Otters in Cauvery Wildlife Sanctuary, southern India

A Study on the Habitat Choice and Diet Composition of the Smooth Coated Otter (*Lutra perspicillata*)

Kausalya Shenoy, Surendra Varma and K. V. Devi Prasad

nityata

ANCF
ASIAN NATURE CONSERVATION FOUNDATION
www.asiannature.org

Otters in Cauvery Wildlife Sanctuary, southern India

A Study on the Habitat Choice and Diet Composition of the Smooth Coated Otter (*Lutra perspicillata)*

Kausalya Shenoy, Surendra Varma and K. V. Devi Prasad

Suggested Citation:
Shenoy, K., Varma, S., Prasad, K. V. D. (2003). Otters in Cauvery Wildlife Sanctuary, southern India; A Study on the Habitat Choice and Diet Composition of the Smooth Coated Otter (*Lutra perspicillata*). Nityata Foundation, #184, 9th cross, Indiranagar 1st Stage, Bangalore 560 038, India, and Asian Elephant Research & Conservation Centre (A Division of Asian Nature Conservation Foundation), C/o Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

Photo Credits: Front and back covers; Figures 2, 7a,b,c,d,8a,14a,b,c: Joshua Barton; 5a,6b,10a,b,21a,b: Kausalya Shenoy, 3c, d, 4b, 5b, 6a,8b,21c, 22a and b: M. Saravanan, 3a,b and 4a: Surendra Varma

About this document

Otters have a long evolutionary history; they are descendents of weasel-like ancestors. They have remarkable adaptations to lead an aquatic life: have coat with water-proof fur, paddle-like feet, thick muscular tail, bristly array of rigid whiskers, and the body is exclusively designed for capturing aquatic prey species.

Otters, though, come out of water in search of food and other resources; their life, unlike other mammals, depends on the quality of aquatic habitat available to them. In this era of increasing conflict over altered land usage, aquatic habitats have shrunk. Even within the protected areas, only a small stretch of habitats are available. These stretches also have been polluted, otter's prey species are over exploited, and all along, tourists, picnickers and their activities cause severe damages to their life.

Three species of otters, smooth-coated otter *(Lutra perspicillata*), Eurasian otter *(Lutra lutra*) and small-clawed otter *(Amblonyx cinereus*) are found in India. Only the smooth coated otter is found all over India. The country, under the Wildlife (Protection) Act, 1972 provides protection for all three species. Smooth-coated otter is listed in Appendix II of CITES. India is a signatory to CITES, Bonn Convention, Ramsar Convention, and Biodiversity Convention, which are also helpful in otter conservation (Anon).

According to Rabb, "a large part of the task ahead in the conservation of otters relates to obtaining more information about them." However, not enough studies have been undertaken on otters in India to know their ecology, behaviour, distribution and other aspects of any of these species.

The Cauvery River Ecosystem in southern India is the last remaining strongholds of the smooth-coated otter. The river has influenced the lives of the people in southern India for centuries. It has been referred to in many ancient texts. Thus, the conservation of this riverine ecosystem is important from ecological as well as other socio-cultural aspects. However, to date, no research pertaining to otters has been undertaken in the Cauvery River ecosystem.

The study site, Cauvery Wildlife Sanctuary, in Karnataka, southern India, though a protected area as under the Wildlife (Protection) Act, 1972, is under high anthropogenic pressure, especially during weekends. A temple at a village located close to the river bank attracts tourists from surrounding towns and cities. These aspects motivated the current investigation, and we assume this study may contribute to an understanding of the habitat inclinations and diet composition of the smooth-coated otter in India.

We would like to reinforce that otters are sensitive to the areas they inhabit as they are not only restricted in the choice of habitat by availability of water but also by availability of appropriate landscape and prey within such aquatic habitat. On the face of it, the river Cauvery appears to be a long stretch of suitable habitat for smooth-coated otters. This, however, is misleading as only a small fraction of the river flows through a protected area. Within the protected area, not all habitats along the river are used by the otters. Thus, actual and effective area available to the species is reduced. Even within the

protected area, human presence occurs in the form of resorts/ fishing camps/ picnickers, which further adds to the reduction of area available to the species.

