RÖHN (1977) suggested that only one percent of the former otter population survived in both German Republics, however, she presented no information to support her statement, and only three years previously, RÖBEN (1974) had stated the population in the Federal German Republic (FDR) was nearly 500 animals. It is locally common in the former German Democratic Republic, but even here, the distribution is becoming more restricted, possibly because of changes in land-use practices and the rapid increase in the volume of traffic in the former GDR following reunification in the late 1980s. REUTHER (1995) reported an east-west split in distribution, the species becoming rarer as one moved westwards.

The **Austrian** population is also expanding. In their account of the status of the otter in Austria, MACDONALD and MASON (1990) reported that the species was threatened. By 1997, A. KRANZ (pers. comm.) suggested otters were found in about 30% of the country. There are two main populations. The larger is found in the northern parts of Upper and Lower Austria and recent surveys have shown that this population is expanding southwards and has crossed the Danube (KRANZ, 1994a, 1995). The smaller population, in the southeast of the country, expanded between 1986 and 1993-94; from 11.1% to 25.2% of the sites visited (SACKL et al., 1996).

Both populations continue to expand (BODNER, 1994; GUTLEB, 1994) and there is some evidence that the two populations have made contact in the Northern Limestone Alps (A. KRANZ, pers. comm*.).*

The otter in Austria is treated as a game species, but since 1947 has had all year round protection. It is listed as an endangered species in the Austrian Red Data Book (BAUER and SPITZENBERGER, 1994)

The otter is also extinct in **Liechtenstein.**

SCANDANAVIA

Denmark, Norway, Sweden, Finland

The countries of Scandinavia, have shown a slight increase in the range of the otter over the past few years. In **Denmark**, game bag statistics showed that otters had been killed all over the country with no apparent effect on the population (JENSEN, 1964). By 1967, however, concern was being expressed about the status of the species and it was granted full protection (SØGAARD and MADSEN, 1996). The otter population at the end of the 1970s was thought to be between 200 and 500 individuals (JENSEN, 1980). This compares with a regular cull of around 200 animals per annum between 1941 and 1962 (JENSEN, 1964). The critical state of the population was evident from surveys in the early 1980s when only 106 (9.2%) of 1,154 sites visited showed any presence of otters (MADSEN and NEILSEN, 1986), with the majority in central and northwest Jutland. Six hundred and thirty three sites were visited in three surveys 1984-86; 1991 and 1995; the number of positive sites in each survey was 15.2%, 24.1% and 35.5% respectively (MADSEN and NEILSEN, 1986; HAMMERSHØJ et al*.,* 1996). Today the otter is still regarded as endangered*.*

The **Norwegian** populations are fragmented in the south, but large and widespread in the north, where it is widely distributed along the coast and inland in lower densities (HEGGBERGET, 1994). MYBERGET and FRØILAND (1972) showed that the species was already uncommon in the south, the decline continuing in many areas in the 1970s (HEGGBERGET and MYBERGET, 1980). During the 1980s and 1990s the population in the north recovered to an estimated 10-15k individuals, while populations in the south of the country are considered fragmented, vulnerable and probably threatened (HEGGBERGET, 1996).

Based on two survey in the mid1960s and 1970s as well as information from game bags, it was concluded that that the otter population in **Sweden** was declining, a decline, which probably began around 1950 (ERLINGE, 1971; ERLINGE and NILSSON, 1978; ERLINGE, 1980). The decline, at least in part of the country continued, and by 1997 it was estimated that there were only 500-1500 otters in the country, which was less than the annual otter harvest for around 1950 (ERLINGE and NILSSON, 1978).

Surveys in the 1980s showed only 5% of 2,000 sites visited in southern part of the country with evidence of otters (OLSSON and SANDEGREN, 1986), while in northern Sweden otters were evident in slightly more, 10% of the sites visited (OLSSON, in MACDONALD and MASON, 1994).

More recent research, based on the otter reintroduction programme in central Sweden has shown an expansion of the otter population, (SJÖÅSEN and SANDEGREN, 1992; SJÖÅSEN, 1996). There is evidence that the reintroduced otters are now in contact with the northern population and signs of otters are being found in areas where there have been none reported for nearly 20 years (T. SJÖÅSEN, pers. comm.). The species is classified as vulnerable in the central and northern parts of Sweden and endangered in the south (SJÖÅSEN et al., 1997).

Historically, otters in **Finland** were found throughout the country, including the coasts and on small offshore skerries. In the late 19th century hunting bags of 1,000 animals a year were reported, but by 1910, bags had fallen to around 100 otters per annum, and this decline in the numbers killed continued over the next 20 years (WIKMAN, 1996). The otter was first protected in 1938, but the subsequent increase in numbers resulted in trapping being legalised again 12 years later, after which bags of 100-200 animals were reported annually. The population declined despite protection being reintroduced in 1975, and MACDONALD and MASON (1990) reported that populations were becoming more fragmented in some areas and absent in others. KAUHALA (1996) confirmed otter numbers declined in the 1970s, but increased again in the 1980s, with a marked increase in distribution between 1981 and 1991.

In Finland, otters are currently thought to be widespread, but with a patchy distribution (SKARÉN and KUMPULAINEN, 1986; Hagner-Wahlsten and Stjernberg, 1991), and while they are rare in the southern part of the country and in coastal areas, good populations are found inland in eastern and central parts of the country (SKARÉN, 1990). WIKMAN (1996) suggested that there are currently in excess of 1,000 otters in the country. The overall picture, however, appears confused, with increases in some areas, decreases in others and some marked fluctuations over the past ten years. The species is classified as "declining, in need of monitoring" (U. SKARÉN, pers. comm.)

EASTERN MEDITERRANEAN AND BALKANS

Italy, Greece, Cyprus, Albania, Slovenia, Croatia, Bosnia and Herzegovina, Federal Republic of Yugoslavia (Serbia and Montenegro), Former Yugoslavian Republic of Macedonia

The **Italian** otter population is endangered and its survival depends upon the conservation of the populations living in the southern part of the country (PRIGIONI and FUMGALLI, 1992). In the early 1970s the species range already appeared to be highly restricted (CAGNOLARO et al., 1975), and in the first national field survey conducted in 1984 found only 6.2% of nearly 1,300 sites visited with evidence of otters. Less than 100 individuals were thought to survive (CASSOLA, 1986). Some areas have been surveyed more recently with differing results. In the Sele-Calore river catchments, for example, the population appears to be stable, while some populations in southern Tuscany and northern Latium showed apparently dramatic decreases by late 1990, and may even be extinct (CASSOLA, 1994).

Otters were found on 50 water bodies, mainly in southern Italy, during the period 1984 to 1994, with the population fragmented into five main groups (PRIGIONI, 1997). Based on an estimate of 1.4 otter/10km of river, and the assumption that the species is distributed along 950km of watercourses, he calculated about 130 individuals in the country.

In Italy, the species has been legally protected since 1977 and is included in the national red data book as critically endangered (AMORI et al., 1996).

The otter is thought to be widespread throughout much of **Greece**, but particularly in the northeast. The distribution is, however, fragmented in some parts of the country, in particular the central area. A recent survey (1997) of the northwest part of the country found signs of otters at 63% of the 46 sites visited, suggesting the species is still relatively widespread (URBAN, 1998). In 1997, however, DELAKI et al. (1989) considered that otters had declined during the previous ten years. The species is still found along the north and east coasts of Corfu, but is absent from the west (URBAN, 1998).
All year protection throughout the country was granted under the hunting laws in 1968.

The otter is not found on the island of **Cyprus** (SMIT and van WIJNGAARDEN, 1976).

Little is known about the distribution of otters in **Albania.** During the 1960s, the species was considered to be widespread in the country. In 1985, PRIGIONI et al. (1986) visited a small part of the country and found evidence of otters at nearly 55% of the sites examined. From this they concluded that the species was likely to be distributed throughout the country, but with some restriction of its range in the central area and coastal plain. URBAN (1998) reported that local fishermen persecute the species.

The situation in parts old **Yugoslavia** is difficult to determine because of the recent conflicts. MACDONALD and MASON (1990) reported that the species was found throughout much of the country, with the exception of the mountainous northwest area of the Adriatic coast. Inland, along the main rivers, the species was thought to be at a low density of extinct.

In **Slovenia** the otter is considered rare. Enquiries in the 1980s (HÖNIGSFELD, 1985a,b) indicated a decline throughout the country as well as a change in distribution over the previous decades. The main stronghold is in the northeast part of the country (Prekmurje), where the population is recorded as viable (HÖNIGSFELD, 1998). Of 74 sites surveyed in this area, between 1996 and 1998, 65 (88%) showed evidence of otters, while the sites with no evidence were considered as unsuitable for sprainting.
The species is listed as endangered in the Red List of Endangered Mammalia in Slovenia (KRYSTUFEK, 1992). It has been fully protected since 1976, and is currently protected by the Order of the Government of the Republic of Slovenia under the Protection of Threatened Animal Species (1993).

Croatia - Rare along coastal strip, but relatively numerous in the northern part of the country (MACDONALD and MASON, 1994);

Bosnia and Herzegovina - Widespread and relatively numerous (MACDONALD and MASON, 1994);

Federal Republic of Yugoslavia (Serbia and Montenegro) - PAUNOVIĆ and MILKENOVIĆ (1996) concluded that the species was more widespread in these two republics than had previously been reported. Animals were found in most areas except for the central part of Serbia and west central Montenegro. The otter is currently protected as a 'natural rarity'. This category has, however, become outdated, and hopefully the legislation will be revised, although it is expected that the otter will remain protected.

Former Yugoslav Republic of Macedonia - Widespread and relatively numerous in areas alongside Albanian border: rare elsewhere. M. Paunović (pers. comm.) confirms that the overall situation in the former Yugoslavia is of a general decline in numbers from east to west.

BALTIC REPUBLICS

Latvia, Lithuania, Estonia

In the Baltic Republics otters are widely distributed. Despite intensive hunting pressures, otters are widespread throughout **Latvia**, being found on most water courses (OZOLINŠ and RANTINŠ (1992a), but with an uneven distribution. More dense populations are in the western and eastern parts of the country, with less dense populations in the north, northeast and on the coastal plain. ORNICANS (1994) detailed the changing otter population in Latvia this century, from around 500 individuals in 1914, numbers dropped to an all time low of 255 in 1947. This decline was associated with the rapid development of agriculture and land reclamation and persecution by fish and crayfish breeders (OZOLINŠ and PILÄTS, 1995). They increased to 2,370 in 1968, before declining again to 1,050 in 1982. Since then there has been a steady recovery, with the 1993 population being estimated at 4,000 animals. Between 1980 and 1987, the otter was included in the *Red Data Book of Latvia*, but was subsequently removed when it became clear from hunting returns that the species was numerous, It is thought that the successful re-establishment of the beaver in Latvia has benefited the otter (OZOLINŠ and RANTINŠ, 1995), the latter making use of the beaver lodges and fish ponds (OZOLINŠ and RANTINŠ, 1992b) state that otters inhabit, at least for a short period, at least 50% of the Latvian lakes and over 80% of the rivers.

In **Lithuania**, the population is described as widespread, the species being found in all 44 regions of the country (MICKEVIČIUS, 1993). There was, however, evidence of a decline between 1969 and 1984, but since then the population has stabilised or increased. Based on a questionnaire survey it was estimated that there were 420 otters in the country in 1990 and 340 in 1991. According to K. BARANAUSKAS and E. MICKEVIČIUS (pers. comm.), the Annual State Wildlife Census suggested that there were 1,430 otters throughout the country in 1997, an increase of 130 from the previous year. These authors, however, feel that this number is rather low, and suggest a more realistic figure of between 3,000 and 12,000. A recent survey of 446 sections on 269 rivers found evidence of otters at 94% of the sites (BARANAUSKAS and MICKEVIČIUS, 1995). Beaver trapping is seen as a serious threat to the otter in this Baltic State, although even this danger has declined as the demand for beaver fur has diminished (BARANAUSKAS et al., 1994).

The species is classified in the *Red Data Book of Lithuania* (2nd edition, 1992) under Category 4, i.e. undetermined, insufficiently investigated.

At the beginning of the 20th century, the otter was considered widespread in **Estonia**, but according to LAANETU (1989), by the mid 1980s, the species was sparsely distributed throughout the country. Between 1920 and 1935, numbers dropped considerably, probably as a result of poaching (N. LAANETU, pers. comm.). Numbers slowly grew and, by the mid 1950s, the population was estimated to be 800-900 individuals, and had increased to over 2,000 by the1960s, but numbers dropped by nearly 50% over the following eight years. This decline continued until about 1975, when it was thought that there were only 300-350 animals; since then numbers remained relatively stable for seven years after which there has been a slight increase with a count of around 550 in 1988. The species is now concentrated in eight districts which are not isolated (KIILI, 1991). The most recent estimates gave 1,400 -1,500 animals in 1993, but since then there has been a decline (N. LAANETU, pers. comm.). The species is currently protected, and is listed in the Red Book of Endangered Species.

EASTERN EUROPE

Czech and Slovak Republics, Poland, Hungary, Romania, Bulgaria Belarus

There have been extensive surveys of the otter in the former Czechoslovakia, and these have continued in the newly formed **Czech** and **Slovak Republic.**

In 1977/78, BARUŠ and ZEDJA (1981) identified 342 localities where otters were present in **Czechoslovakia**, and estimated that the minimum number to be 174 individuals. TOMAN (1992) reported the results of the most recent surveys using both snow tracking and spraints. He estimated 300-350 animals in the **Czech Republic** in three isolated populations - a small one in the north extending to the German border, another, in the east, joining with Slovakia and a third, the main centre of otter activity, in the South Bohemian fish pond area, a population that extends into the Austrian Waldviertel. He suggested that about 25% of the country is occupied by otters, and that numbers have increased slightly over the past five years In *The Atlas of Mammals of the Czech Republic*, three or four populations are identified, numbering 350-400 individuals (ANDERA and HANZAL, 1996).

In **Slovakia**, the status seems unclear, (KADLECIK, 1994) regarded the species to be seriously endangered, but the same author (KADLECIK, 1992) had earlier stated the species was still widely distributed, with the main population in the central and eastern parts of the country. URBAN (1992) reports a marked drop (70%) in otter numbers in part of Pol'ana, Slovakia over the previous quarter of a century, but showed that the population then remained stable in the area up to 1995 (URBAN, 1995).

Following the most recent survey in 1994-1995, KADLECÍK and URBAN (1997) concluded that there had been no major changes in otter distribution over the past 20 years, the species had, however, occupied new parts of the country.

In the Czech Republic the species has been protected since 1949, but in 1996 was listed in the new hunting laws, with a year-long open season. Thus the otter is currently subject to two conflicting laws, although the former still ensures the animals' protection (A. TOMAN, pers comm.). The species is listed as "endangered" in the *Red Data Book* (BARUS, 1989).

In Slovakia, the otter is strictly protected under the Act on Native and Landscape Conservation, and is listed as "vulnerable" in the Red Data Book (STOLLMANN, et al., 1997).

In **Poland**, BUCHALCZYK (1983) reported that the otter was still numerous, but several other reports published in the early 1980s indicated a decline of otters throughout the country (ROMANOWSKI, 1984; BIENIEK, 1988). The species was described as rare and endangered in the Polish Red Data Book (BIENIEK, 1992). Between 1991-1994, evidence of otters was found in nearly 80% of over 2000 sites (BRZEZIÑSKI and ROMANOWSKI, 1997), this represents one of the highest percentages of positive sites of otters in continental Europe. Only two areas, Silesia and central Poland had no signs of the species (ROMANOWSKI and BRZEZIÑSKI, 1994; BRZEZIÑSKI et al., 1996). The last named authors reported increases throughout much of the country, including the capital Warsaw. They attributed the increase to a reduction in the effluent entering the water, and possibly the increase in beaver numbers. Summarising the national otter survey, BRZEZIÑSKI and ROMANOWSKI (1997) concluded that the species is widely distributed throughout Poland and should no longer be considered endangered in the country.

The **Hungarian** otter population is thought to be stable, but there has been a decline in the area east of the Danube (NECHAY, 1980). A large scale questionnaire survey in 1995/96 showed that out of 464 10x10 km UTM squares, otters were living permanently in 333 (72%) (EGYETEMES et al., 1997), a slight drop from the 1987-88 survey, where the species was recorded in 86% of the sites visited (KEMENES, 1991). The population was reported as being stable, but growing. There was, however, concern about illegal killing (EGYETEMES et al., (1997). The species was given "strict" protection in 1978, but legal killing of individuals can be sanctioned after it has been established that they have been responsible for damage (RAKONCZAY, 1990; LANSKI and KÖRMENDI, 1996).

There are few data from **Romania.** Numbers declined from 2,050 in 1950 to 1,550 in 1991 (WEBER, in MACDONALD and MASON, 1994). GEORGESCU (1994) reported that the species was found throughout the country, from sea level to the subalpine zone (1,700m asl) but that the population had declined from 2,180 in 1980 to 920 in 1993. IONESCU and IONESCU (1994) also reported a decline in population, in this case, between the delta of the Danube to the Carpathian Mountains, from *ca.* 3,200 animals in 1955 to *ca.* 1,700 in 1994. There are obvious discrepancies in the estimated number of otters, but the important feature is that they have all shown declines over the past 25-30 years.

According to SPIRIDONOV and MILEVA (1994), the **Bulgarian** population is considered to have been stable for the previous 15 years, and numbers 1,000 to 1,400 animals. They are widely distributed throughout the country from sea level to about 1,400m asl. MACDONALD and MASON (1994), however, report that numbers declined since the 1950s, with increases in some areas. The species is currently considered "endangered" and has been protected since 1962 (ROMANOWSKI, 1991).

The otter in **Belarus** is widespread, and, since 1995 can only be hunted under license. Numbers were thought to have stabilised over the period 1984-1989, except for a slight decrease in numbers in the southwest of the country, and in areas of high human population (SIDOROVICH, 1991). The population was estimated as being nearly 12,000 individuals between 1984 and 1988, this had dropped to 7,000 by 1989-1991, the decline caused principally by large scale poaching (SIDOROVICH and 1991; SIDOROVICH and LAUZHEL, 1992).

It is currently estimated that the average density of otters on the country's rivers varies between 1.7 and 4 individuals per 10 km of river in protected areas to between 1.2 and 2.0 in exploited areas.

CIS RUSSIAN FEDERATION

The **CIS Russian Federation** extends from Eastern Europe through Asia to the Pacific Ocean. Within this area are many republics and provinces. Information from such a vast country is, as would be expected, patchy. The otter is distributed throughout the country with the exception of the tundra. It became extinct on the Kuril Islands at the beginning of the 20th century and more recently has disappeared from many waterways in the regions of Krasnodar and Kursk (BYTCHKOV and CHACHIN, 1994). In the European sector, the otter population is thought to have been stable over the past decade, but overall numbers have declined by 30-40% since the 1930s and 1940s when the population was thought to number 80,000-100,000.

The species has been confirmed in the Zabaikalsky National Park, Lake Baikal, Siberia (KRANZ et al., 1995), from Sakhalin Island, Kargasoksky District (Tomskaya Region), Todzhinsky District (Tuvinskaya Autonomous Region) and the mid-reaches of the Pur River (Tyumenskaya Region), while the status in Northern Magadan district, Chukotka and Koryak is unknown (ZHOLNEROVSKAYA et al., 1994). Otters are rare in **Tajikistan** and **Uzbekistan** (ANON, 1983; ZHOLNEROVSKAYA et al., 1994; PERELADOVA, KREVER and WILLIAMS (1997). They are also reported in **Turkmenistan (**MAROCHKINA, 1995), **Kazakhstan** (ANON, 1977) and the Far Eastern Primorye Province (R. Melisch, pers. comm.).