Short term studies like the present one, attempt to identify those areas used and inhabited by otters using communication tools (statistics or data processing tools used in this study for example) to highlight the patterns and relationships existing between the studied species and its habitat. We believe, these tools should not take precedence over the knowledge that has emerged, viz., the species' needs for specialized resources and the limited availability of such specialized resources to the species.

This document presents the results of the study conducted between January 2002 and mid-March 2002. The investigation covered aspects such as otters of the Cauvery Wildlife Sanctuary, habitat status, preference, holts, diet composition, status of otters, interspecific competition, disturbance levels and conservation implications.

Due to the lack of time and other aspects, some constraints were encountered— due to the water level decreasing drastically, not all parts of the river were navigable and so all islands could not be sampled. Although some knowledge on otter's prey preference was obtained, the availability of prey species was not attempted. However, we assume this investigation and the resultant knowledge accrued through this document may create some interest in initiating long-term investigations and develop strategies for the conservation issues highlighted.

Acknowledgments
We would like to thank the following people without whose help this thesis would not have been possible; the trustees of the Nityata Foundation, Mr. Gopakumar Menon and Dr. H. Jamadagni, for financial and on-field support. The Karnataka Forest Department, and Mr. Manjunatha, DCF, Cauvery Wildlife Sanctuary, for allowing us to work in the Cauvery Wildlife Sanctuary, and for support and co-operation on field. Joshua Barton, for the brilliant photography and everything else he helped us out with.

Dr. Kumaraiah and Dr. N. M. Chakrabarty of the Central Institute of Freshwater Aqualculture, Peninsular Division, Bangalore, helped in analysis the spraint. Mr. Saandeep of Asian Elephant Research and Conservation – AERCC, extended his support in GIS and Madhu in statistical analysis. Mr. Harish Bhat supported in identifying plant samples. Ms. Meena, Mr. Narendra babu, Mr. Robin and Ms. Nandini, for their support with their valuable inputs. Dr. S. L. Shanbhogue provided his inputs and support on the prey aspect of the study. Mr. Sunder and Ms. Premi of Jungle Lodges and Resorts provided all the help, moral support and good food in field for the field investigator. Field tracker Naga, and the people of Muttatti who were all very hospitable and friendly and tried to make our field investigator's stay away from home as less lonesome as they could. Many other people who have not been mentioned have helped in their own little ways and we are grateful to all of them.

Abstract

This study was an attempt to elucidate factors that determined the choice of home area of the smooth-coated otter, *Lutra perspicillata,* along the river banks and islands, and its diet composition, in the Cauvery Wildlife Sanctuary. The study was carried out over a period of eight weeks between January 2002 and mid-March 2002. A 5km stretch was chosen as the intensive study area. Various habitat parameters were looked for and assessed. It was found that otter sites varied significantly from non-otter sites. High percentage of loose sand and low percentage of hard sand seemed to be the important factors governing site selection by otters. Otters seemed to avoid areas having high levels of human disturbance. Spraint samples were analysed for undigested prey remains. Otters in the study site were found to prey mainly on fish of the family Bagridae and Cyprinidae. Small sized fish were preyed upon (10 – 20 cm in length). This study has categorised the preferred habitat and diet composition of otters, which are of importance to conservation.

Introduction

Otters form a distinct group within the mammalian family Mustelidae. They are grouped into a sub-family of their own – Lutrinae (Sivasothi, 1995). They are the only group among carnivores that are semi-aquatic (Nowak, 1991). Otters are found in all continents of the world except Australia and Antarctica. There are 7 genera and 13 species of otters world wide, of which five are found in Asia (Appendix 1). Three species - *Lutra perspicillata* (smooth-coated otter), *Lutra lutra* (Eurasian otter) and *Amblonyx cinereus* (small-clawed otter) - are found in India (Reuther, 1999).