On the basis of census returns, ROZHNOV and TUMANOV (1994) estimated the Russian population to be in the region 60,000 individuals in 1987 - 27,000 in the European sector; 3,500 in the region of the Urals and 30,000 in the Asian sector. There is a decrease in density from west to east. Between 1991 and 1995 numbers dropped from 60,400 to 52,600 animals, a decline of 13% over the five year period. Declines were recorded in all but one of the 12 regions listed, with the greatest decline 17.5% in the Far East (BORISOV, 1996).

At present the species is protected in some, but not all of the republics, including Kazakhstan, Turkmenistan, Tajikistan, Uzbekistan, Kirghiztan. It is considered rare in both Tajikistan and Uzbekistan (PERELADOVA, KREVER and WILLIAMS, 1997).

Two sub-species *L. l. seistanica* and *l. l. meridionalis* were listed in the *Red Data Book of the USSR* (Vol. 1) published in 1984.

THE OTTER IN ASIA

There are possibly six species of otters breeding in Asia - the Eurasian (*Lutra lutra*), smooth-coated (*Lutrogale perspicillata*), hairy-nosed (*Lutra sumatrana*), Asian small-clawed, and Japanese (*Lutra nippon)* and sea otter (*Enhydra lutris)*. In this paper, we restrict our comments largely to the Eurasian otter. FOSTER-TURLEY and SANTIAPILLAI (1990) reviewed the status of the otters in Asia and showed the paucity of information of the species over much of the continent. In Asia, the otter is found as far south as Sumatra in Indonesia (CORBET and HILL, 1992). Throughout its range several sub-species have been identified, and many synonyms proposed which may reflect the difficulties to be dealt with when evaluating older and historical accounts. A fuller account of the otters in Asia can be found in CONROY et al. (1998).

NEAR AND MIDDLE EAST

Turkey, Israel, Palestine, Jordan, Syria, Lebanon, Iraq, Iran, Afghanistan

The species was once widespread and common throughout **Turkey** (Turan, 1984), with healthy populations in the western and eastern parts of the country (M. Eroglu, pers. comm.). According to KUMERLOEVE (1967) in SMIT and van WIJNGAARDEN (1976), 30,000 otters were killed annually. It is now considered endangered in the south and threatened in the north, where, largely as a result of habitat destruction, and river management, the population declined (EROGFLU, 1994). In recent years there has been an increase in the number of otters in the northeast part of the country, associated with the development of a fish pond culture. There is, however, some evidence that this population might again be on the decline because of illegal killing, despite the fact that the species is currently protected throughout the country (KRANZ, 1994b; M. Eroglu, pers. comm.).

In **Israel** the otter has disappeared from the coastal plain, but it is still found in good numbers throughout the catchment of the River Jordan. In June 1994, a survey of 54 sites found that 25 (53%) had evidence of otters, a decline of 26% from a similar survey carried out in 1986 (MACDONALD et al., 1986; SHALMON, 1992; B. Shalmon, pers. comm.). The otter is protected and considered "endangered" by the Nature Reserves Authority (B. Shalmon, pers. comm.).

The **Jordan** population is restricted to the three permanent rivers in the country, and is considered threatened (FOSTER-TURLEY and SANTIAPILLAI, 1990). Because the species occurs in Israel and Jordan, FOSTER-TURLEY and SANTIAPILLAI (1990) assume that the species also occurs in **Lebanon** and **Syria**.

HATT (1959) showed evidence of otters on the upper sections of the Euphrates River and the Hindiya Barrage on the Tigris River in **Iraq**, and concluded that *it seems probable that the species ranges through all the major streams of Iraq from the Persian Gulf to the northern frontiers.* THESIGER (1964) writes of the otter as being common around Zirki, where it breeds on floating islands. He also tells that over a period of two months, a single hunter killed 40 animals.

There is little detailed information from **Iran**, GUTLEB et al. (1998) reviewed current knowledge. According to HARRINGTON (1977) and TAJBAKHSH (1995) the otter can be found on most rivers throughout the country, being absent only from the central desert region. MISONNE in MELISCH and RIETSCHEL (1996) recorded the species as present from the west, north and east of the country, but absent from the central and south. ZIAIE and GUTLEB (1997) report that the species can be found in the Zagros, Elbruz and Koppe-Dagh mountain range and in Iranian Azarbaiejan. It is present in the Hamoon Wetland bordering with Afghanistan and possibly found on the south shores of the Caspian Sea.

Until recently, the most comprehensive work on the distribution of the otter in **Afghanistan** was HASSINGER (1973), who compiled the data available to 1968. More recently, MELISCH and RIETSCHEL (1996) published 22 distribution records from throughout the country. They showed the species was widely distributed. Otters are still hunted in the country and the skins are highly prized (NIETHAMMER, 1983; NAUROZ, 1974 in MELISCH and RIETSCHEL, 1996).

EAST ASIA

Mongolia, North Korea, South Korea, Taiwan, China, Japan

According to STUBBE et al., (1989) otters still exist in three areas in **Mongolia**, but at low densities. The species is listed in the *Red Data Book of Mongolia* 1987, and should therefore be protected in that country. There are, however, reports of Eurasian otter pelts being on sale between 1985 and 1994, some reportedly from the Changai Mountains of Central Mongolia (H. MIX, in CONROY et al., 1998).

There is no information from **North Korea**. In **South Korea** the species was once widely distributed throughout the country, but it is now considered rare. ANDO (1995) reported that spraints are found on most coastal areas, but are less common on rivers. After surveying the country between 1992 to 1996, SASAKI et al., (1998) found the species to be present throughout the country but in decline in most places due to wetland reclamation and fisheries conflicts. Despite being declared a National Monument in 1982, there was evidence of a decline over the next decade, and the author is not optimistic about the future of the species in that country.

The otter is found throughout **China**, but like the other species found there, numbers have decreased in recent years (FOSTER-TURLEY and SANTIAPILLAI, 1990). This species, and *Aonyx cinerea,* are listed under *The Schedules of Nationally Protected Fauna and Flora in China.* The Eurasian otter is found in the provinces of Sichuan, Yunnan, Shaanxi, GaoLi, Guangxi, Fujian, Zhejiang, Heilongjiang and Jiangsu.

Despite being protected, the otter is still hunted. It is highly valued as a fur bearer and illegal killing has resulted in its decline; hunting returns showed that the number of pelts reported in 1980-82 was 382; 6.75% of the 1950s total (SHENG, 1992. TIEYI (1992) considered the Eurasian otter to be endangered after a sharp decline in numbers along the Yangtze River during the 1960s and 1970s. The author predicted that it would become extinct in the area following the construction of the Three-Gorge Dam.

According to FOSTER-TURLEY and SANTIAPILLAI (1990) otters were found in **Hong Kong**, now part of China, in the north-west New Territories in the 1960s, but with the exception of one found in 1986, the species had not been recorded since then. In December 1997, however, R. Melisch and L. Young (pers. comm.) found fresh spraints of *L. lutra* in the Mai Po Nature Reserve in the New Territories of **Hong Kong**. The area is mangrove swamp marshes with brackish-water fish-ponds. The species is also found in **Tibet** (L. YOUNG in CONROY et al., 1998).

FOSTER-TURLEY and SANTIAPILLAI (1990) state that the species was recorded in **Taiwan**, but there is no recent information about its status.

Following the analysis of DNA taken from a 30 year-old carcass, SUZUKI, et al. (1996) proposed that the otter found on the islands of Honshu, Kyushu and Sjikoku in **Japan** was not a subspecies of *L. lutra*, but a separate species

L. nippon. Because of this, only the island of Hokkaido in Northern Japan had been included as being within the range of *L. lutra,* where a separate subspecies *L. l. whitleyi* occurred. However, according to H. SASAKI and T. SASAKI (in CONROY et al., 1998) this form of the Eurasian otter is now thought to be extinct on Hokkaido.

L nippon is now also thought to be extinct in Japan, where the last animal was found in 1986. SASAKI (1995) reported that the otter was widely distributed throughout the county until the 1920s. The population, thought to number about 20 in the early 1970s, was restricted to Shikoku Island. No animals have been seen since 1983, and few signs have been recorded; these too have been decreasing (AKOI, 1995). The species has been protected, as a national monument, since 1965.

SOUTHERN ASIA

India, Pakistan, Sri Lanka, Bangladesh, Nepal, Bhutan

All otter species in **India** are becoming rare, with populations fragmented. Little is known about the Eurasian otter. It breeds in the foothills of the western Himalayas and in some southern states. In protected areas there are thriving populations (FOSTER-TURLEY and SANTIAPILLAI, 1990). In 1996, NAGULU et al., (1997) surveyed in Western Ghats, Kerala in south-west India. Three species were reported from the area, *L. lutra, Lutrogale perspicillata* and *Aonyx cinerea,* their distributions being described as sparse. The presence of *L. lutra* was not, however, proved during the survey. There are specimens in local collections and discussions with local people suggest that the species is still found in the area, but in recent years has become less common. SANYAL (1991) stated that there are good otter populations in the intertidal zone between Calcutta and Suderbas. SHARMA, SHARMA and MATHUR (1995) regularly found tracks of the Eurasian otter on the Deydungari Islands near Hirakud Dam during surveys of the River Mahanadi in Madhya Pradesh.

V. NAGULU (pers. comm.) states that the status of *L. lutra* is a cause for concern. Despite being protected under Schedule II of the Wildlife (Protection) Act of 1972, indiscriminate poaching, habitat destruction and livestock interactions have led to an alarming decline in numbers.

TATE (1947) included **Assam** within the range of the Eurasian otter.

As in India, the otter is rare in **Pakistan**, and restricted to areas away from human populations. According to ROBERTS (1977) the species was rare along the Pakistani/Afghanistan border by the 1970s. It formerly occurred in all northern river systems to an altitude of 3,500m, and is known as the Himalayan otter (CHAUDRY, 1991). In recent years there has been a serious decline in the populations, it is currently rare in the accessible mountain regions, but absent from the plains areas. Today, it has partial protection, but bounties were paid on otters until 1970 (CHAUDRY, 1991).

Lutra lutra is the only otter in **Sri Lanka,** occurring on all river systems, where it is moderately plentiful, but numbers have declined in recent years (PHILLIPS, 1984). However, de SILVA (1991a) surveyed six rivers in 1990, and found evidence of otters at 68% of the sites visited, while in the south west highlands, otter presence was established at nearly 85% of the sites visited (60 from 71) (de SILVA, 1991b). According to de SILVA (1995b), the species in Sri Lanka has been squeezed out of much of its former range.

In **Bangladesh**, the population was once widespread, but the otter is now very rare, and absent from large tracts of the country (de SILVA, 1995a). It is interesting, however, that RAHMAN (1995) and RAHMAN (1996) when discussing endangered, rare and uncommon mammals of that country makes no mention of the otter.

From a recent survey in western **Nepal**, ACHARAYA and GURUNG (1994) concluded that the species was still quite common in the area. Population estimates of between 1,000 and 4,000 animals were based on interviews with local people. These figures are, however, considered by the authors to be exaggerated. Conflicts between man and otters are common place due to competition for fish and the disturbance of human fishing activities by otters, which are killed whenever possible by fisherman. There is evidence, however, that numbers have increased in the country, especially in areas that are relatively undisturbed.

Little is known about the status of the species in **Bhutan,** but according to de SILVA (1995a), the species is found in the Terai region of the Himalayas, of which Bhutan is a part. Material in the Zoologische Museum in Hamburg, confirmed the co-existence of both Eurasian and smooth-coated otters along the Jankosh River in 1957 (H. SCHLIEMANN, in CONROY et al., 1998). The current status is not known.

SOUTHEAST ASIA

Myanmar (Burma), Cambodia, Laos, Malaysia, Indonesia, Thailand, Vietnam

Lutra lutra cannot be clearly identified separately from the hairy-nosed otter (*L. sumatrana*) in the field. Any reports of either species have thus to be treated with caution in those regions where both species potentially occur sympatrically or parapatrically. Gaining a better understanding of the *L. lutra/L. sumatrana* complex is thus a priority point of action recommended by the IUCN Otter Specialist Group in order to enable correct conservation measures.

The otter was reported upper **Myanmar (Burma)**, but was considered rare (SALTER, 1983). The otter is not protected by national law and its present status is unknown.

FOSTER-TURLEY and SANTIAPILLAI (1990) state the species was recorded in **Cambodia**, but there is no recent information about its status.

The species may be one of four otters found in **Laos**, but no detailed work has been undertaken on these animals (de SILVA, 1995a). After surveying Sekong Province and Hongsa Special Zone, and reviewing the literature on the mammals of Laos, BERGMANS (1995) found reports, but no recent hard evidence for the presence of *Lutra lutra* in the country.

The Eurasian otter is found on the island of **Sumatra** and the western regions of **Indonesia**, where it is considered threatened (ASMORO and KUSUMAWARDHANI, 1995). Initially, MELISCH et al. (1994) found evidence suggesting that the species might be found on **Java**, but more recent investigations, suggest that this claim was due to misidentification; MELISCH et al., (1996) undertook extensive field surveys, and examined museum collections, and from these studies concluded that the Eurasian otter never reached Java. PAYNE et al. (1985) listed *L. lutra* from the island of **Borneo**, but stated its status as uncertain, and reviewing the literature, CONROY et al. (1998) found no concrete evidence of the species from that island. There is, however, evidence of a *Lutra* sp., but because of the *L. lutra/L. sumatrana* complication, we cannot be certain as to which species this is.

None of the four species of otters found in Indonesia are currently protected, although their status is threatened (KUSUMAWARDHANI et al, 1994).

Along the **Malaysian Peninsula**, there has been only one record of the Eurasian otter, which according FOSTER-TURLEY and SANTIAPILLAI (1990), was recorded in 1978 on Langkawi Island. SIVASOTHI and NOR (1994), however, reviewed the status of the species in the area and pointed out that there are only two records, both from 1900 (FLOWER, 1900; MOLLER, 1900); the first is unconfirmed, the second a female from Pulau Langkawi. It is to this last named that FOSTER-TURLEY and SANTIAPILLAI (1990) refer, mistaking the reference in MEDWAY (1978) for a recent record and not one made over 70 years previously. SIVASOTHI and NOR (1994) stated that the species might not have lived in Malaya this century.

LEKAGUL and McNELLY (1997) reported the presence of the otter from the mountainous part of **Thailand**, KRUUK et al. (1993, 1994) found it to be abundant in the Uthai Thani Province in west Thailand, while PIERCE et al. (1990) recorded the species in the southern part of the country. According to KRUUK et al. (1993) the original distribution of the species was in the north and northwest of the country. All otters in Thailand have been protected since 1961, being are listed under Schedule 1 of the W*ild Animals Preservation and Protection Act.*

In **Vietnam**, the current status of the species is uncertain, it has, however, been identified as living in seven of the northern provinces of that country *viz.* Kuangbinh, Hatinh, Nghean, Laitiau, Hoabinh, Bacthai, Zalam and Phang-Vong Island (ROZHNOW et al., 1993). ANH et al. (1995) report the species range is restricted to north of the 17^{th} Parallel, in both marine and freshwater habitats. The species remain unprotected in the country, where they are killed for both food and their pelts.

THE OTTER IN AFRICA

Four species of otter breed in Africa – three, the Cape clawless otter (*A. capensis*), the Congo clawless otter (*A. congica*), the spotted-necked otter (*L. maculicollis*) and the Eurasian otter. The first three species are sub-Saharan in distribution and are endemic to Africa, while the last named is restricted to rivers and wetlands flowing from the Atlas mountains (ROWE-ROWE, 1990, 1991). Other than a few surveys, there has been little detailed work on the Eurasian otter in Africa

The species is considered to be very localised in **Algeria**. It is found in the western coastal hills, and the northeast of the country (ROWE-ROWE, 1990). The population in the west is thought to be visitors from neighbouring

Morocco (KOWALSKI and RZEBIK-KOWALSKI, 1991). In **Morocco**, the otter is widely distributed in rivers of the foothills of the Moyen Atlas. It is also found on rivers on the Sahara side of the Atlas; but is scarce and populations are fragmented in the lowlands (BROYER et al., 1984; MACDONALD and MASON, 1984; AULANGIER, 1985). Recently, JACOBY and WILLIAMS (1995) reported signs of otters were regularly seen in the middle of the country, but were surprised that there was no evidence of the species from the fish-rich estuaries. In **Tunisia,** the southern limit of the species in Africa, the otter is restricted largely to the land west of Tunis and north of the Oued Medjerda; within this area, however, it is widespread and locally common (ROWE-ROWE, 1990). An isolated population was reported in the south and east of the region (MACDONALD and MASON, 1983).

In a recent review on the otters of Africa, NEL and SOMERS (in press) concluded that apart from Tunisia, where it is still locally common, the species has become rare and more localised or restricted in distribution. All reports suggest that the populations are declining. The species is totally protected in all three African countries.

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DNA TYPING FOR INDIVIDUAL AND POPULATION STUDIES OF THE EURASIAN OTTER, *Lutra lutra*

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Abstract: We have developed a DNA typing system for the Eurasian otter for identification and sexing of individuals, and for estimation of population genetic composition. The system involves the detection of microsatellite polymorphism, and the presence or absence of the male-specific SRY gene, by the polymerase chain reaction (PCR). These markers can be detected in DNA extracted from both tissue and spraints. Primers for thirteen microsatellites and the SRY gene are presented. Between three and eight of these are also polymorphic in four other Lutra and Aonyx species, but are less polymorphic in the Brazilian otter, *Pteronura brasiliensis*, and the sea otter, *Enhydra lutris*. Individual DNA profiles of carcasses from two Scottish areas (Deeside and Shetland) nearly all showed mismatches. The proportion of mismatched loci was much higher in Deeside than in Shetland due to higher levels of polymorphism. The success rate of typing microsatellites and the SRY locus in DNA from wild-collected spraints of fresh appearance lies between 10% and 50%. We expect that this system will be useful for studies in which genetic data on otters must be obtained by non-invasive means.

INTRODUCTION

The Eurasian otter, *Lutra lutra*, displays great differences in density, habitat and behaviour throughout its range (KRUUK, 1995), and is a focus of conservation effort following rapid population declines in the mid-1950s (STRACHAN and JEFFERIES, 1996). Likewise, most otter species are of biological interest and are important targets for conservation (FOSTER-TURLEY et al., 1990). However, even basic information such as numbers present is difficult to obtain because otters are rarely observed, and are very difficult to trap, mark and recapture. As an alternative, we are developing a method for individual identification using genetic profiles detected in DNA from otter spraints. This involve the use of the polymerase chain reaction to detect genetic polymorphism at nuclear microsatellites developed for the Eurasian otter (DALLAS and PIERTNEY, 1998), and the presence or absence of the male-specific SRY gene. The microsatellites seem sufficiently polymorphic to be useful in between one and six other otter species (but not in other mustelid species), the SRY locus is male-specific in all mustelid species tested, and none of these markers is detectable in two common prey species.