Distinguishing between the various otter species can be quite perplexing. Often otter species are wrongly identified. However there are certain keys that are to be followed in identifying otter species on the field. The smooth-coated otter has a relatively short pelage giving it a smooth, velvety appearance (Sivasothi, 1995; Hussain and Choudhury, 1996). It is by far much larger than the other Indian otter species, measuring upto 1065-1300 mm (Hussain and Choudhury, 1996), and has a relatively robust form (Sivasothi, 1995).

The terminal half of its tail is dorso-ventrally flat (Sivasothi, 1995; Hussain and Choudhury, 1996). The snout is blunt and the border of the rhinarium is convex (Sivasothi, 1995, Hussain and Choudhury, 1996). Claws are pointed (Sivasothi, 1995), and pugmarks are usually around 7cm or more in length (Claus Reuther, pers. comm.). Cheeks are very light grey to white, and sharply demarcated from colour of upper parts of the face (Hussain and Choudhury, 1996). *Lutra perspicillata* (smooth-coated otter) is found throughout the country from the Himalayas southward. They have been reported from Karnataka, Kerala, Andhra Pradesh, Madhya Pradesh, Maharashtra, Bihar, Gujarat, Himachal Pradesh, Punjab, Uttar Pradesh, and West Bengal (Hussain, 1993; Prater, 1998).

The Eurasian otter has a denser, coarser fur, with a grizzled appearance due to the paler tips of the guard hairs (Sivasothi, 1995; Hussain and Choudhury, 1996). Its length ranges from 1020-1370 mm (Hussain and Choudhury, 1996). The snout is longer than that of the smooth coated otter (Hussain and Choudhury, 1996). The dorsal border of the rhinarium is tridentate, or w-shaped (Sivasothi, 1995). Claws are pointed (Sivasothi, 1995; Hussain and Choudhury, 1996), and pugmarks measure about 6cm in length (Claus Reuther, pers. comm.). The cheeks are not clearly demarcated from the rest of the face (Hussain and Choudhury, 1996). Eurasian otter is essentially an otter of cold hill and mountain streams (Prater, 1998). It is found in the foothills of the Himalayas, Orissa, Uttar Pradesh, Kerala, Tamil Nadu, Karnataka, and Andhra Pradesh (Hussain, 1993; Prater 1998).

The small-clawed otter is the smallest otter species in India (Anoop, 2001), measuring around 650-940 mm in length (Hussain and Choudhury, 1996). Its claws are reduced or blunt (Sivasothi, 1995) and the third and fourth digits are markedly longer than second and fifth on each foot (Harris, 1968). The dorsal border of the rhinarium is straight (Sivasothi, 1995). Throat is whitish to greyish, sharply separated from colour of upperside (Hussain and Choudhury, 1996). Small-clawed otter is distributed discontinuously in the Himalayan foothills from Kulu in Himachal Pradesh, eastward to

the North Eastern states, plains of Assam and West Bengal, higher elevations of hill ranges of Coorg (Karnataka), Goa, Nilgiris and Palini hills of Tamil Nadu (Prater, 1998; Turly and Santiapillai, 1990). The Eurasian otter and small-clawed otter are found north of the Ganges and in southern India. They are absent in Central India. Only the smooth coated otter is found all over India (Hussain, 1993).

If otter populations are to be conserved, it is essential that its ecology, behavior and habitat preference be studied thoroughly. According to Rabb (1990), "a large part of the task ahead in the conservation of otters relates to obtaining more information about them." For over two decades, European research on otters has been restricted to only one species, the Eurasian otter (Sivasothi, 1995). Little is known about the ecology of Asian otters in the wild other than their dietary habits (Foster-Turley, 1990). Otters have not been studied well enough to characterize spraint sites (Sivasothi, 1995). Very little is known about the relationship between habitat structure and its use by otters (Durbin, 1998). Not enough work has been done on otters in India to know precisely the distribution of each species (S. A. Hussain, pers. com.). To date, no research pertaining to otters has been undertaken in the Cauvery River ecosystem.

Major threats to otter survival in India are loss of wetland habitats, reduction in prey biomass, pollution and poaching. Developmental projects such as dams and barrages, and aquaculture activities have taken their toll on wetlands and consequently on the otters. Other reasons for the decrease in otter populations are poaching for pelts, and illegal dynamite fishing which sometimes kills otters. Being the natural predators of fish they are often the targets of local fishermen

The Indian government offers protection to all three species under the Wildlife (Protection) Act, 1972. The small-clawed otter is included in schedule I and Eurasian otter and smooth-coated otter in schedule II, which protects them from hunting, trapping and killing (Hussain, 1993). Also, Eurasian otter is listed in Appendix I, and smooth-coated and small-clawed otter are listed in Appendix II of CITES. India is a signatory to CITES, Bonn Convention, Ramsar Convention, and Biodiversity Convention, which are also helpful in otter conservation (Anon).

This study is essential in contributing to the knowledge on the habitat preferences and diet composition of the smooth-coated otter in India. Its conservation and management will lead to further research and conservation of species placed lower down in the chain, ultimately helping in conservation of riverine ecosystems, which are fast disappearing. The Cauvery River has influenced the lives of the people in South India for centuries (Rajamani, 1994). It has been referred to in many ancient texts. Thus the conservation of this riverine ecosystem is important from ecological as well as other socio-cultural aspects.

Definitions, earlier studies and literature available on Lutrines

Home range, social structure and interactions

Home range of an animal is described as the area traversed by an individual in its normal activities of food gathering, mating and caring for young (Burt, 1943). It is positively

correlated with group size and negatively with habitat quality (Neville, 1968; Yoshiba, 1968; Kano, 1972; Makwana, 1978; Maruhashi, 1982). Resource availability is the most important factor deciding the spacing patterns (Macdonald, 1983) and size and shape of home range has little or no significance without regard for other factors (Sanderson, 1966). The home range of an adult male smooth-coated otter was found to be 17km in the National Chambal Sanctuary, and 5.5 km for a female with pups (Hussain, 1993). Density of European otters in Sweden was found to be 1.7 to 5.6 individuals per 10km, and 0.75 breeding females per 10 km in Scottish streams (Green et al., 1984); river otters in Idaho – 1.7 to 3.8 individuals per 10km (Melquist and Hornocker, 1983).

Haque and Vijayan (1995) reported 20 –25 individuals of smooth-coated otters in a lake covering 8.5 km^2 in Keoladeo National Park, Rajasthan. Sivasothi (1995) while studying smooth-coated otters, sampled a stretch of 10.6 km of the Penang coastline. He found that only about 2 km of the coastline was the core area of otter usage. Ranges of families may overlap (Sivasothi, 1995; Hussain, 1993). Members of different groups may associate with each other at any one foraging trip. If groups are related, tolerance may be exhibited, as the smooth-coated otter is gregarious (Sivasothi, 1995). Subadults may or may not associate with the group (Sivasothi, 1995). A report of the small-clawed otter in Palao Tekong suggests that sub-adults do associate with parents and the next generation (Sivasothi, 1995).

Male parental care is absent in sea otters. It is not reported and probably absent in Eurasian and river otters. Male parental care has been reported among giant otters (Duplaix, 1980), smooth-coated otters (Desai, 1974; Wayre, 1974), cape clawless otters and spotted necked otters (Mason and Macdonald, 1986). Infanticide by adult male sea otters may occur in captivity (Riedman and Estes, unpubl.).