MATERIAL AND METHODS

Microsatellite loci were isolated from genomic libraries of one male *L. lutra* using standard (RASSMANN et al., 1991) and enrichment (ARMOUR et al., 1994) methods. Microsatellite-containing clones were sequenced, and PCR primers designed (DALLAS and PIERTNEY, 1998). PCR products were

generated from three Scottish male *L. lutra* from Aberdeenshire, Dumfries and Galloway, and Shetland using the conserved primers SRY 593 and SRY 764 (PALSBOLL et al., 1992). Products were sequenced in both directions, then the primers
Lut-SRY F (5′ GAATCCCCAAATGCAAAACTC 3′) and
R (5′ GGCTTCTGTAAGCATTTTCCAC 3′)
were designed to detect as short a product as possible (70 bp), and to avoid regions of high G+C content. Microsatellites were amplified in otter DNA samples using radioactive PCR. Forward primers were end-labelled with gamma 32P ATP, and the PCR conditions were 1 x NH_4 buffer, 0.01 units / μl Taq DNA polymerase (both BioLine), 2.5 mM $MgCl_2$, 200 μM dATP, dCTP, dGTP, dTTP, and 0.25 μM of each primer. The PCR programme used was: 90 °C / 2 min. 15 sec., [90 °C / 15 sec., 60 °C - 0.5 °C per cycle / 15 sec.] x 20 cycles, [90 °C / 15 sec., 50 °C / 15 sec.] x 15 cycles, 72 °C / 1 minute. Microsatellites were resolved on denaturing PAGE gels, then detected by autoradiography at – 80 °C. Allele sizes were determined relative to an M13 DNA sequencing ladder, and were scored with reference to those of four standard individuals. The SRY region was amplified using non-radioactive PCR. Unlabelled primers were used at 0.5 μM each, and other PCR conditions were as for radioactive PCR. SRY products were detected on EtBr-stained agarose gels on the basis of size relative to a 100 bp ladder size marker. DNA was extracted from carcass tissue using the salt-chloroform method (MÜLLENBACH et al., 1989), and from spraints using the guanidine thiocyanate-silica method (BOOM et al., 1990).

RESULTS AND DISCUSSION

Thirteen microsatellites displayed high levels of polymorphism in a standard panel of 32 *L. lutra* from Scotland, SW England, Wales, SW Ireland and NE Germany (Table 1). These levels are within the range found in other mammalian species, and appear adequate for providing information for both individual identification and population comparisons. The alleles of the GATA loci were well defined whereas those of the CA loci were more difficult to score due to stuttering and background smears. The 13 microsatellites were also tested for polymorphism in six other otter species representing all four otter genera, in four other mustelids, and in one non-mustelid carnivore. All loci were polymorphic in between one and six other otter species (Table 2). Again, the GATA loci were much easier than the CA loci to interpret as alleles due to the lack of stutter products. Levels of polymorphism appeared to be much lower in the four other mustelids. The SRY primers detected a male-specific product of the expected size in all the otter and other mustelid species except European badger, in which no products were detected. None of the primers detected products in the non-mustelid species tested: neither in the spotted hyaena, nor in European eel and Atlantic salmon. The latter are common prey species whose DNA is likely to be copurified with otter DNA from spraints.

Table 1. Attributes of 13 microsatellites in 32 *L. lutra* from Britain, Ireland, and Germany; EMBL accession numbers Y16292 to Y16304

Locus	Primers: 5' to 3'	Repeats	H	Alleles	Sizes (bp)
Lut435	F TGAAGCCCAGCTTGGTACTTC R ACAGACAGTATCCAAGGGACCTG	$(CA)_{29}$	0,61	10	130 - 160
Lut453	F AGTGCTTTGTACTTGGTAATGG R AGACTGAAAGCTCTGTGAGGTC	$(CA)_{26}$	0,50	8	175 - 203
Lut457	F CAGGTTTATGGCTTTATGGCTTTC R CAGGGTTTGATTTCTGGTGAGG	$(CA)_{26}$	0,52	9	224 - 252
Lut604	F TATGATCCTGGTAGATTAACTTTGTG R TTTCAACAATTCATGCTGGAAC	$(CA)_{26}$	0,48	5	197 - 211
Lut615	F TGCAAAATTAGGCATTTCATTCC R ATTCTCTTTTGCCCTTTGCTTC	$(CA)_{27}$	0,65	7	244 - 262
Lut701	F GGAAACTGTTAAAGGAGCTCACC R CAGTGTTCATAAGGATGCTCCTAC	$(GATA)_{11}GAA(GATA)_2GAA(GATA)_4$	0,57	5	192 - 208
Lut715	F TTCACAATAGCCAAGATATGGAC R TGGCATAATATCCTTTCTCATGG	$(GATA)_6GAT(GATA)_7GAT(GATA)_5$	0,52	6	197 - 217
Lut717	F TGTTGCCTTCAGAGTCCTGTG R GTCAGGCATTGTAACATATTCTCAG	$(GATA)_{12}$	0,61	6	175 - 203
Lut733	F GATCTCATTTTAAATGTTCTTACCAC R TGGTTCTCTTGCAGGATCTG	$(GATA)_4GAT(GATA)_{12}$	0,56	5	164 - 192
Lut782	F GAGATATCACTAAGCAATACACGATG R ACAAAGACTGAGCAAAACAAGC	$(GATA)_6GAT(GATA)_{10}$	0,47	6	161 - 197
Lut818	F AAGGATGTGAAACAGCATTG R CCATTTTATACACATAAATCGGAT	$(GATA)_{11}$	0,59	6	150 - 178
Lut832	F TGATACTTTCTACCCAGGTGTC R TCCTTAGCATTATCTTATTTACCAC	$(GATA)_{11}$	0,44	6	178 - 198
Lut833	F CAAATATCCTTTGGACAGTCAG R GAAGTTATCTAATTTGGCAGTGG	$(GATA)_{15}$	0,59	8	155 - 183

H : observed heterozygosity

Population samples consisting of carcasses from two Scottish areas, Deeside and Shetland, were typed for the eight GATA microsatellites Lut 701–833. Deeside and Shetland represent the upper and lower extremes of levels of population polymorphism in *L. lutra* from the UK (J. DALLAS, unpublished data). The degree of matching among all possible pairs of individual DNA profiles was determined using the programme MATCHPROG (P. PALSBOLL, personal communication). The distributions of the numbers of mismatched loci show that in Deeside, which contains the highest levels of polymorphism, most pairs mismatch at five or more loci (Fig. 1). In Shetland, which contains the lowest levels of polymorphism, most pairs mismatch at two to four loci, and 7% of pairs either match completely or mismatch at one locus only.

Table 2. Cross-species utility of microsatellite and SRY primer sets from *L. lutra*

		[a]Locus													
Species	N	Lut435	Lut453	Lut457	Lut604	Lut615	Lut 701	Lut715	Lut717	Lut733	Lut782	Lut818	Lut832	Lut833	[b]Lut-SRY
Otters															
L. canadensis, river otter	12	7	4	5	3	m	5	5	m	6	4	6	m	m	3M+ 4F-
L. maculicollis, spotted-necked otter	6	4	2	3	5	4	4	3	m	m	3	m	3	m	1M+ 2F-
Aonyx capensis, Cape clawless otter	5	2	3	4	2	4	4	3	m	m	2	3	2	2	4M+ 1F-
A. cinerea, Asian short-clawed otter	2	3	2	3	m	3	3	2	2	3	2	2	3	2	
Enhydra lutris, sea otter	4	m	3	4	2	2	2	m	m	m	m	m	2	m	2M+ 2F-
Pteronura brasiliensis, Brazilian otter	4	m	3	m	m	m	3	m	m	3	2	m	2	m	2M+ 2F-
Other mustelids															
Martes martes, pine marten	5	m	m	m	m	2	-	-	m	m	m	m	m	m	2M+ 2F-
Mustela vison, American mink	4	m	m	m	4	m	-	-	m	3	2	2	-	m	2M+ 2F-
Meles meles, European badger	4	-	m	m	m	m	-	-	m	m	-	m	-	m	2M- 2F-
Gulo gulo, wolverine	4	-	m	m	2	2	-	-	m	m	m	m	m	m	2M+ 2F-
Carnivore															
Crocuta crocuta, spotted hyena	4	-	-	-	-	-	-	-	-	-	-	-	-	-	2M- 2F-
Contaminants of spraint DNA															
Anguilla anguilla, European eel	4	-	-	-	-	-	-	-	-	-	-	-	-	-	all -
Salmo salar, Atlantic salmon	4	-	-	-	-	-	-	-	-	-	-	-	-	-	2M- 2F-

[a] values are the number of alleles detected; [b] results are given only for individuals previously identified as males or females
N, number of individuals tested; m, monomorphic; +, expected product; -, no product

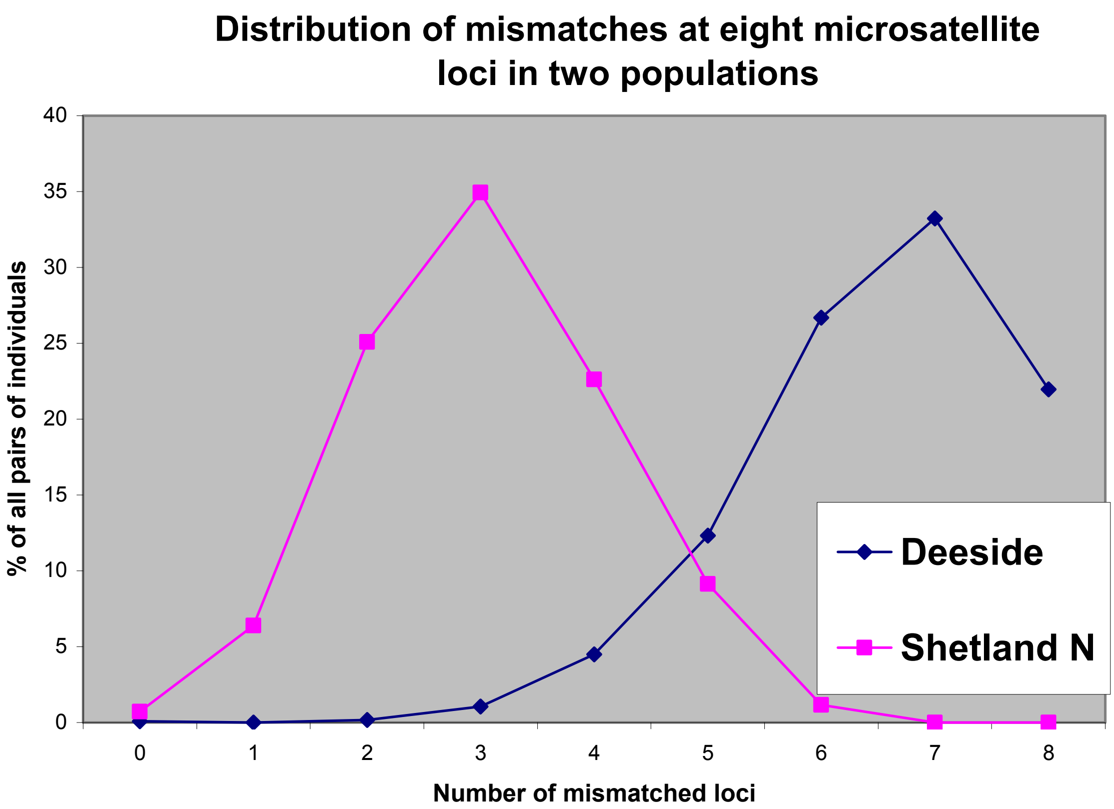

Figure 1. Distribution of mismatches at eight microsatellite loci in two populations

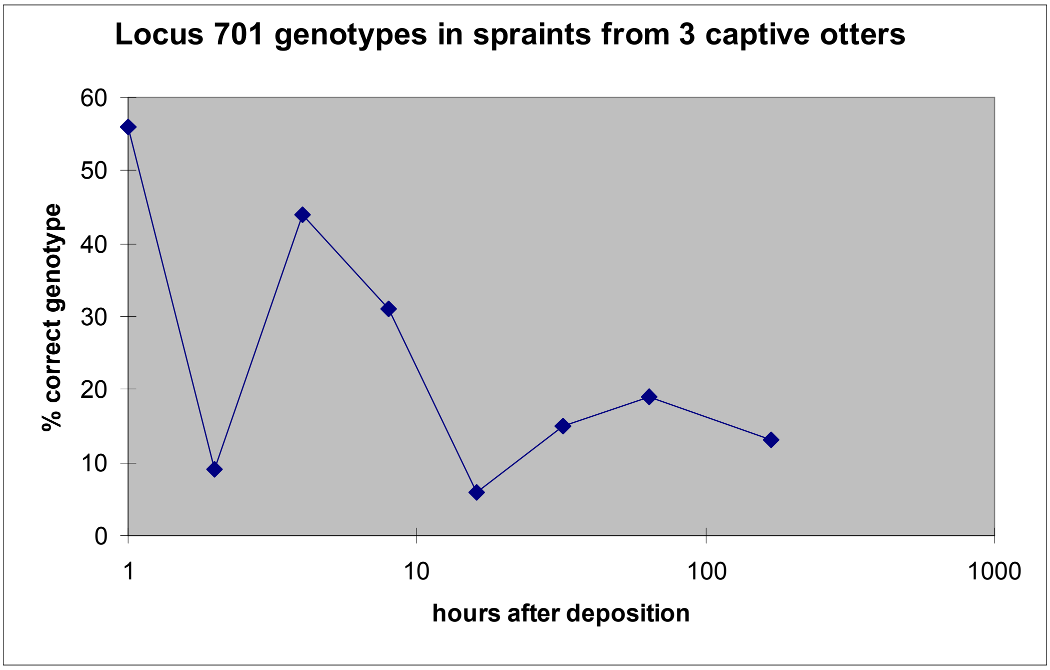

Figure 2. Decay of detection rate of one microsatellite

The decay of detection rate of one microsatellite, Lut 701, was studied in spraints collected from three captive otters held at the Institute of Terrestrial Ecology Research Station at Banchory (Fig. 2). The correct genotypes of these individuals had been determined previously from blood samples. The X-axis shows the time in hours during which spraints were aged at ambient temperature prior to DNA extraction. The Y-axis shows the percentage of spraints in which the correct genotype was detected. The rate of correct detection decayed rapidly from a maximum of around 60% at deposition to a plateau of 10-15% after 16 hours, with a half life of around 8 hours. The predicted rate of detection for fresh spraints deposited overnight and collected the next morning is 15%: this was the rate of typing of three microsatellites and the SRY locus in spraints of wild otters collected from Deeside (J. DALLAS, unpublished data).

The rate of detection of seven of the GATA microsatellites (all except 782) and the SRY locus in DNA extracted from spraints is currently being assessed by collection of spraints of fresh appearance from sites in SW England. The results from collections made during winter suggest that the rate of detection falls between 10% and 50%. When sufficient polymorphic microsatellites become available for all otter species, we expect these DNA typing methods to provide useful data for studies in otter ecology and conservation.

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PECULIAR ANATOMICAL FEATURES IN THE HEART AND LIVER OF THE EURASIAN OTTER *(LUTRA LUTRA)*

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Abstract: Two remarkable anatomical features of the Eurasian otter are reported.
(i) In the fibrous skeleton of the otter's heart, hyaline cartilage and bone was found at the sites of the *Trigona fibrosa,* where it was embedded into coarse connective tissue without clear demarcation. Bony areas differentiated in the centre of the cartilage, thus resembling endochondral ossification. Cartilage and bone obviously serve to stabilize the heart during contraction and correspond to similar supportive structures described in the heart of various domestic animal species. Fibrocartilage is found in the dog, hyaline cartilage in the horse, and bone is present in large ruminants. Transformation of connective tissue into fibrocartilage, hyaline cartilage and subsequently into bone is likely in all these animals and is considered to be an age-dependent process.
(ii) In the otter's liver we demonstrated venous sphincters in sublobular veins. Similar sphincters have been previously described in the liver of the dog but were absent in commonly used laboratory animals (rat, mouse, guinea pig, rabbit). Venous sphincters consisted of circularly or spirally arranged smooth muscle bundles, which upon contraction could lead to considerable reduction of blood flow. Immunohistochemical staining for nerve fibres failed to demonstrate innervation of these sphincters. Therefore, the smooth muscle cells are suggested to respond to blood-borne substances (like catecholamines, serotonin) or to metabolites of endothelial cells or nearby tissue (like endothelines, prostaglandines, NO).

INTRODUCTION

The skeleton of the heart comprises connective tissue structures at the border between the aorta or pulmonary trunk and the heart, as well as between the atria and ventricles. It consists of the *Anuli fibrosi* and the *Trigona fibrosa*, known to be composed of coarse connective tissue, fibrocartilage, hyaline cartilage. Bones are regularly seen in the cardiac skeleton of large ruminants (NICKEL et al., 1984). These structures obviously serve to separate atrial and ventricular myocardium morphologically as well as functionally, to stabilize the heart during contraction and relaxation, and to provide insertion for heart muscle fibres. Pieces of cartilage were found in three of ten interatrial septa of Eurasian otter hearts in the course of anatomical studies (ZOGALL, 1992) thus giving the impression of occurring accidental.

We examined the fibrous skeleton of the heart of Eurasian otters (*Lutra lutra*) in order to establish whether cartilage or bone is a regular constituent and to correlate its occurrence to age and sex of the respective animals.

The term "venous sphincter" specifically defines tufts of smooth muscle bundles subjacent to the endothelium inside the internal elastic lamina.

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TISCHENDORF (1939) described protrusions into the lumen of sublobular veins (SLV) in the liver of dogs and some other mammalian species, and speculated that diving aquatic animals, like the Eurasian otter, might also have venous sphincters in their livers. AHARINEJAD et al. (1997) studied these sphincters in the dog in order to find out whether they are innervated and whether they are affected by bloodborn substances.

Having obtained livers from a number of otters, we wanted to examine whether Tischendorf 's suggestion is correct and if so, whether venous sphincters in the otter also lack innervation.

ANIMALS, MATERIAL AND METHODS

Tissues were collected from 13 road-killed otters, which had been frozen and thawed for pathological and toxicologic examination. Samples were fixed in 4% buffered formalin and embedded in paraffin for routine histological staining procedures and for immunohistochemistry (IHC).

Heart: To study the fibrous skeleton in the heart, we stained sections with Hematoxylin and Eosin (H&E), Alcian blue at pH 2.5 and 4.0, Safranin O, and Hale's colloidal iron preparation to demonstrate acidic extracellular matrix (ECM), and Peroidic Acid Schiff reaction to demonstrate the presence of glycogen.

Liver: Sublobular veins in the liver were depicted by staining with anti-α-smooth muscle-actin and their possible innervation was studied by using general marker proteins for peripheral nerves (anti-PGP 9.5, anti-Leu-7, anti-Neurofilament, and anti-S-100 protein). An indirect IHC method (biotinylated secondary antibody, and Avidin-Biotin-Complex with diaminobenzidine (DAB) development) was used to demonstrate antigenic sites.

RESULTS

Heart: In the fibrous skeleton of the otter's heart, hyaline cartilage and bone were found at the sites of the subaortic curtain between the lumen of the aorta and the left atrium and the *Trigona fibrosa*, where cartilage was embedded into coarse connective tissue without clear demarcation (Fig. 1). Bony areas differentiated in the centre of the cartilage, thus resembling endochondral ossification. In addition, single small pieces of cartilage were seen in *Anuli fibrosi* and in the interatrial septum. Cartilage was found in all 13 samples examined and bone in seven of these (5 adults, 2 subadults).

Liver: We demonstrated the presence venous sphincters in sublobular veins. Sphincters consisted of circularly or spirally arranged smooth muscle bundles, best seen after anti-α-actin staining (Fig. 2a). Immunohistochemical staining for nerve fibres failed to demonstrate any innervation of these sphincters, although our staining method readily showed nerve fibres in periportal areas, thus serving as a positive control (Fig .2b).

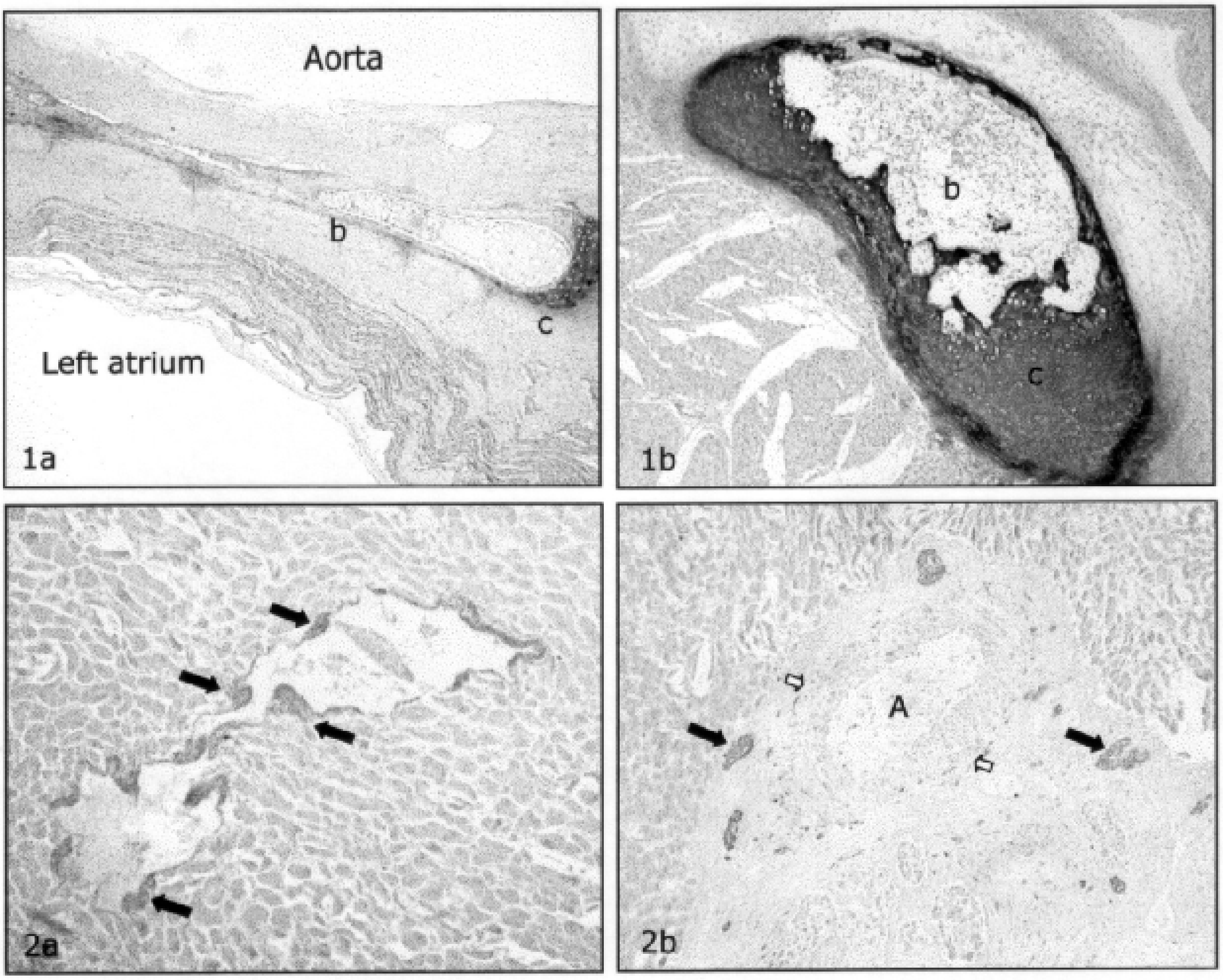

Figure 1. Heart skeleton. 1a) bone (b) with a cap of cartilage (c) in the coarse connective tissue of the subaortic curtain between the lumen of the aorta and the left atrium. 1b) bone (b) differentiation in a piece of cartilage (c) situated in the left *trigonum fibrosum.*

Figure 2. Liver. 1a) α-actin positive smooth muscle bundles (arrows) in venous sphincters of a sublobular vein of the liver of the Eurasian otter. 1b) Immunohistochemical demonstration (Anti-Leu-7) of nerve fibres (black arrows) and the perivascular plexus (white arrows) in the periportal area of the liver.

DISCUSSION

Cartilage and bone in the fibrous skeleton of the otter's heart correspond to similar supportive structures known in domestic species. Fibrocartilage is found in the dog heart, hyaline cartilage in the horse, and bone is present in large ruminants. Transformation of coarse connective tissue into fibrocartilage, hyaline cartilage and finally bone in all these animals is an age dependent process (NICKEL et al., 1984). This is confirmed by our results as five of the seven otter hearts which showed bone were from adult animals. The remaining two were from male subadults, a fact that is probably due to a slightly bigger heart of males compared to females of the same age (ZOGALL, 1992). Our findings include the first description of bone in the heart skeleton of a relatively small animal. This indicates that mechanical stress but not the size of the heart is important for bone differentiation within the fibrous heart skeleton.

Venous sphincters in the liver may substitute for venous valves to prevent retrograde blood flow (AHARINEJAD et al., 1997). Contraction of the sphincters may reduce blood flow in the preceding central veins and sinusoids. This could affect diffusion of metabolites and may also serve as a device to regulate core body temperature. As the sphincters are apparently not innervated, smooth muscle cells probably respond to blood born substances (like catecholamines and serotonin) or metabolites from nearby tissue. It is known from the dog that Endothelin-1 leads to significant contraction of smooth muscle sphincters in sublobular veins (AHARINEJAD et al., 1997).

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THE EFFECT OF HABITAT DESTRUCTION, ISOLATION AND HUMAN INDUCED STRESS ON SURVIVAL OF THE GIANT OTTER (*Pteronura brasiliensis*) IN PERU AN ASSESSMENT OF MANAGEMENT OPTIONS USING A SIMULATION MODEL

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Abstract: We present a simulation model for the giant otter in Peru that allows the survival chance of the species to be assessed. Based on this, we reveal on what factors ought a preservation management be focused to ensure long-term regional otter persistence.

INTRODUCTION

The giant otter (*Pteronura brasiliensis*) is one of the world’s most endangered otter species. In Peru, they only occur in oxbow lakes, which line the large rivers. While the otter was widespread in the past, only a remnant population survived. There is a number of threats facing the species (STAIB, 1995; SCHENCK, 1998), such as clear felling along the shore lines of the oxbow lakes, gold mining making use of mercury (GUTLEB et al., 1993), domestic animal diseases and tourism. To effectively safeguard this species, guidelines are needed that allow the relative importance of these threats to be determined and appropriate management priorities to be set. We present a simulation model based on empirical data on the giant otter’s ecology (social behaviour, reproduction, dispersal) taken from a monitoring programme in the Departamento Madre de Dios, Peru, (SCHENCK and STAIB, 1995). This model allows these goals to be addressed on a wide front.

STUDY AREA

The study area of the monitoring, the Manu National Park (NP), is located in the Departamento Madre de Dios (Peru) and covers about 18.000 km^2 (for further details see SCHENCK, 1998). Eighteen oxbow lakes of the Manu River have been observed. The monitoring data reveal that giant otters live in separate family groups, each using one or more oxbow lakes. Immigration into a group only occurs when a reproductive position becomes vacant. At the age of two years, the cubs become subadult, leave the group and migrate over large distances (up to 100km; SCHENCK, 1997) to find both a vacant oxbow lake and a partner to establish a new group. Thus, the giant otter population in Peru can be described as a ”metagroup” (in imitation of the concept ”metapopulation” (LEVINS, 1969) that can only persist over the long term if a certain balance between group extinction and oxbow lake recolonization is ensured.

METHODS AND MODEL

The dynamics of the giant otter population in Peru can be described as a sequence of recolonization and extinction processes. In order to analyze the role of both the otter's ecology and the landscape, simulation models for each of the processes should be developed.

A simulation model for the oxbow lake recolonization

The monitoring in the Manu NP (SCHENCK and STAIB, 1991-96, personal observation) shows that the recolonization of a vacant oxbow lake takes much longer to happen (several years) than the filling of a vacant reproductive position in an otter group (few weeks). Hence, the recolonization model has explicitly to take "otters meeting at a given vacant oxbow lake" into account. The following assumptions are based on the monitoring data: (a) The population contains (NG) otter groups, each emitting (NF) floaters per year so that we get a total number (NG*NF)*$\frac{1}{\mu}$ of floaters with μ being the floater mortality. The sex ratio among the floaters is assumed to be 1:1, because of the fact that the sex ratio is 1:1 within an otter group (SCHENCK and STAIB, personal observation) and all subadult individuals emigrate, regardless of their sex. (b) Each floater visits the given oxbow lake VS times a year, where the actual moment of visiting is random. (c) A visiting otter waits (TW) days for a partner and leaves the oxbow lake in case of failure. (d) The oxbow lake is said to be recolonized if at least once two or more otters of different sex meet each other and started using the lake. With these rules, otters meeting be simulated and the yearly recolonization probability (RC) an be determined.

A simulation model for the local group dynamics:

The following assumptions are based on the monitoring data of the giant otter's reproduction and social behaviour in the Manu NP (STAIB, 1995). (a) An otter group consists of one reproductive pair, its newborns (0-1 year old cubs) and its yearlings (1-2 year old cubs). (b) In each year, each group member has some chance of dying or progressing to the next age-class, while the yearlings become floaters. (c) Since the yearlings participate in group hunting and baby sitting, their number strongly influences the mortality of the newborns. However, even if the otter group is large enough to sustain itself, there is some basic newborn mortality (m_o), which is correlated to the size of an oxbow lake (SCHENCK, 1998), but also reflects the group's exposure to human induced threats (e.g. domestic animal diseases, mercury-contaminated fish). (d) The reproductive female is sensitive to human disturbance. The resulting stress can affect female mortality, female condition and thus newborn mortality (due to starvation). This effect can also be found under conditions of captive breeding (GATZ, 1998; SYKES, 1998). (e) When the reproductive female dies, two alternatives can occur. Firstly, as long as some yearlings are remaining in the group, the vacant position is taken by a new female from outside. But all newborns will die so that no yearling will be found in the next year. Secondly, when yearlings are missing the group is taken to be extinct. (f) All age-class specific mortalities can be extracted from the monitoring data. Using these rules, the group dynamics can be simulated and both the mean lifetime (TG) and the yearly number of emitted floaters (NF) determined.

RESULTS

A balance between recolonization and extinction is indispensable for long-term regional survival of the giant otter in Peru. Two questions will be addressed: (a) What conditions have to be met for a successful recolonization?, and (b) What role do the otter groups play?

Conditions for a successful oxbow lake recolonization

Figures 1a-b show some results of the recolonization model. As the bullet indicate, there is a critical number of otter groups (NG_{crit}) only above which a recolonization is almost certain ($RC \approx 1$). Below this critical value, the probability of recolonization (RC) rapidly decreases and the number of otter groups (NG) further declines. In this case we get a strong downward trend in both (RC) and (NG), each amplifying the negative effect of the other. This means that long-term regional otter survival can only be attained if the critical number of otter groups (NG_{crit}) is exceeded. But we also can see that, whenever the floater mortality μ increases (Figure 1a) or the number of floaters NF a single otter group emits per year decreases (Figure 1b), the required minimum number of otter groups (NG_{crit}) increases. Due to such a change, a former safe system may become critical. This shows that when the number of otter groups is already low the population is very sensitive to any further deterioration of dispersal or local conditions.

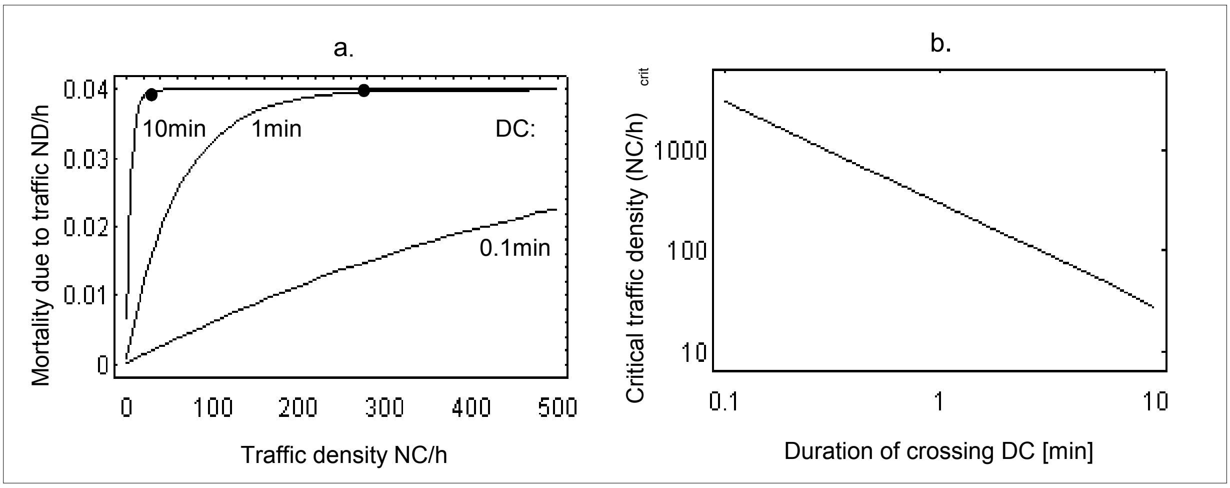

Figure 1. Recolonization probability RC versus number of otter group NG for different values of (a) floater mortality μ and (b) number of floaters NF emitted per otter group and year.

Local conditions for long-term regional otter persistence

To reveal what local conditions have to be met to ensure long-term regional otter survival, the group dynamic model can be used. Figures 2a-b indicate that, whenever the degree of stress (ST) or the basic mortality (m_o) in an oxbow lake increases, the otter population suffers twofold: both the yearly number of emitted floaters (NF) (Figure 2a) and the mean lifetime (TG) (Figure 2b) of the relevant otter group decreases, each jeopardizing the required balance between otter group extinction and oxbow lake recolonization. Hence, long-term regional otter persistence can only be sustained if there is minimum number of oxbow lakes ensuring both a low basic mortality and a low degree of stress. This means that large oxbow lakes, far away from domestic animals, gold mining and human disturbances, are indispensable for the survival of the giant otter population in Peru.

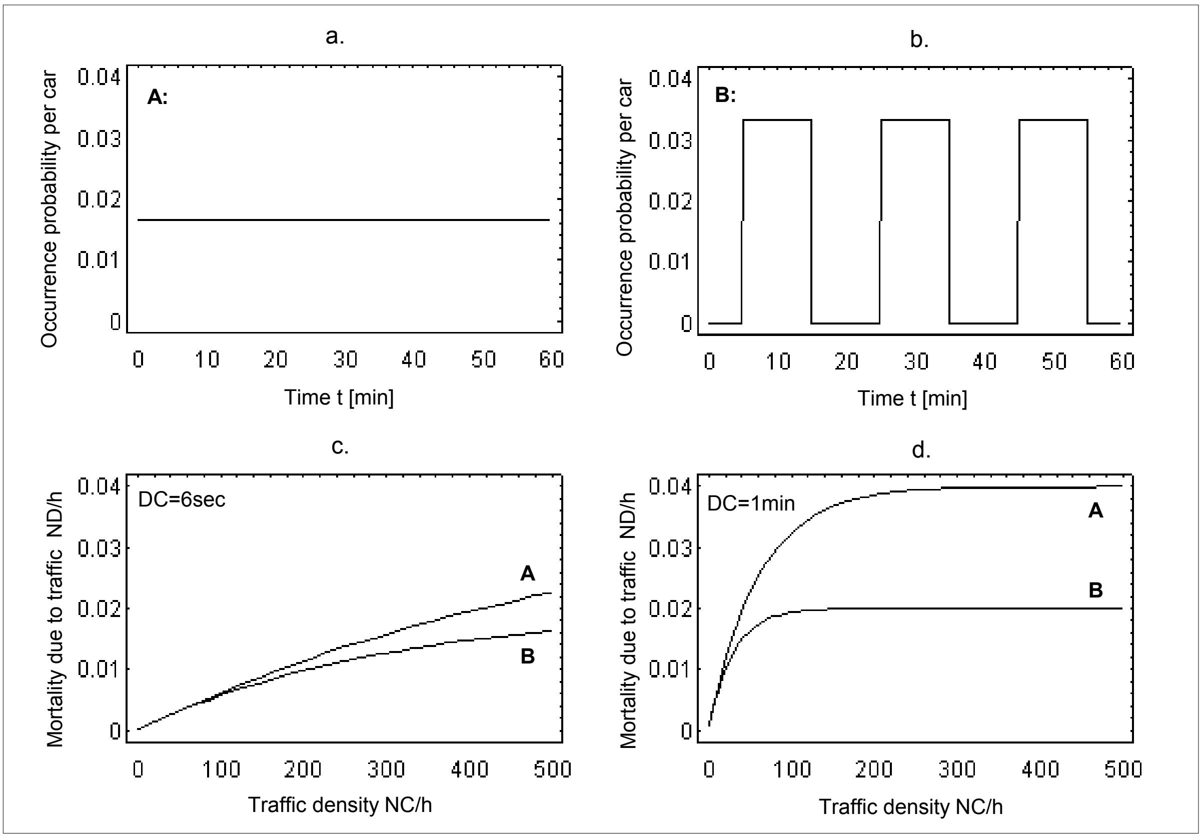

Figure 2. (a) The yearly number of emitted floaters NF and (b) the mean lifetime TG of an otter group versus the index of stress ST for different values of the basic mortality m_o.

Consequences for the tourism in the Manu National Park

These findings demonstrate the special role of tourism, which is both a viable opportunity (it is an alternative to rain forest destruction and other unwanted land use options) and a danger (it occurs in the otter habitat and becomes a stress factor). Thus we have to look for a compromise. One possibility is to allow tourists to visit those oxbow lakes where the effect of an increasing stress on giant otter regional survival is minimum. Figures 2a-b indicate that, as long as the basic mortality m_o of the newborns in an oxbow lake is high, there is no possibility of meeting the required local conditions for long-term regional survival (large values for TM and NG) so that the destabilising effect of an increasing stress is only low. In the case of a low m_o, however, this effect is extremely high. Thus the basic mortality m_o can be used for ranking all oxbow lakes according to the impact of tourism on the Giant otter regional survival. Based on the resulting rank order, appropriate protection priorities can be set and options for sustainable tourism decided upon. Since m_o is -correlated to the size of an oxbow lake, we get the following rule of thumb: "Keep the large oxbow lakes free from tourism. Concentrate all visitors to the small oxbow lakes." It is planned to implement these recommendations in a Manu NP management plan.

CONCLUSIONS

Disturbance regulation as an approach to sustainability

As we have seen, an appropriate regulation of disturbance opens up new opportunities to find compromising management solutions in cases where (a) a sufficient large-scale reduction of the disturbance cannot be attained, or (b) the disturbance also has some positive effect on species survival (such as tourism as an alternative to rain forest destruction). To look for a sustainable regulation of the disturbance also allows a change in the conservation focus, from a single target species to classes of species (suffering from the disturbance in the same way). However, to concentrate the disturbance to the right area is essential, otherwise negative effects can be even amplified.

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A SIMULATION MODEL FOR ASSESSING OTTER MORTALITY DUE TO TRAFFIC

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Abstract: A simulation model is presented that allows the mortality due to traffic of (especially otter) species to be determined. This model takes the spatio-temporal characteristics of both traffic and animal spacing into account. We demonstrate that appropriate regulation of traffic can considerably reduce mortality. We also analyze how the results obtained depend on the animal's social behaviour.

INTRODUCTION

Anthropogenic disturbances in Europe, such as traffic, have enormously increased the mortality rate in many (especially otter) species (KRUUK and CONROY, 1991; STUBBE, 1993; ZINKE, 1996). Therefore, conservation strategies are needed which will reduce these mortalities. Here we present a model that was originally developed for assessing mortality due to traffic of the Eurasian otter (*Lutra lutra*) in the heath and pond landscape of Upper Lusatia (Saxony, Germany). This model can also be applied to many other situations (other species, landscapes and/or kinds of disturbance).