Otters are, however, known to exhibit family oriented group living. Male Eurasian and river otters display mutual avoidance but they do not appear to actively maintain territories by direct interactions or contests (Erlinge, 1968; Hornocker et al., 1983). Adult Eurasian and river otters are solitary except for females with their most recently born young (Erlinge, 1967; Melquist and Hornocker, 1983; Chanin, 1985; Mason and Macdonald, 1986). Giant otter groups consist of an adult male, an adult female and offsping from the two most recent litters (Duplaix, 1980). Occasionally family groups may join (Laidler and Laidler, 1983). Spotted necked otter family groups consist of a male, a female and their most recently born young (Rowe-Rowe, 1978). Families may join to form groups of upto about twenty individuals (Practir, 1963).

Small-clawed otters have been seen in groups of upto fifteen individuals in the Malay Peninsula (Mason and Macdonald, 1986) and form groups of 4 – 8 individulas in Sabah (Furuya, 1976). Sea otters forage alone (Estes and Jameson, 1988), but they commonly rest in groups that may contain hundreds and even thousands of individuals (K. Schneider, pers. comm. cited in Estes, 1989). A typical group of smooth-coated otter observed by Wayre (1974) consisted of two parents with upto six young. Coastal otters are more gregarious than riverine otters (Foster-Turley, 1989). Smooth-coated otters are more social than Eurasian otters or N. American river otters (Hussain, 1993). Hussain

(1993) reports that smooth-coated otters in the National Chambal Sanctuary formed groups while foraging. Group living seemed to be largely driven by kinship.

Breeding biology

Lutrines are polygamous (Estes, 1989). They generally breed at specific time of the year. In the National Chambal Sanctuary, India, pups of the smooth-coated otter with mothers were seen from early February to September (Hussain, 1993). It was estimated that pups are not born later than November (Hussain, 1993). In the case of smooth-coated otters, mean litter size is three. Pups are weaned after 130 days. Mean gestation period is 62 days (Desai, 1974). Evidence of pups of the Eurasian otter on the river Severn was seen between January and August (Macdonald and Mason, 1987). Sea otters bear single young (Gittleman, 1986).

Before parturition the female is mainly nocturnal. By three weeks postpartum, her activity returns to pre-birth levels. After eight weeks, the pups emerge. The N. American river otter brings back live prey to her young and releases it for them to kill (Liers, 1951). The young of the sea otter remain with the mother for over a year. Hall and Schaller (1964) regularly saw juveniles dive after the mother when she went down to hunt, presumably to learn how to hunt.

It appears that older offspring disperse when the females litter (Hussain, 1993). Melquist and Hornocker (1983) observed such dispersal of offspring during littering season of adult females in N. American river otters. Other factors affecting activity patterns of otters are physical factors like temperature, or anthropogenic factors like disturbance (Hussain, 1993).

Habitat

Otters are found in wetlands (Mason and Macdonald, 1986) and are the top carnivores of the wetland ecosystem. In coastal mangroves, large groups are seen more frequently than solitary otters, whereas there is a high incidence of solitary sightings in freshwater systems with the absence of large groups (>= 4) (Shariff, 1984). In peninsular Malaysia, the smooth-coated otter occupies a niche (rocky shorelines) in parallel with the marine otter found along the coasts of Chile, S. America (Sivasothi, 1995). They are also known to inhabit rice fields (Shariff, 1985; Foster-Turley, 1992). Hussain's study (1993) showed a high preference by otters for rocky river tracts in all seasons, while river stretches with bank side vegetation and marsh were preferred next.