STUDY AREA

The otter habitat in Upper Lusatia is characterized by a constellation of fish-ponds between which the otters often move. Due to optimum foraging conditions and prey density, the resident otter population is at a high density. This area is also intensively cultivated and fragmented by roads and settlements so that the danger of road kills is obvious. Empirical studies show that about 53% of all otter carcasses found in Saxony between 1950-1993 were roadkills (ZINKE, 1996). This agrees with results from Germany (62%; STUBBE, 1993) and Shetland (49%; KRUUK and CONROY, 1991).

METHODS AND MODEL

Below we present an approach which allows the mortality of otters due to traffic to be quantified and analyzed. Empirical data especially from the study in Upper Lusatia show (a) that traffic and otter spacing strongly vary in location and frequency and (b) that otters move alone or in groups (HERTWECK, personal observation). To take these effects into account, as a first step, landscape and time are divided into discrete units while otter groups are classified according to their group size. In a second step, for each unit and group class, the mortality due to traffic is separately determined. This can be done by using the simulation model developed below. In a third step, all separate results are added up giving the yearly mortality due to traffic for the whole landscape.

Dividing landscape and time into discrete units

The disturbance category ”traffic” is restricted to the landscape structure ”road”. In order to take significant differences in traffic density into account, the whole road network has to be divided into road units of equal traffic density. Time should be divided into units which correspond to the temporal scales upon which the relevant processes vary. Since traffic and otter spacing show seasonal and daily differences, the hour is a useful time unit.

The simulation model

Now we focus on a certain road unit, a certain hour and a certain otter group class. To simulate mortality due to traffic, the following assumptions are made: (a) There is a certain number of otter groups (NG) crossing the road unit in the relevant hour, where the actual moment of crossing is random. (b) Each otter group stays a certain time (DC) on the road. (c) There is a certain number of cars (NC) passing the road unit in the relevant hour, where the actual moment of passing is random. (d) An accident happens when a car passes the road unit at a moment where an otter group is crossing. (e) How many individuals are killed in an accident depends on whether a single member, or the whole group is affected. These rules indicate what model input is needed:

1. The duration of crossing DC which may depend on the group size. The larger a group is, or the stronger the social interaction between its members is, the longer a crossing event may last.
2. The frequency distribution of the crossing groups as determined from direct observations, indirect proofs (such as tracks or spraints) or telemetry. In this way, a high flexibility in input can be attained.
3. A frequency distribution of the passing cars as determined from traffic counts and,
4. The rule concerning how many group members will be killed in an accident.

By taking this information as a basis, the hour under consideration will be divided into units given by the duration of crossing DC. For each unit, it will be randomly determined whether an otter group is crossing and, in case this happens, whether one or more cars are passing. By applying the accident rule, the number of killed animals can be determined. This procedure will be repeated according to the number of units in the hour and the corresponding results will be added up. By making series of simulations, the mortality due to traffic (ND/h), i.e. the mean number of animals killed during this hour, can be determined. This quantity can be either directly analyzed or used as input into a population model. In the latter case, the relative importance of the mortality due to traffic for a species’ survival can be assessed and effective compensating strategies suggested.

RESULTS

In the following, we address two principal questions of conservation management:

(1) What effect does traffic reduction have on mortality?
(2) Can traffic pulsation be an alternative?

Traffic reduction

Results from running our model reveal (Figure 1a) that there is a critical traffic density $(NC/h)_{crit}$ above which the induced mortality is nearly constant. This means that a reduction in traffic can only lead to a significant reduction in mortality if traffic density drops below this threshold. Figure 1a also indicates that the critical traffic density $(NC/h)_{crit}$ strongly depends on the duration DC a crossing group stays on the road. But as Figure 1b reveals, only the orders of magnitude are important. As long as a crossing is rapid, $(NC/h)_{crit}$ is relatively high. But the longer a crossing lasts, the lower $(NC/h)_{crit}$ becomes and so the chance of effectively reducing mortality through in reduction in traffic. This becomes the more important the larger the crossing groups and/or the stronger the social interaction between the members.

Traffic pulsation

Finally, we address the strategy of "traffic pulsation" where, during each hour, some cessation of traffic flow will be organized (here: 50%; Figure 2b). In the remaining time, traffic density is of course correspondingly higher. The total number of cars is the same as in the "uniform" case (Figure 2a). As Figures 2c-d reveal, traffic pulsation has a strong reducing effect on mortality. This especially becomes important for higher traffic densities where traffic reduction cannot be implemented. As long crossings are rapid (Figure 2c), the effect of pulsation will be low. But especially for longer durations of crossing (Figure 2d), where the critical traffic density $(NC/h)_{crit}$ is found to be very low (see above) and so only hard to be fallen below, traffic pulsation is effective.

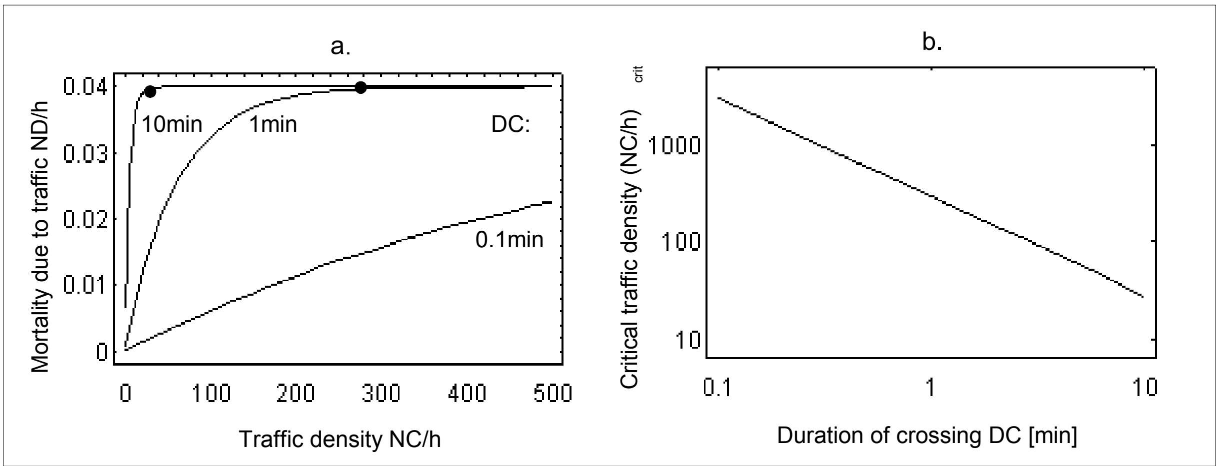

Figure 1. left) The simulated mortality due to traffic ND/h versus traffic density NC/h for different durations of crossing DC. The bullets indicate the existence of a critical traffic density only below which a reduction in traffic has a significant effect on mortality. right) The found critical traffic density $(NC/h)_{crit}$ versus duration of crossing DC (note the logarithmic scales for both).

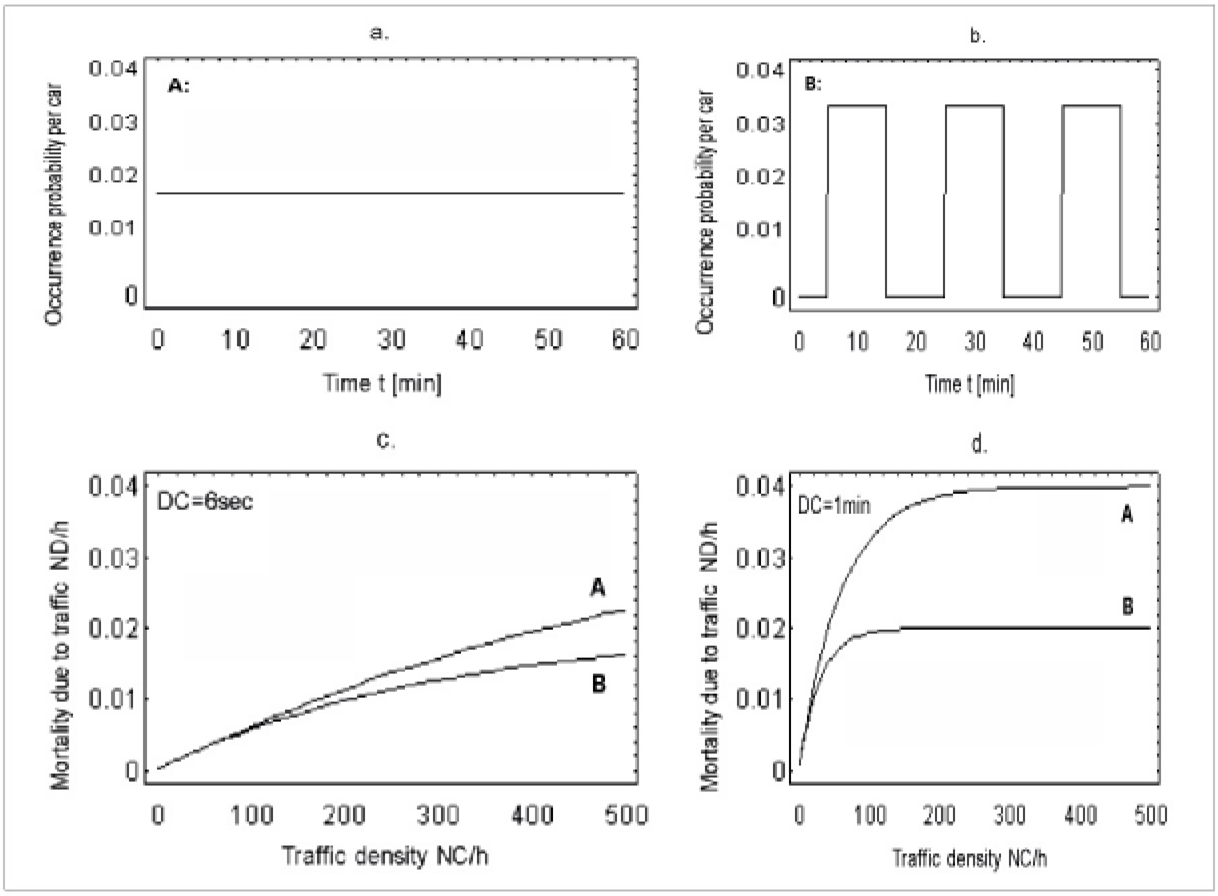

Figure 2. The probability of occurrence of a car in the course of an hour for (left) a uniform and (right) a pulsated traffic flow (here 50% cessation of traffic with a double car density in the remaining time). The mortalities ND/h resulting from these scenarios are shown versus the traffic density NC/h for a short (DC=6sec; c) and a long (DC=1min; d) duration of crossing.

CONCLUSIONS

Traffic regulation as an approach to sustainability

Results from our model reveal that, through a temporal or spatial regulation of traffic alone, positive effects on species survival can be attained. This opens up new prospects in finding compromising management solutions for situations where conservation interests compete with land use options that prevent a sufficient reduction in traffic.

Model-based criteria for determining how to effectively reduce mortality due to traffic

The obtained critical traffic density NC_{crit} represents a criterion which enables the planner, for each road unit, to determine to what extent the current traffic density ought to be reduced to have a real effect on mortality, and to estimate the chances of realizing this in practice. This allows both the road units to be ranked according to the chance of effective traffic reduction and management priorities to be set. Note that correct recommendations for management can only be given if the animal's social behaviour during spacing is taken into account. The relationship found between critical traffic density NC_{crit} and duration of crossing DC (Figure 1b) can be used as a rule of thumb.

The idea to give ”model-based criteria for evaluating the effectiveness of a management strategy” can be extended to all strategies relevant in the context of reducing mortality due to traffic (such as ”otter bridge” (STRIESE and SCHREYER, 1993) or ”traffic pulsation” (see above). With these criteria, the planner becomes able to determine, for each road unit separately, which option, out of a variety of management alternatives, is best. This allows a management plan for the whole landscape to be constructed that is geared to the peculiarities of all landscape, traffic and otter spacing.

Potentials of applying the presented approach to other situations

The standard method of simulating spatio-temporal dynamics of the *occurrence of discrete events* can be described as follows: space and time are divided into units of uniform occurrence; within the units, the dynamics is completely represented by both the frequency distribution and the duration of the occuring events.

This principle is strongly followed in the present approach: we have a standard algorithm for identifying the right units and, for each unit, a standard set of characteristics to be specified (see above). This allows the approach to be applied to other species (i.e. wild cat, badger, or marten), other landscapes and other kinds of *discrete* disturbances (i.e. trapping, hunting or putting out poisonous baits). Based on the corresponding model results, landscape-specific recommendations for a sustainable (from the target species point of view) disturbance management can be deduced.

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PROTECTED CONTACT TRAINING OF THE GIANT OTTER (*Pteronura brasiliensis*)

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INTRODUCTION

The giant otter *(Pteronura brasiliensis)* is one of the most endangered mammals in the world. Numbers in the wild are estimated between 1,000 and 5,000 individuals. Numerous human activities threaten the "river wolf" (as it is called in South America) and its habitats. The tropical rainforest of South America, home of this species, is a unique ecosystem with the planet's greatest diversity of species. The destruction of the rainforest means an enormous loss of biological diversity and dramatic changes in the earth's climate.

The Dortmund Zoological Garden is specialised in breeding South American animals and opened its giant otter exhibit in 1996 - a new winter pavilion will follow in summer 1998. Currently, we are keeping an adult pair - male "Kuddel" and female "Katja". Both were born at Hagenbeck's Tierpark in Germany - so far the only zoo outside South America, which to have bred these animals successfully. Unfortunately, the breeding female died in 1994. About 30 giant otters live in South American zoos, but only nine outside South America. Currently only the zoos of Brasilia, Dortmund and the Chestnut Otter Centre in England have breeding pairs, but neither of the latter two have successfully reared litters. Despite this, an exchange of otters with (or even between) South American zoos is almost impossible, due to bureaucratic and political reasons. Therefore, the achievement of successful breeding of giant otters is a top priority at the Dortmund Zoo.

THE PROBLEM

Four births occurred in Dortmund during 1995 and 1996. The first two litters were killed by the mother. Two other cubs were bottle fed, but both died after a few days. There might be several reasons to explain why the female killed her cubs on the first two occasions, but it seems most likely to be stress related. Giant otters are very susceptible to any human disturbance, especially within the surroundings of the natal den, which may have fatal consequences for the young.

To aid successful cub rearing the following tasks needed to be accomplished:
- build up a positive keeper - animal relationship;
- reduce stress;
- provide extensive enrichment;
- monitor the weight of the female during pregnancy
- get a milk sample and examine milk composition of giant otters.

ONE POSSIBLE SOLUTION

Husbandry training can be essential for easier management during husbandry procedures (i.e. weighing, physical examinations, ultrasounds, transport, etc.) and is a source of behavioral enrichment. Husbandry procedures can therefore be completed with low stress and safety to the otter and human. Because we have had significant success with a husbandry-training programme for pinnipeds, we decided to try something similar with the giant otters to help meet some of the previous listed tasks. Of course this is not the only solution to the problems (i.e. parents must be isolated from human disturbance/presence during cub rearing, etc.).

Giant otters are known to be potentially dangerous, and serious accidents have occurred with visitors and keepers in other zoos. Therefore, keepers should not be encouraged to enter the enclosure when otters are inside, and all training has to be done in protected contact from outside of the enclosure.

Husbandry training

Test training started in spring 1996. The formal training programme started in November 1996 and was carried out until April 1997. Training sessions took place two to three times a week and each lasted five to ten minutes. The animals were trained with operant conditioning and only positive reinforcement. This type of training is used with many marine mammals in controlled environments around the world. Positive reinforcement is anything, which occurring in conjunction with an act, tends to increase the probability that the act will occur again. The whole training process has to be a very positive experience. A highly motivated animal is crucial because its voluntary cooperation is required. We never force an animal to work! Simply offering positive reinforcement for behavior is the most rudimentary part of reinforcement training. Therefore, the animal increases the frequency, intensity, and duration of the desired behavior. Reinforcers let the animal know when it has performed the desired behavior.

To instantly reinforce an animal while it is performing, we need a signal to tell the animal "Yes, you have done that behavior correctly". This signal "bridges" the time lapse between the instant the animal performs the correct behavior and the instant it is reinforced for it. We refer to this signal as a bridge signal. For the giant otters we have used a dog whistle as the bridge and it took only a few sessions for the otters to understand the meaning of the signal.

The giant otters presented us with unique training challenges. It is very difficult to keep their attention longer than a few seconds. The male was especially suspicious. A key to early stationing (i.e. staying at a target for an extended time period) success was the use of small, but frequent reinforcers. We use herring or mackerel pieces as a reinforcer (both are favorite foods but contain too much fat for regular feeding). To train an animal it is often helpful to lead the animal through a behavior in small steps. In protected contact training, we rely almost totally on a target. A target is simply an extension of our arm. It is a focal point. We do not use our hand as a target (which is usually done with pinnipeds), because occasionally the otters might bite quickly and unexpectedly. Targets had to be made of wood or durable plastic so that the otters would not destroy them. We start by waiting for the animal to touch the end of the target with its paws or nose, then sound the bridge signal and reinforce the animal. We repeat this several times. Next, we position the target a little bit away from the animal and wait for the animal to touch the target and immediately sound the bridge signal and reinforce the animal. By now the animal knows that whenever it touches the target, it is reinforced, so it moves toward the target. Soon we have the animal following the target.

Training steps

During training sessions, we separate the male and female to get their full attention. This was almost impossible prior to the training programme, because both animals became very nervous, noisy, and aggressive. After a few sessions with positive reinforcement, this problem was almost eliminated. First, the otters learned to follow the target on land, above and under water. "Katja" learned to stand on a scale so that her weight can be monitored throughout the pregnancy. On exhibit, "Katja" follows a long target to her scale, which is fixed in a wooden frame. The curious otters would throw it around otherwise. Her normal weight is between 20 and 22kg at the end of pregnancy. While separated, "Kuddel" learned to distinguish "his" symbol target (a blue triangle) from several other symbols with different colours and shapes. This has been done to keep him busy during the more important training sessions with the female and gives a promising outlook for possible future research. With operant conditioning, it is now possible to touch "Katja" from the tail to forepaws and to station her up to twenty seconds. For successful handrearing, we needed to know the exact composition of giant otter milk - which has never been examined. To achieve this we created a special frame in the lattice for the female, which offered her an easy place to stand and protected us from possible bites (which did not occur). In a few weeks we were able to manipulate her teats. Afterwards a special pump was used to extract milk from the lactating otter's teats - but we were not able to obtain any milk. Anyway, this seems to be a pump problem - not a training problem, because "Katja" is very calm during this procedure!

CONCLUSION

Operant conditioning training is a little used tool in the husbandry of otters. With giant otters it has only been used in Dortmund and Philadelphia Zoos. Through protected contact training we have established a positive keeper - animal relationship, provided behavior enrichment, and accomplished husbandry procedures with less stress and safety to both otters and keepers. All of these aspects helped to reduce stress and gave us a better control over our otters well being. Hopefully this will help aid successful breeding in the near future! Although we have not reached all of our goals yet, we have learned a lot about training a unique species and about the nature and fascinating abilities of giant otters.

DIET OF OTTERS (*Lutra lutra*) IN RELATION TO PREY AVAILABILITY IN A FISH POND AREA IN GERMANY

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Abstract: The diet of European otters in a fish pond area in Saxony, eastern Germany, was studied in 1994-1996 by analysing 1099 spraints. Fish availability was estimated from pond stock data and electrofishing in order to investigate the relationship between available and consumed fish. The spraints were analysed both qualitatively and quantitatively. Otters were found to be specialized fish feeders, and selected certain fish species in this carp pond area.

INTRODUCTION

The most frequently applied method in dietary studies of European otters (*Lutra lutra*) is qualitative faecal analysis (e.g. WATT, 1995; LANSZKI and KÖRMENDI, 1996). In spraint (faeces) analysis interference with animals are minimal, and there is a large renewable source of material. However, spraints contain only the undigested fragments of prey animals so that estimating ingested food quantity is difficult. The 'frequency of occurrence' method (ERLINGE, 1967) is the most commonly used in spraint analysis. The problems associated with the use of this method have been well documented (CARSS and PARKINSON, 1996). However, it shows a reasonable result in estimating diet composition of otters and does allow comparison with other studies (JACOBSEN and HANSEN, 1996). Regarding the problem of "otters and fish ponds", investigations in pond areas are essential to get more information about what fish species and fish numbers/biomass otters eat there, and to help to determine the economic impact of otters on the commercial fish stock. For a dissertation and as part of the "Saxonian Otter Conservation Programme", investigations on food consumption and principles in diet selection by otters were undertaken in the Oberlausitz carp pondland in Saxony, Germany, during two years (1994-1996). For this both qualitative and quantitative information about fish diets of otters and prey fish availability were needed. The availability of a prey is the quantity accessible to the animal (or population of animals) during a fixed period of time (MANLY et al., 1993). Thus the method of qualitative spraint analysis was extended to obtain quantitative food data as well. The main questions asked were: 1. What is the composition of the otters' diet in the pondland? 2. How does otter diet relate to prey fish availability in the carp pond area? 3. What is the otters' impact on the commercial carp stock?

STUDY AREA

Since the 16th century the Oberlausitz pondland - the largest interconnected pond area in Germany - has been characterized by carp (*Cyprinus carpio*) pond farming. The study area is located within the Biosphere Reserve "Oberlausitzer heath and pondland" in north-eastern Saxony, Germany. The area contains 13 fish ponds measuring from 0.055 to 21 ha (75 ha of water surface) and a small river (7 m wide, up to 1.5 m deep). Both flowing and still waters of different sizes, bank structures and with diverse food/fish availability are close together and otters can easily move between them.

MATERIAL AND METHODS

The study area, particularly along ponds and river banks, and ditches was searched for sprainting sites. The recorded sites were used as the collection points, and each site was assigned a serial number (GEIDEZIS and JURISCH, 1996). Throughout the study period newly discovered sites, which were searched for by walking always on fixed routes, were specified by further continuous numbers. Along the fixed routes all 'collecting sites' were visited monthly over several, at least on two consecutive days, always in the same sequence. At the first day of a monthly collection session, all (old) spraints were removed from the collecting sites. On the following day, only the fresh deposited spraints, less than 24 h old, were taken for subsequent analysis (GEIDEZIS, 1996). For that reason, and proved through feeding trials with captive otters (JURISCH and GEIDEZIS, 1997), the collected spraints reflected approximately the fish diet otters had consumed the night before in the study area, and allowed a quantitative estimation of eaten prey fish (number/biomass) per night. For spraint analysis the undigested remains were identified using a key to fish vertebrae (MEHNER, 1989) and reference collections. Proportions of prey categories were assigned on the basis of two different techniques of analysis: a) Relative 'qualitative' proportions by frequency of occurrence of a prey category in the spraints (number of spraints in which prey type occurs x 100 divided by the sum of counts for all prey types). b) Relative quantitative food consumption by estimated number of eaten prey fish. Due to the '24 h-spraint-collecting' in a defined area, and always at the same collecting sites, it was possible to establish the number of fish eaten, even considering that remains of one fish appear in several consecutive spraints. Determining which remains belonged to a particular fish was done by size comparisons and counting specific bony structures, e. g. vertebrae, pharyngeal teeth, operculae, praeoperculae, and additionally for carp dented fin rays and praemaxillare. Fish size was estimated by measuring the length of vertebrae from each species present in a spraint (WISE, 1980; MEHNER, 1989). Fish length was used to calculate mass of each fish individual consumed. The relationship between fish length and mass was obtained from data at the Saxonian Fisheries Authority.

Fish availability in the study area was recorded by pond stock data and seasonal electrofishing. The recorded abundances of the different fish species were calculated as number of individuals per hectare area of water surface.

Standardized selection index B_i (MANLY et al., 1993) was calculated to compare the proportions of prey fishes in the spraints to the available fishes in the environment. B_i gives the estimated probability that an otter would eat a certain fish category if all categories were available with equal frequency. The index B_i varies from 0 to +1. Test on selection for certain fish species was performed by chi-square statistics.

The analysis is based on 1099 spraints, collected between June 1994 and June 1996. Data were divided into 1. study year June 94-May 95, and 2. study year June 95-May 96.

RESULTS

Through feeding trials with captive otters it was ascertained that the minimum passage rate of fishes through the digestive tract of otters is 3.15 h ± 40 min (JURISCH and GEIDEZIS, 1997).

Fish was the dominant prey of the otters in both years of study with a frequency of occurrence of 92 and 96% respectively (Table 1). Crayfish (*Orconectes limosus*) was the next most important prey in the first year but had a low occurrence in the second year. Whereas the occurrence of amphibians remained fairly similar in both years, becoming the second most important prey in the 2nd year, insects, mammals and birds made a small contribution to the diet.

Table 1. Diet of otters in the Oberlausitz pondland in 1994-1996. 1st and 2nd study year, percentage frequency of occurrences in spraints. n=total number of occurrences of prey categories.

	Prey categories					
	Fish	Crayfish	Mammals	Amphibians	Insects	Birds
1. Study year n=1438	92.0	3.7	0.5	2.4	1.0	0.4
2. Study year n=421	95.5	0.5	0.2	2.8	1.0	-

The diet of otters in relation to fish availability for the 1st and 2nd year is given in Table 2. Carp made up the highest percentage of available fish (numbers and biomass) in both years but was consumed by otters (cf. number of eaten carp individuals) in a much lower level than expected by availability (Standardized selection index: B_i=0.001-0.008, $P<0.001$, χ^2-Test). Pike (*Esox lucius*), perch (*Perca fluviatilis*), belica (*Leucaspius delineatus*) and roach (*Rutilus rutilus*) were available in fairly low numbers in comparison to carp, but were eaten more frequently than expected by available numbers and biomass (see different selection indices B_i, Table 2).

CONCLUSIONS

Otters were found to be specialized feeders on fish in this pond area throughout both years (92 and 96%). This finding is similar to other studies from freshwater habitats in Europe (WEBB, 1975; HOFMANN and BUTZECK, 1992). Other prey categories, like amphibians, crayfish, insects, birds and small mammals, were only occasionally taken by the otters. These are considered important alternative prey if for instance fish abundance/availability is declining (cf. O'SULLIVAN, 1994), however, this was not the case at this study site.

Table 2. Fish availability (numbers/biomass) versus fish utilization (identified prey items/estimated prey individuals/calculated prey biomass) by otters in the pond area during 1st and 2nd study year. B_i=standardized selection index (P<0.001, χ^2-Test). 'n' refers to the total quantities

	1. Year							
	Fish numbers (%)	Prey items (%)	B_i	Prey individuals (%)	B_i	Fish biomass (%)	Prey biomass (%)	B_i
3sp. Stickleback	0.1	1.2	0.163	1.6	0.194	0.001	0.03	0.184
Pike	1.5	11.9	0.133	6.2	0.064	1.5	9.8	0.056
Pike-Perch	0.04	0.2	0.089	0.07	0.026	0.1	0.03	0.002
Perch	3.5	20.5	0.096	17	0.073	0.2	1.7	0.072
Ruffe	0.09	1.8	0.344	1.9	0.336	0.004	0.2	0.411
Gudgeon	0.5	1.4	0.050	1.4	0.046	0.02	0.1	0.043
Tench	1.1	0.5	0.008	0.7	0.009	0.3	0.3	0.006
Carp	78.9	35.9	0.008	13.8	0.003	94.5	79.1	0.007
Chub	0.1	0.08	0.012	0.07	0.011	0.06	-	-
Belica	2.5	8.1	0.053	31.8	0.189	0.03	0.5	0.171
Roach	11	14.3	0.022	24.8	0.034	1	3.3	0.027
Grass Carp	0.6	0.8	0.022	0.7	0.017	2	5	0.021
Cyprinids undet.	-	3.2	-	-	-	-	-	-
Pisces undet.	-	0.2	-	-	-	-	-	-
Unsampled rest	0.07	-	-	-	-	0.3	-	-
n	106506	1324	-	1389	-	40260 kg	189 kg	-
	2. Year							
	Fish numbers (%)	Prey items (%)	B_i	Prey individuals (%)	B_i	Fish biomass (%)	Prey biomass (%)	B_i
3sp. Stickleback	3.5	2.2	0.005	4.1	0.012	0.006	0.1	0.057
Pike	0.2	20.4	0.829	12.7	0.608	0.3	15	0.159
Pike-Perch	-	-	-	-	-	-	-	-
Perch	3.5	16.7	0.041	15.1	0.044	0.04	2.3	0.186
Ruffe	0.4	0.3	0.005	0.3	0.007	0.001	0.07	0.216
Gudgeon	0.2	-	-	-	-	0.01	-	-
Tench	0.5	0.3	0.004	0.3	0.006	0.3	0.2	0.002
Carp	84.8	30.1	0.003	11.5	0.001	98.5	73.7	0.002
Chub	0.1	-	-	-	-	0.3	-	-
Belica	0.6	6	0.081	16	0.255	0.005	0.5	0.271
Roach	6	21.6	0.031	39.9	0.067	0.3	8.2	0.107
Grass Carp	0.03	-	-	-	-	0.2	-	-
Cyprinids undet.	-	2.5	-	-	-	-	-	-
Pisces undet.	-	-	-	-	-	-	-	-
Unsampled rest	0.07	-	-	-	-	0.1	-	-
n	133386	402		338		63132 kg	34 kg	

Stocked carp was eaten in a lower amount than expected on the basis of availability (79 and 85% of fish individuals, 94 and 99% of fish biomass), whereas other fish species like roach and belica and, especially, the predatory species pike and perch were significantly preferred. The number of consumed carp individuals was lower than that of other main prey fishes; however, the proportion of carp in the total fish biomass eaten was much higher when compared to other fishes.

The data indicate that otters do not always feed on the most abundant fish, but are selective for certain fish species in this food-rich environment (cf. KRUUK and MOORHOUSE, 1990). Models of optimal diet selection suggest that where prey is abundant and quality varies animals should be more selective than where prey is less abundant. That seems to be the case for otters in this carp-rich pond area. Carp are one, but definitely not the preferred food source of otters. Due to the immense carp abundance and relative high mass of one carp individual they form a great proportion in fish biomass eaten by otters but not in prey fish individuals consumed over the two years.

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BEHAVIOURAL USE OF VOCALIZATIONS BY EURASIAN OTTERS (*Lutra lutra*)

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Abstract: Six Eurasian otters of various ages were filmed in a large enclosure during a period of eight months. Acoustic interactions were analyzed, with regard to the kind of uttered sounds, the individuals involved, and their location and behaviour before, during and after vocalizing.
Each of the eight considered sounds were associated with some other sounds, senders, addressees, distances, environmental and behavioural contexts. Some typical situations and postures associated with whistle, moan, and hiss were identified.
Chuckle was used as an affiliative sign at short distances, while chuckle-chitter, chitter and squeal were more often associated with agonistic contexts, including play. Hiss, snort and moan were often addressed to unwelcome conspecifics or human beings met along the way. Whistle was used as a contact call by cubs, but also in conflicting situations by subadults; it was the only sound largely used in water. The other sounds mostly occurred on land: this is probably related to their acoustic features.
Although some basic meanings can be guessed, the same sound can be used in very different contexts. Such a complexity in the acoustic communication system of the Eurasian otter can be seen as a case of using innate behavioural patterns quite freely, which is typical of evolved mammal and bird taxa; this suggests that patterns should be named on the basis of their objective features rather than their supposed function.

INTRODUCTION

Acoustic communication has been studied in several Carnivore species (PETERS and WOZENCRAFT, 1989). Most researches, however, focus on the sound inventory of a species, while the behavioural role of acoustic communication is not very clear.

Among the Lutrinae family, vocalizations of *Lutra perspicillata* (SHANKER and RAJENDRA MADHAV, 1991), *Pteronura brasiliensis* (DUPLAIX, 1980; PETERS, 1984), *Enhydra lutris* (SEBEOK, 1968; SANDEGREN et al., 1973; KONSTANTINOV et al., 1980; McSHANE et al., 1995) have been studied. DUPLAIX (1969, 1982) compared the vocalizations of different otter species. DAVIS (1978) considered vocalizations' complexity as a systematic character at the tribe level.

On the vocalizations of the Eurasian otter (*Lutra lutra*), many authors refer only to a descriptive or anecdotal level (BOUCHARDY, 1986; DUPLAIX-HALL, 1971; GOETHE, 1964; GREEN et al., 1984; MASON and MACDONALD, 1986; SCHEFFLER and THALER, 1986; WATSON, 1978; WAYRE, 1989). A more detailed description of the sound inventory of the species is given by SCHEFFLER (1985). ROGOSCHIK (1987, 1989, 1995) made prolonged studies on the vocalizations uttered by several individuals in strict captivity, focusing on their acoustic structure and their ontogenetic development, and listing eight basic sounds.

The aim of this study was to look in more detail at the use of sounds by the Eurasian otter, focusing on relations between vocalizations and behaviour. To this purpose, some individuals were studied in a large enclosure, where they could act quite freely and naturally, and at the same time were easy to observe. Some preliminary results were presented in previous papers (GNOLI and PRIGIONI, 1995; GNOLI et al., 1997).

METHODS

The study was carried out in an enclosure measuring 1.64 ha, located at Bosco Vedro, within the Ticino Valley Nature Park (Piemonte, Italy) (see FUMAGALLI et al., 1995). The area was occupied by riverine vegetation, with trees and shrubs; 40% was covered by two connected ponds.

From January to August 1993, about 100 hours of observation were carried out and 27 hours 18 minutes of activity recorded, on a Sony 8 mm video camera with a monophonic microphone.

During this period there were six individuals in the enclosure: two adults (a 5 year old male and a 6 year old female), two 1.5 year old subadults, and two cubs born in October 1992; age classes were defined as in WATT (1993). Human intervention was limited to providing part of the food, veterinary care, and carrying out other ethological research. Although the animals were accustomed to human presence, they did not show themselves confident, and had an autonomous behavioural activity.

Films were analyzed, identifying 632 episodes in which animals uttered one or more vocalizations. For each episode, data were recorded about the kind of vocalizations (on the grounds of the list of eight basic sounds pointed out by ROGOSCHIK, 1989: see Table 1); the identity of senders and addressees, and their behaviour and postures before, during and after vocalizing; distance between interacting individuals, and the environmental context.

Table 1. English (ROGOSCHIK, 1995), German (ROGOSCHIK, 1987, 1989) and Italian (proposed) terms meaning the 8 basic sounds

English	chuckle	chuckle-chitter	chitter	squeal	[moan]	whistle	hiss	snort
German	Muckern	Mucker-Keckern	Keckern	Quäken	Langgezogener Laut	Pfiff	Fauchen	Schnauben
Italian	mormorio	mormorio querulo	grido querulo	strillo	gémito	fischio	soffio	sbuffo

In this paper the terms by ROGOSCHIK (1995) are employed; the "langgezogener Laut" is translated as "moan".

Relations between such parameters were evaluated by the χ^2 test, and an *association index* (*AI*):

$$AI = \frac{o - e}{e}$$

where *o* = observed contemporary occurrences of the two classes considered, *e* = expected contemporary occurrences; *AI* can vary from −1 (no association) to +∞ (complete association).

Communicative functions of expression and appeal (BÜHLER, 1934) were evaluated, by comparing (χ^2 test) the animals' activity before and after episodes with the general mean frequency of each activity (data reported in POLOTTI, 1995).

RESULTS

Most frequent sounds were whistle, chitter and hiss (Table 2). Within a sequence, significant associations were found between whistle and chitter, hiss and moan, hiss and snort (Table 3).

Table 2. Occurrences and number of repetitions within an episode for each sound. n=occurrences, % freq. = relative per cent frequency (n=799)

sound	n	% freq.	repetitions		
			min-max	mean	s.d.
chuckle	45	5.63	1– 9	1.92	1.61
chuckle-ch.	62	7.76	1–20	2.14	2.74
chitter	112	14.02	1–13	2.42	2.06
squeal	26	3.25	1–10	1.81	1.96
moan	55	6.88	1– 6	1.49	0.96
whistle	396	49.56	1– >100	(high)	n.r.
hiss	92	11.52	1–22	3.11	3.41
snort	11	1.38	1– 5	2.11	1.45

Table 3. Association between sounds within a sequence: association index

AI	chuckle -chitter	chitter	squeal	moan	whistle	Hiss	snort
chuckle	+ 0.57	– 0.39	+ 0.75	– 1.00	– 0.84	– 1.00	– 1.00
chuckle -chitter		+ 0.04	– 0.25	+ 0.61	– 0.42	– 0.53	– 1.00
chitter			+ 0.17	– 0.52	+ 1.23*	– 0.50	– 0.69
squeal				– 0.48	+ 0.12	– 0.47	+ 1.70
moan					– 0.21	+ 3.26*	– 0.17
whistle						– 0.59	– 1.00
hiss							+ 6.72*

*=P<0.01

Senders and addressees

Significant associations emerged between senders and addressees (Figure 1). In particular, the male and the female vocalized frequently towards the cubs and human beings, and the cubs towards the female. Senders and addressees resulted inequally distributed for the different sounds: whistle was uttered significantly more often by cubs, chitter or squeal by subadults, moan by male and subadults, hiss or snort by female; preferred addressees were female for whistle, male, subadults and cubs for chuckle or chuckle-chitter, male and subadults for chitter or squeal, human beings for moan, hiss and snort.

Distances

Significant associations also resulted between the different sounds and the classes of distance (Figure 2). Each sound typically occurred at certain classes of distance, and progressively less frequently at greater or smaller distances.

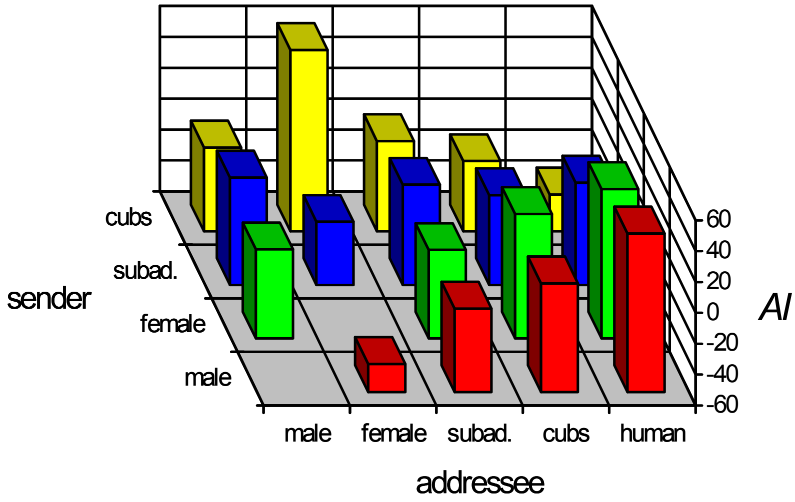

Figure 1. Association between senders and addressees

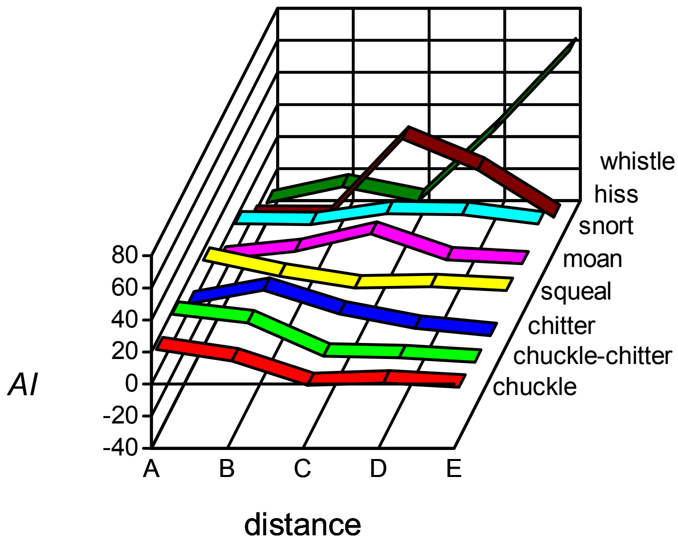

Figure 2. Distances between senders and addressees for each sound, expressed by association index. Classes of distance: A: physical contact, B: < 1 m, C: 1÷5 m; D, 5÷10 m, E: > 10 m

Environmental context

Most episodes (54.9%) occurred while the sender was standing on land; as only 21.8% of the observed activity was on land, it follows that acoustic communication was more important on land. Episodes in water occurred mostly near the banks; only whistles were often uttered while swimming far from the banks. On land and along the banks, favorite environments were blackberry bushes and grass, where most activity was actually performed.