Otters in the Periyar Tiger Reserve, Kerala, showed a preference for soil with high sand content for grooming. They also seemed to prefer shallower and narrower regions of the lake, banks with gentle slope, and areas where number of streams joined the lake (Anoop, 2001). For resting, otters prefer dry substrates (Sivasothi, 1995). Spraint sites of smooth coated otters in Penang were found to be along flat expanses of rocks along the shore and steep slopes were generally avoided (Sivasothi, 1995). The importance of bank side vegetation for resting has been stated by several workers (smooth-coated otter, Melisch et al., 1996; Hussain and Choudhury, 1995,1997; spotted necked otter and cape clawless otter, Rowe-Rowe, 1992; Procter, 1963; Eurasian otter, Macdonald and Mason, 1987).

Holts

An otter's den is called a "holt". Holts are found in rock crevices, among tree roots, or dug out on banks of water bodies. Certain trees have complex root systems, which provide convenient holts for the otters (Macdonald and Mason 1980). There are reports that the entrances of holts are marked heavily by otters (anon). However, some reports suggest that during period of occupancy, no external signs of otter presence are visible, indicating the difficulty of finding natal holts without telemetry (Durbin, 1996). The smooth-coated otter is a powerful burrower and is able to dig into banks to make dens (Sivasothi, 1995). On the River Chambal, dens were found to be mostly on islands (Hussain, 1993). Den usage was mostly between September and March (Hussain, 1993). Dens are important foci of activity (Hussain, 1993). Holts are used only during cub rearing. At other times, an otter has no permanent home (Burton, 1968). On average, holts are changed at the rate of about once every two days; this may be to familiarise the pups with their range and enable the female to use different resources (Durbin, 1996).

Grooming and basking

Grooming is the vigorous rubbing of fur on loose sand, soil or grass on the ground, rolling and blowing of air into the fur (Anoop, 2001). Basking is the inactive state after grooming when they heat up their body with sunlight (Anoop, 2001). Grooming and basking are closely associated with sprainting behaviour (Anoop, 2001).

Thermal insulation is of vital importance to the otters. For this, they rely almost entirely on their fur (Scholander et al., 1950; Tarasoff, 1974). They have fur of two kinds – fine soft waterproof underfur, interspersed with longer and thicker guard hairs (Burton, 1968). As soon as the otter submerges, the guard hairs become wet and lie flat over the underfur, largely preventing water from entering it. Dense underfur carries air trapped among the hairs, so that any water passing the guard hairs is excluded (Burton, 1968; Estes, 1989). Trapped air serves to insulate the body, preventing loss of body heat (Burton, 1968; Estes, 1989).

The longer the time spent under water, and deeper the dive, the longer the time spent by the otter in grooming and resting after the hunting bout (Nolet, et al., 1993). Thus, fur maintenance plays a prominent role in the otter's life (Kruuk and Balharry, 1990). Kruuk and Balharry (1990) observed that the body shake seemed to be the most frequent form of fur maintenance. Other grooming behaviours they observed were licking of fur, rubbing and rolling.

Playing

The playful nature of otters has been observed in captivity (Leslie, 1971; Duplaix-Hall, 1972) and in the wild (Sivasothi, 1993). Chanin (1985) is of the view that otters slide for practical reasons of locomotion rather than play. But Shariff (1984) observed otters in Kuala Gula, Perak, repeatedly belly sliding down banks for long periods of time. Such behaviour was classified as "play". Hiscock (1990) observed an otter in the Singapore mangroves repeatedly wriggling on all fours over a slight tidal incline to gain momentum before releasing its forelimbs to belly slide, for long periods of time.

Sprainting behaviour

The faeces of otters are called "spraints" and the behaviour associated with deposition of spraints is called "sprainting". Kruuk (1992) indicated the following as the functions of sprainting:

(i) Spraints signal between sexes on readiness to mate or within sexes on aspects of competition for mates.
(ii) Spraints also help in marking out territories.