Behavioural context

Most of the activity happened silently, even for half an hour or more. Vocalizations occurred rarely while fishing, and quite rarely while moving in water or on land, feeding, marking and smelling the marking sites. Sometimes, instead, various activities were accompanied by prolonged series of contact whistles by cubs, clearly addressed to their mother who was far away. The context in which acoustic communication mostly occurred were parental cares, and secondly contacts with human beings and playing activity.

Both the sender activities in the five seconds before the episode (function of expression), and the addressee activities in the five seconds after (function of appeal) significantly varied in relation to the mean.

In 60 seconds before and after the episode, the addressee increased its moving activities (swimming, walking or running) in comparison with the finalized ones (fishing, playing, marking, intraspecific interactions, etc.).

Typical patterns

Analysis of filmed images allowed to point out some typical situations when vocalizations occurred, and some typical postures during sound utterance.

Moan often occurred when an animal met with a conspecific or a human being. Then it became motionless, keeping its body near the ground, and while fixing its eyes on the addressee it vocalized. Such a posture can be interpreted as a combination of threat and fear displays (DUPLAIX, 1982).

Whistle was uttered in various situations; the most frequent senders were cubs calling their mother; subadults often uttered whistles together with chitters, in appearently conflictual contexts: such whistles are loud, and their spectrogram shows several harmonics. While whistling, the body did not move: only the head shook lightly and instantaneously while the mouth opened.

Hiss was uttered typically after having actively approached the addressee (often a human being). When it was in water, the animal swam normally, at times rising lightly the head while hissing; sometimes it assumed the so-called "periscope-like" posture (LAPINI, 1985). When it was on land, the animal alternately moved and stopped to look at the addressee for one or few seconds, with an exploratory attitude; then it hissed diverting its look, moving the neck and head downwards or sidewards so as to describe a short arc. Such a behaviour seems to show a motivational conflict between interest and fear.

DISCUSSION

As the animals were free to move in a natural environment, it was possible to undertake fairly reliable observation on their behaviour. On the other hand, closeness of individuals made acoustic interactions more frequent than in the wild, allowing the recording of a broad range of different situations.

Results show that acoustic communication by Eurasian otters plays a remarkable role in social interactions, like courtship, parental care, and play, as well as in aggressive interactions at low and medium distances – while olfactory communication acts in remote interactions. Acoustic communication is less efficient in water, probably due to noisiness of the environment; whistles are an exception, as their tonal structure and high frequency make them very perceivable: a similar whistle is indeed used for keeping contact by the sea otter (SANDEGREN et al., 1973).

Table 4. Message systems and types for each sound

sound	system	type
chuckle	integrative	(close) contact
chuckle-chitter	agonistic, integrative?	offensive threat
chitter	agonistic	offensive threat, fighting
squeal	agonistic	fighting
moan	agonistic	defensive threat, offensive threat
whistle	integrative, agonistic?	contact, distress, offensive threat?
hiss	agonistic	defensive threat
snort	agonistic	defensive threat

Each sound can be assigned to one or more message systems, following the classification by R. PETERS (1980; reported in G. PETERS and WOZENCRAFT, 1989) (Tab. 4); some sounds also occur within the sexual system, not considered in this study. However, this pattern only refers to typical situations, while the same sounds can actually be used in very different contexts: this is especially true in the case of the chuckle-chitter, the chitter and the whistle.

Such a variability of behavioural contexts has been reported also for other Carnivore sounds, like cat's purring (LEYHAUSEN, 1979). PFISTER (1997) found that different raven pairs use the same sounds in a different way. In general, a quite free use of innate patterns, adapting them to different environmental situations (EIBL-EIBESFELDT, 1950), seems to be characteristic of neuroethologically evolved taxa, like Carnivores and Crows are. This makes more appropriate to name behavioural patterns on the basis of their objective physical features, rather than their supposed function (LEYHAUSEN, 1979); such criterion should apply to sounds too. On the other hand, knowledge on the ontogenetic development of sounds can be helpful to better understand their function in different contexts.

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DISEASE AND HEALTH PROBLEMS IN BRITISH OTTERS (*Lutra lutra*) AT A REHABILITATION CENTRE

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Abstract: Since 1985 the Vincent Wildlife Trust has cared for 134 otters, of which 96 were orphans and 38 injured. Males outnumbered females. Mortality was 33%; orphans had a mortality rate of 25% and injured adults one of 79%. Female mortality was higher. Trauma, from bites and road traffic accidents (RTAs) caused most deaths. The commonest single cause of death is other otters. Any health problem predisposes otters to others. Despite concern about environmental pollution in wild populations no poisoning or gross abnormalities were found on autopsy, apart from three cases of hydrocephalus. One genetic abnormality, an albino, was seen. Human actions separated 44% of cubs from their families. 77 animals have returned to the wild.

INTRODUCTION

The Vincent Wildlife Trust has cared for 134 otters (*Lutra lutra*) since 1985. Facilities and practice are described elsewhere (GREEN and GREEN, 1992). Otters came from all over Britain (Tab. 1). Numbers varied throughout the year (Fig. 1).

Table 1. Origin of otters sent for rehabilitation

COUNTRY	CLASS			
	adult injured	juvenile injured	orphans	all
Scotland	13	11	41	65
England	0	0	20	20
Wales	3	1	16	20
Northern Ireland	3	2	24	29
TOTALS	19	19	96	134

The largest category was 96 orphan cubs, aged five days to three months. Some arrived sick, but most needed only hand rearing. Adverse weather is a factor in cubs being orphaned or abandoned, since in the UK otters breed all year round. Human intervention was the cause of family separation in 42 cases. Injured otters numbered 38, of which half were adult and half juvenile. It is not known whether dependent juveniles were abandoned after injury or were injured while trying to fend for themselves. Males outnumbered females by 80:54, making up 74% of adults and 57% of juveniles (Tab. 2).

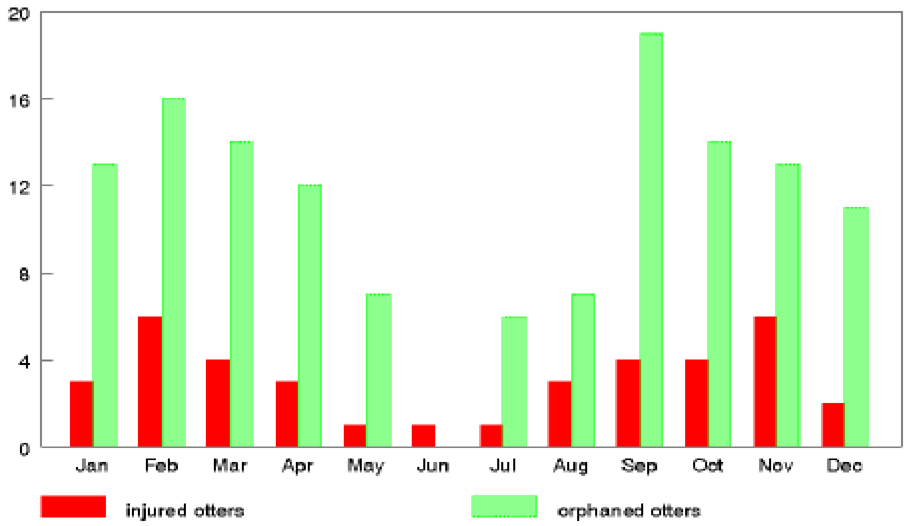

Figure 1. Showing the seasonal distribution of the arrivals of injured and orphaned otters

Table 2. Sexes of otters sent for rehabilitation

MALE	FEMALE	CLASS and ORIGIN
43	22	Scotland
9	11	England
11	9	Wales
17	12	Northern Ireland
14	5	Adult Injured
13	6	Juvenile Injured
58	43	Orphans
80	54	TOTALS

HEALTH PROBLEMS ON ARRIVAL

1. Juveniles

All cubs were hungry, thirsty and cold, some needed only warmth and feeding, but others displayed dehydration, emaciation, infections, fever or agonal symptoms on arrival. Traumas ranged from severe head injury to small haematomas. Table 3 shows 123 conditions presented by 56 animals. In otters problems rarely come singly.

Three undersized females showing pronounced incoordination, feeding problems and a history of deliberate abandonment all had hydrocephalus. The degree of impairment varied; the most severe had no eyes, enlarged head and stunted body. One case was not immediately apparent. Two had adult dentition, giving a minimum age of four months, but the size and weight of cubs half that age. Gait and behaviour were abnormal and all were unresponsive to stimuli, one became blind and had frequent fits. All three were euthanised. Two cases are shown in Figure 2.

Table 3. Health problems in juvenile otters on arrival

CONDITION	NUMBER
starvation	28
dehydration	28
hypothermia	20
ticks	8
dog bites, crushing and shaking injuries	5
otter bites and secondary infection	3
urinary tract infections	2
abraded feet	5
diarrhoea	4
subcutaneous haematoma	1
impacted gut	1
in-coordination, circling, feeding difficulties	4
fever and shivering	2
minor head injuries, concussion, tooth damage	4
ruptured stomach and peritonitis	1
serious head injuries and paralysis	3
pelvic injuries and nerve damage	3
severe stress	1
TOTAL	123

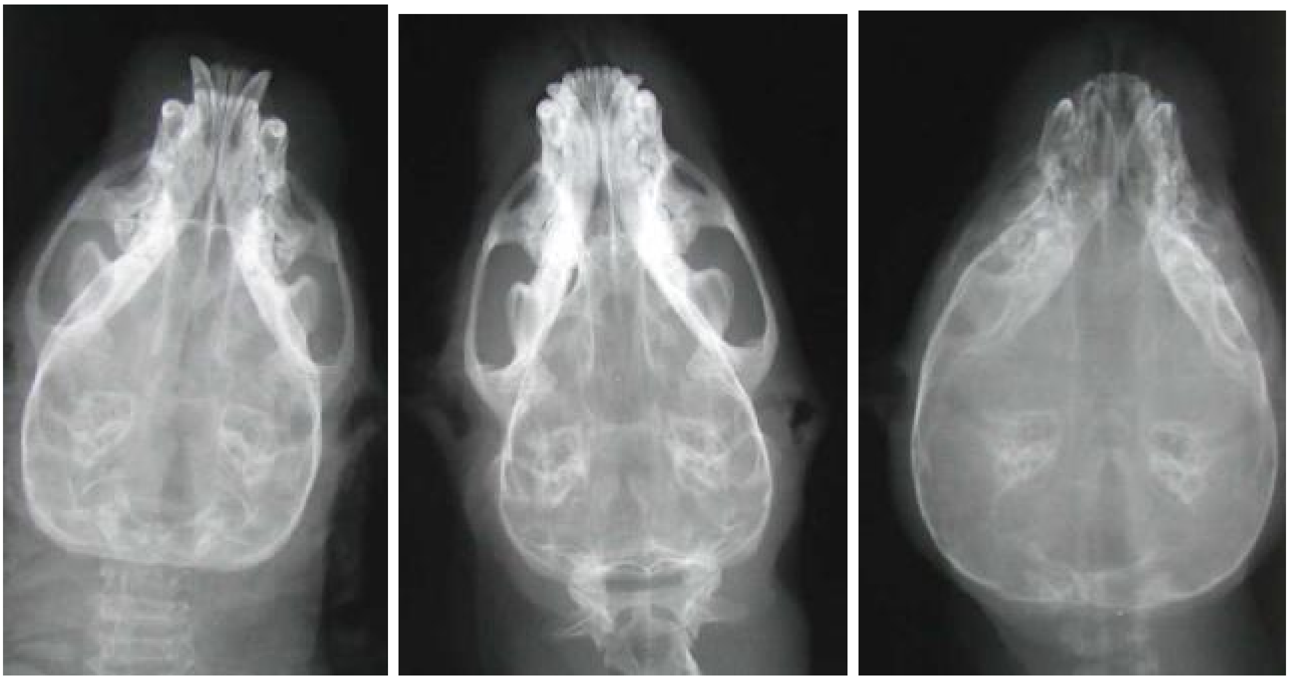

Figure 2. X Ray of the heads of two hydrocephalic juvenile female otters and a normal juvenile female (middle) for comparison. "May", aged 22 weeks, has a short, rounded cranium and undershot jaw, with teeth failing to occlude. She weighed 1,550g. The unnamed, normal otter was aged 24 weeks and weighed 3,650g when found dead after a storm. "Polly" was aged about 12 weeks, with permanent teeth starting to erupt. Despite the pronounced rounded and shortened skull, her condition was not apparent without the X-ray.

2. Adults

Adults were in poor health because only when *in extremis* can otters be easily caught. More animals arrived dead than alive. Of 19 injured adults, eleven were injured in RTAs, seven by other otters and the cause of one injury was unknown. Twelve had wound infections and other complications. Two had spinal fractures incompatible with life. Tooth wear indicated that six adults were aged and four were young. Adults injured by other otters were all male, four young, including an albino, and three old animals. Three of the RTAs were old and one young.

Two animals exhibiting deranged behaviour had systemic infection from damaged teeth and an old, emaciated female died from dental infection. Ten otters had worn, damaged or lost teeth.

HEALTH PROBLEMS ARISING IN CARE

1. Juveniles

Otter cubs depend on their mothers for at least 10 months so rehabilitation is lengthy. Nearly half the juveniles required treatment for conditions listed in (Tab. 4). Some problems associated with hand rearing have been overcome by improved management. Twelve habitually sucked their own or a companion's body, resulting in infections; both suckers and sucked were predominantly male. Cubs with matted coats often showed associated symptoms, which appear to have a dietary origin as they have been eliminated by improved diet and use of anabolic steroids.

Table 4. Health problems arising during rehabilitation in juvenile otters

CONDITION		NUMBER
a) Associated with hand rearing		
sucking:	penises	7
	vulva	1
	ears	2
	tail	1
	nipples	1
urinary infection from penis sucking		3
local infection from sucking		5
matted coat		16
slow wound healing		3
initial failure to thrive		8
cracked skin on feet		5
b) Associated with a period of starvation or unsuitable food		
intersusseption		2
impacted gut		2
diarrhoea		8
abdominal pain and bloating		2
vomiting, other than with the above conditions		5
c) Associated with bites		
local infection		26
severed tail		2
meningitis		1
pneumonia		2
d) Other		
Pemfigus foliaceous		2*
mouth/tooth damage, gum infection, tooth impaction		15
worms		6
respiratory infection		6
urinary tract infection		1
TOTAL		132

* A third member of this family died of starvation within hours of arrival

After a period without food, or being fed unsuitable food by "rescuers" most cubs scour, some requiring rehydration and antibiotics. In unweaned cubs diarrhoea can be severe. A mixture of milk powder, dietary supplements, fish and fish oil has been used to rear cubs from 200g. Two emaciated males appeared to thrive, but after three months died of intersussceptions, other males suffered a variety of digestive problems.

Play among cubs is rough, even milk teeth can do damage. Twenty six cubs were treated for infected bites from companions and one died of meningitis resulting from superficial bites on the face infected with a group G *Streptococcus*. This appears to be the first verified case of meningitis, which is surprising as the usual sites of otter bites predispose to infections of the central nervous system.

Of conditions not apparent on arrival most serious was pemphigus foliaceous in a sibling pair. Twenty otters required dental treatment. A cub had chronic facial infection until three of his canines were removed, making his return to the wild impossible. The 132 conditions listed in Table 4 affected 52 cubs, only four were treated for a single problem. The most unfortunate arrived with otter bites to the hindquarters and in 11 months suffered five different problems before dying of pneumonia; an autopsy found damaged heart valves, an abscess in the heart membranes and copious pus in the lungs.

Seven injured juveniles recovered without complications, four died soon after arrival, but others suffered complications of original injuries but were released in good health. Four males had heart murmurs, which were judged to have little clinical significance (LEWIS, pers. comm.) and they were released. One has been recovered dead after a RTA in good condition aged 4 years. Parasites were uncommon, only 6% of animals had infestations of *Ixodes* sp. ticks and no gross evidence of worm infestation was seen. High eosinophile counts led to a few precautionary prescriptions of vermicide.

2. Adults

Twelve adults (63%) died within 14 days. The survivors were all treated for their original injuries and complications, such as pneumonia following bacterial infection in the nasal cavity. Unrelated problems developing in captivity did not occur.

MORTALITY

Total mortality was 33.6%, 33 otters dying of existing conditions and twelve from accident or disease arising in care, (Table 5). The larger male sample accounted for a higher number, but smaller percentage of deaths than the female sample, (31%:37%). Trauma, of which bites accounted for over half, caused 50% of all deaths. Otters indirectly caused five more deaths, making them the commonest cause of death in this sample, at 34%. Table 6 analyses all trauma cases by age, sex and percentage mortality. Males were more often bitten or killed by otters, but females were more likely to die from dog bites. Adults and females involved in RTAs were more likely to die of their injuries than juveniles or males. Autopsy failed to show any obvious cause for one death. Seven otters were euthanised.

DISCUSSION

Analysis of health problems presented by this sample of otters leads to the following conclusions:

a) No infectious diseases were presented
b) Very few endo- or ectoparasites were found
c) Despite concern about the effects of pollution on otters no cases of poisoning were seen
d) Trauma, starvation and separation from family are the most frequent causes of otters coming into care
e) Other otters and road traffic emerge as the most frequent cause of trauma
f) Other otters were the commonest cause of death
g) Human action, not always ill intentioned, is responsible for a variety of otter health problems
h) One health problem leads to another so an otter treated for one is likely to need treatment for others
i) Males are more likely to be found in trouble and in captivity suffer more minor injuries and ailments, but also respond better to treatment, so have a lower mortality rate than females.
j) The condition of the teeth is important to general health
k) Genetic or congenital abnormalities occur at a low level
l) Injured otters and orphans are more successfully rehabilitated if brought into care quickly

STRACHAN and JEFFERIES (1996) review the literature on otter diseases listing a number as recorded or suspected. REUTHER (1984) cites a surprising number of gastric and kidney problems in captive animals resulting from unsuitable diet or feeding regime. However, apart from pemphigus foliaceous, diseases in this sample were all consequences of the trauma, infection or starvation, which brought the animals into care.

There has been concern that the effects of environmental pollution observed in seals (BERGMAN and OLSSON, 1986) and experimentally demonstrated in mink and ferrets (BLEAVINS et al., 1980) would affect otters, (KEYMER et al., 1988). Six otters with symptoms associated with poisoning, such as emaciation or pedal lesions and with a diagnosis of possible poisoning all proved to have injuries from RTAs, indeed pedal lesions are characteristic of RTAs. No tumours or gross abnormalities were found at autopsy even in old animals. High pollution burdens may predispose otters to injury or abandoning cubs, but analyses of otters from this sample (HANSON, CONROY pers. comm.) did not show high levels. Developmental hydrocephalus may be a response to environmental factors and requires further study.

Bites have been attributed to dogs by KRUUK and CONROY, (1991) but in this sample, and that of SIMPSON, (1997), otter bites were frequent and severe. Only cubs were bitten by dogs and in each case the history was known. Wounds produced by otters and dogs and modes of attack are different. Otter bites are designed to create maximum damage, causing deep punctures, bruising and jagged tears, characteristically on face, genital area and feet. They almost invariably become infected, leading to cellulitis, dehydration, emaciation and death. *Streptococci* found in cultures from infected otter bites are considered characteristic. Wounds are sometimes colonised by opportunistic infections such as *Corynebacterium jeikheim*.

Road traffic is an increasing problem for otters. Eleven Scottish otters injured in RTAs came to hand in a period in which 1300 deaths were recorded. RTAs play a part in orphaning cubs.

The imbalance between the sexes in numbers coming into care and in death rates suggest that males more often stray or are involved in accidents, but are more likely than females to benefit from rehabilitation. Females are more cautious from an early age so are less likely to get into trouble, but are less likely to be found. Smaller size and proportionally shorter gut make female cubs less able to withstand a period of starvation. In care the confident, greedy behaviour of males makes them easier to observe and treat.

Damaged teeth not only compromise prey capture and self-defence, but lead to systemic problems which can be fatal. Dental treatment is an important part of successful otter care.

Only two conditions of congenital or genetic origin were noted; hydrocephalus and albinism. The mothers of hydrocephalic cubs recognised that they were unviable and abandoned them. As 12.5% of cub deaths resulted from hydrocephalus, it is recommended that any undersized cub with a history of deliberate abandonment and abnormal behaviour should be X rayed. The young adult male albino died after being severely bitten, but it is not clear whether albinism was a factor as he had survived two years and his injuries were no worse than those of normal males.

What is clear from this analysis is that once an otter is sick its chances of further ill health increase. Much suffering could be avoided if injuries were correctly diagnosed and aggressively treated, or the animals euthanised, and cubs were sent for rehabilitation as soon as they were removed from the wild.

Despite the problems related in here, 77 otters have been returned to the wild, nine are in good health at the centre and three have gone to captive breeding programmes. The use of rehabilitated otters in reintroduction programmes has proved a cost effective tool in the strategy to return the species to its former range.

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TREATMENT, MEDICATION AND ADMINISTRATION OF DRUGS TO OTTERS

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Abstract: Treatments, which have been found useful for injured and orphan otters are described. Administration of drugs to otters is discussed and the drugs used are listed.

INTRODUCTION

Since 1985 we have cared for 134 orphaned or injured otters (*Lutra lutra*), returning them, when fit, to the wild. Return to the wild requires minimal handling or human contact, which poses difficulties in diagnosis, treatment or hand rearing.

Most injuries result from traffic accidents or otter bites. Otters can inflict serious damage on each other (or the rehabilitator). Injuries often become infected and lead to problems such as bacterial pneumonia.

Otters are difficult to examine, to dose and to monitor without doing further damage. They are challenging to contain and may behave self destructively in captivity.

TREATMENTS FOR INJURED OTTERS

ANAESTHESIA is necessary to examine most otters and may be needed for capture. Drugs administered from a distance without involving intubation or gas are preferred for use in the field. A safety margin is advantageous when weights are unknown and reversibility is useful. Blowpipes are routinely used to deliver anaesthetics.

ANTIBIOTICS are the most frequently used class of drugs. It has been found necessary to treat infections aggressively over extended periods. Broadspectrum antibiotics are used widely as swabs for sensitivity testing may not be available.

ANALGESICS, ANTI-SPASMODICS and ANTI-INFLAMMATORIES play a part in aiding recovery and making animals comfortable. Corticosteroids are used only when rapid onset of activity is needed in cases of overwhelming infection, toxicity or shock. Non-steroid, non-narcotic analgesia use is more frequent. Topical treatments to clean wounds, remove necrotic tissues and promote healing are in frequent use, but are not easy to apply to a conscious adult otter.

SEDATION may be needed to control self-destructive behaviour, damaging escape attempts or violent activity.

As most drugs are administered orally with food and most otters are underweight the use of APPETITE and GROWTH PROMOTERS has proved valuable, as have specially formulated vitamin supplements for fish eaters.

Table 1: Drugs, which have been useful

DRUG	BRAND NAME	COMMENTS
ANAESTHETICS		
ketamine hydrochloride	Vetalar or Ketaset	dissociative agent
midazolam hydrochloride	Hypnovel	improves quality of anaesthesia
medetomidine hydrochloride	Domitor	used alone or in combination, reversible
atipamezole hydrochloride	Antisedan	Reverser for above
zolazepam and tiletamine	Zoletil	used alone or in combination
xylazine	Rompun	as above
ANTIBIOTICS		
clindamycin	antirobe	palatable capsules, wound, bone dental infection
metronidazole	Flagyl (tabs) Torgyl (sol)	anaerobic infections
enroflaxacin	Baytril tablet or injectable	broad spectrum, bacterial infections of skin, gut, urinary or respiratory tracts
amoxicillin trihydrate	Clamoxil tablet or injectable	gut infections and wounds, can be used on young animals
neomycin sulphate	Neobiotic Aquadrops	bacterial enteritis in young animals
neomycin sulphate and bacitracin zinc	Cicatrin	aerosol antibiotic powder for wounds
ofloxacin	Exocin	external eye infections
TOPICAL APPLICATIONS		
	intrasite gel	promotes wound healing
propylene glycol and malic acid	Dermisol Cream	removes dead or necrotic tissue
benzoic acid and salicylic acid	Dermisol multicleanse solution	wound cleaning and removal of debris
camomile extracts	Kamillosan ointment	soothes soreness
blackcurrant twig infusion and orange oil		discourages comfort sucking or biting at wounds
ANALGESICS, ANTISPASMODICS and ANTI-INFLAMMATORIES		
flunixin meglumine	Finadyne tablet or injection	potent non-steroid, non-narcotic pain relief, trauma or post operative
methyl prednisolone sodium succinate	Solu-Medrone V intra venous infusion	overwhelming toxicity, infection or shock
prednisolone and dexamethazone	Opticortinal table or injectable	anti-inflammatory, wide range of uses - trauma infection, allergy etc.
hyoscine-N-butyl-bromide and dipyrone	Buscopan Compositum injectable	pain relief in urino-genital disorders
OTHER DRUGS USED		
ivomectin	Ivomec injectable	Endo- and Ecto parasites, given in food
N-cyclohexyl-N-methyl-(2-amino-3, 5-dibromobenzyl)-amino hydrochloride	Bisolvon Powder	respiratory problems, retention of mucus
ethylestrenol	Nandoral tablets	malnutrition debility, loss of appetite, promotes tissue repair
nandrolene laurate	Laurabolin injectable	as above, 1 dose lasts 3 weeks, used after surgery
diazapam	Valium tablets or injectable	sedative and appetite stimulant
pentobarbitone sodium	Euthanasia injection	euthanasia

aminoacetic acid, citric acid, potassium citrate, potassium di-hydrogen phospate, sodium chloride, dextrose	Lectade	oral rehydration
vitamin B complex, dextrose, amino acids and electrolytes	Duphalyte	oral rehydration

PARASITICIDES are used on otters with ticks or high endoparasite burdens, diagnosed by routine blood tests or the appearance of worms in the faeces.

Young cubs often suck parts of their own or a companion's body for comfort, causing soreness, swelling and infection. Injured adults may bite at injuries or sutures, increasing damage and infection, so agents to discourage such behaviour can be usefully applied around sutures or cleaned wounds while the otter is anaesthetised.

ADMINISTRATION OF MEDICATION

Whenever possible drugs are given with food so palatable tablet or capsule formulation is an advantage. Some injectables, such as Ivomec for tick infestation, can be satisfactorily administered in food.

Blowpipes are used for intramuscular or subcutaneous injections, if an animal will not eat. However, the darts are potentially harmful and are difficult to retrieve if the otter remains conscious. It is preferable to give injections of long acting drugs to anaesthetised otters and follow up with oral administration.

Captivity is stressful for adult otters, but continuity of care and routine for cleaning, feeding and treatment help to build confidence. Otters quickly learn to recognise their regular carer, using aural rather then visual cues, so talking quietly to the animal is beneficial. Most do not bite unless handled or provoked and, once accustomed to their carer and routine, will accept topical treatment of wounds. Sedation is recommended as even a sedated otter, accustomed to carer and routine, will be alarmed by close approach. Wounds can be flushed from a distance with a syringe or plastic bottle and gel or cream applied to wounds using a long handled artist's brush or a sponge rubber washing-up mop. The latter is easily sterilised, gentle on wounds and, if bitten, unlikely to damage teeth. Once the otter has experienced the treatment it should be shown the syringe, mop or brush so it will recognise them again.

Pedal wounds are common, but it is rarely possible to treat feet topically. It is easier to get the otter to apply cream to its own feet by spreading it on a plastic tray in front of the feeding bowl so the otter stands on it while eating. This is facilitated by feeding pieces too small to be taken away to eat under cover.

HAND REARING OF OTTER CUBS

Orphaned otters are usually hungry, dehydrated and may have diarrhoea. Oral rehydration is valuable at this stage. Unweaned cubs have been successfully raised on a mixture of skinned, boned and liquidised white fish, milk replacer for carnivores (dogs, cats, zoo animals), cod liver oil, boiled water and vitamin supplements for fish eaters, given by syringe. Equipment should be scrupulously sterilised. Stimulation to urinate and defaecate after each meal is necessary and is a useful check on the digestive process. Faeces should hold their shape and be dark in colour. Light coloured, loose or liquid faeces are a signal to increase fluid intake with Lectade or other oral rehydration and water, cut out at least one meal of fish mix and check sterility of equipment. Matching liquid input to output may overcome diarrhoea, if tackled at once. Persistent problems may be remedied by changing the type of fish or milk powder. Once cubs have learned to feed from a syringe it has been found important to maintain continuity of carer and routine.

It is difficult to produce a sufficiently nutritious, palatable milk substitute so early weaning is recommended. Food per day should equal or exceed 20% of body weight and water should always be offered. Feeds should be given eight times per day for very young cubs decreasing to four or five at weaning.

Comfort sucking is a common problem in hand-reared cubs. Veterinary products to discourage sucking or those for nail biting have little effect. It was discovered that otters are repelled by the odour of blackcurrant leaves or orange peel. A home made infusion of blackcurrant twigs prevents sucking, but efficacy is short lived and the aqueous solution is rapidly diluted. Highly concentrated orange oil, available from culinary suppliers, has proved effective, long lasting and safe on damaged tissues. Ointment based on camomile extracts has been successful in treating soreness caused by sucking.

OTTER (*Lutra lutra*) SURVEYS ON CORFU ISLAND AND AT LAKES PRESPA, GREECE

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Abstract: The present surveys show that otters seem able to cope or perhaps even to thrive despite intense human activity. In April 1997, otters survived on Corfu Island in the Ionian Sea even in towns and on popular beaches despite the high human density and seasonal pollution from seaside resorts and from olive oil units. Moreover otters are recolonizing the west coast. In August 1997, the present study revealed numerous sign of otters all along the shoreline at the Balkan Lake Mikri Prespa in Macedonia, Greece, in spite of extensive use of fertilizers and pesticides from the surrounding bean culture.

INTRODUCTION

In Greece, otter (*Lutra lutra*) populations are still thriving. But the Greek wetlands are under threat from human activities: intensive development of agriculture, fish-farming, tourism and of road networks. The insular or remote otter populations are especially vulnerable when faced with such economic development. Thus the main threat to otters is the dramatic development of tourism on Corfu Island and the increase in bean culture at Lake Mikri Prespa. The ecological impact of these developments is so immediate and important that conservationists should regulary carry out otter surveys in order to monitor the response of these populations.

STUDY AREAS

On Corfu Island, in the Ionian Sea, small rivers and fresh water seepages are common on the east coast, while a lack of fresh water is a limiting factor to otter distribution on the west coast. The Corfu Channel (2 km wide) separates this island from the Albanian coast. The human density on Corfu is high, especially along the seashore even in winter (100,000 inhabitants, on 592 km^2). The lack of concern regarding the ecological effects of olive oil production and the development of tourism result in serious damage: heavy organic pollution, refuse dumping, uncontrolled urban expansion and wetland destruction.

Mikri Prespa is a shallow (4 m) and large (48 km^2) mountain lake in the Balkans, at an altitude of 853 m. It is surrounded by extensive reedbeds, wet meadows, moist woodlands and intensive bean monoculture. It is partly a Ramsar site (8,000 ha) and a National Park (19,470 ha). Today, Lake Mikri Prespa belongs mainly to Greece except for the southern corner, which lies in Albania. Abundant water flows from the surrounding mountains (up to 2150 m) in streams or underground courses ending at the lake, which flows out by a short channel into Lake Megali Prespa. This huge (272 km^2) and deep (50 m) lake is mainly in Albania and in Former Yugoslavian Republic of Macedonia, but is also partly in Greece. A narrow strip of alluvial land (200 m wide and 3 km long) separates these lakes.

MATERIAL AND METHODS

The present surveys were carried out in April 1997 on Corfu and in August 1997 at Lake Mikri Prespa. They involved a search for otter signs *viz.* foot prints, spraints, holts, carcasses along accessible shores of lagoons, rivers, streams, ditches, wetlands, even urban areas, ports and/or tourist resorts. Some areas were not suitable for finding otter signs, or were not accessible e.g. drowned reedbeds without exposed rocks, or karstic cliffs without a shoreline. Since 1991 such surveys have been regulary carried out on Corfu by the same researcher, using the same methods every time. Thus the annual results can be compared directly (GREMILLET 1993, 1995 and unpublished data; GREMILLET and WALMSLEY, 1992). Only the Greek shores of the Prespa lakes were surveyed.

RESULTS

On Corfu, despite the high human density, heavy organic pollution, habitat destruction and tourism development, otters continue to occur at the same sites on the north and east coasts even within urban areas, ports, tourist beaches and the international airport as they did in 1991 (Figure 1). Furthermore females breed within these disturbed and polluted sites. Seasonally, however, streams can become completely unsuitable for otters due to crude sewage entering directly from olive oil presses. Surprisingly otters don’t desert holts situated along these polluted courses: they are used to reach clean sites (often the seashore or lagoon) by way of the river banks. Some months later, when these courses become clean again, otters return to fish near their holts. Moreover, on Corfu, otters are often seen foraging in very eutrophic waters in the presence of near domestic sewage.

Up to a certain level, seasonal organic pollution fatten the otter's prey, tourists, sewage, crabs, mullets and otters belong to the same food web!

In spite of being illuminated at night and continual human disturbance, otters occur in tourist resorts if they are well stocked with fish. Moreover, in 1997 otters started to recolonize some remote sites on the north-west and south-west coasts, especially Lagoon Korission. The species still occurred in this lagoon in 1986 (GAETHLICH, 1988), but disappeared after 1991 (GREMILLET 1993 and unpublished data).

In 1983 the Greek Government started a development project in order to improve agriculture, fish-farming and the road network at Lake Mikri Prespa. Soon after - between April 1985 and August 1986 - DELAKI et al. (1988) carried out an otter survey. They suggested that such human activities might lead to an irreversible decline of the otter population. In 1997 intensive bean monoculture was the main economic activity in the Mikri Prespa area, especially in the surrounding lowlands of the north-eastern part. Large reclamation projects have destroyed rich wetlands. Misuse of fertilizers, pesticides and water extraction for irrigation purposes were standard practice. A network of drainage ditches collects these polluting agents from fields and pours them into Lake Mikri Prespa. However the present survey (1997) showed that otters occur widely in Lake Mikri Prespa despite this unsustainable development (Figure 2). Absolutely all accessible sites yield a variety of otter signs. Otters pass from one lake to the other through the Koula Channel, or by some well-used otter paths, which cross the dangerous Koula road (road casualties result from a lack of a safe underpass). These movements perhaps explain why otters are still widely present at Lake Mikri Prespa despite increasing pollution. Similarly pelicans (*Pelicanus onocrotalus* and *P. crispus*) fly from their breeding colony at Mikri Prespa to their feeding area at Megali Prespa.

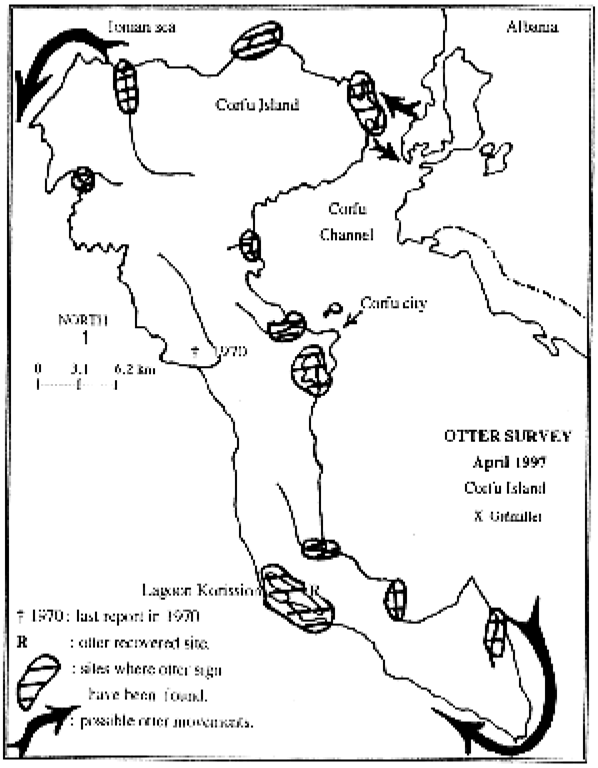

Figure 1. Otter survey. Corfu Island, Ionian Sea, Greece. April 1997.

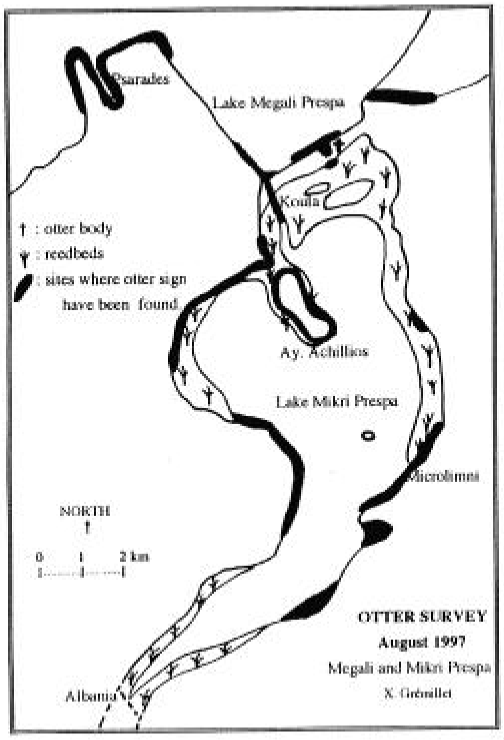

Figure 2. Otter survey. Lakes Megali Prespa and Mikri Prespa, Macedonia, Greece. August 1997.

DISCUSSION

On Corfu and at Lake Mikri Prespa otters are faced with heavy organic pollution, habitat destruction and human disturbance. Current economic plans ignore the ecological requirement of these areas. At present otters remain there despite unsustainable development. Through lack of time and funds, only simple surveys of otters could be carried out, but these allow the mapping of the animals' presence. They show that otters are present in an environment, which seems at first sight unsuitable for them. Unless deliberate or acute toxicity by pollution are present, otters are able to fish, sleep and even breed alongside intensive economic activities or human disturbance, provided that the site supplies the main otter requirements such as safe holts (even artificial ones) and a sufficient biomass of available prey. These simple surveys, however, don’t provide accurate information concerning otter movements or population density. We need to know what part migrating individuals play in such situations and if the surplus otters from the undeveloped Albanian coasts cross the Corfu Channel and strengthen the population of Corfu.

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