All lutrines studied thus far establish spraint sites in conspicuous places allowing for their use as indicators or for diet studies – Eurasian otter (Erlinge, 1968), Giant otter (Duplaix, 1980), Spotted necked otter, cape clawless otter (Rowe-Rowe, 1977), N. American river otter (Melquist and Hornocker, 1983), southern river otter (Chehebar, 1985). Spraints are largely black in colour, with a pleasant sweet-musky odour, occasionally combined with a fishy smell when fresh (Mason and Macdonald, 1986; Kruuk, 1995; Sivasothi, 1995). Otters frequent their spraint sites with such regularity and consistency that they are called "toilet sites" or "latrines", which may be used over several decades (Sivasothi, 1995).

Smooth coated otters in the Periyar Tiger Reserve, Kerala, were observed to show site fidelity. Sites that were submerged during the rains were used again, once they were exposed (Anoop, 2001). Similar site fidelity was observed for Eurasian otters in Scotland (Kruuk, 1995). However, Sivasothi (1995) found that not all spraint sites are visited regularly. They tend to use the same routes, forming distinctive pathways through the vegetation (Gorman et al., 1978).

Spraints, urine and at times, a gelatinous secretion thought to originate from the paired anal sacs, are deposited at conspicuous points along these paths (Gorman et al., 1978). Macdonald and Mason (1978) noticed a seasonal cycle in the total number of signs of otters and in the number of sprainting sites, with a clear increase during winter and early spring. Green, et al. (1984) observed that the spraint sites of the female Eurasian otter centred around areas of high activity rather than the boundaries of her range.

This was also observed among captive otters (Hillegaart, et al., 1981, Sivasothi, 1995). In the National Chambal Sanctuary, Hussain (1993) observed that marking by defecation or urination was usually adjacent to dens, at grooming sites, along regular travel routes, or near foraging sites. Marking often occurred in groups while grooming or foraging. Marking by one individual induced this behaviour among other members of the group. Males always sniffed and examined the area before sprainting.

Sprainting is usually either followed by or preceded by basking and grooming, except when otters are retiring from foraging grounds for the day (Anoop, 2001). Association of spraints with grooming sites is very strong (Anoop, 2001). Otters are also known to deposit spraints before and after intensive hunting bouts, and sometimes while landing during a hunting bout (Kruuk, 1992). Indigestible parts of the prey present in the spraints can be used to identify prey species and its size, especially for fish, which is a major constituent of the diet of otters (Wise, 1980)

Gorman, et al. (1978) observed in a pair of captive Eurasian otters that anal sac secretion was usually associated with the act of excretion. But in the wild, blobs of jelly are sometimes found separate from faeces (Gorman et al., 1978). The captive otters would sniff at an established latrine site, urinate and/or defecate and then eject part of the contents of the anal sacs on top, or to one side of the excrement. Deposits were usually green or brown and had a typical otter odour. It was also observed that production of these deposits was periodic. The onset and ending of secretion was synchronised between the two animals.

Diet

Diet is one aspect of the ecology of otters that has been studied quite thoroughly in various parts of the world (Eurasian otter: Erlinge, 1968; Wise et al., 1980; Jenkins and Harper, 1980; Wise et al., 1981; Kruuk and Moorhouse, 1990; Kruuk and Moorhouse, 1991; smooth-coated otter: Tiler et al., Foster-Turley, 1992; Kruuk et al., 1994; Haque and Vijayan, 1995; Hussain and Choudhury, 1998; Neotropical otter: Pardini, 1998; cape clawless otter: Perrin and Carrugati, 2000; Spotted necked otter: Perrin and Carrugati, 2000, small clawed otter: Wayre, 1978; Kruuk et al., 1994). However such studies have not been conducted in free flowing rivers in southern India. It needs to be seen whether any comparison exists between diets of smooth-coated otters in various habitats in India.

Animals may be either of two kinds of foragers – specialist or generalist foragers. Specialist feeders are highly specific in food selection, whereas generalist feeders feed on a varied range of food species (Krebs and Davies, 1984). Food probably exerts the greatest influence on frequency of movement of otters (Melquist and Hornocker, 1983). Hussain (1993) observed that movement of otters was greater during summer than winter or monsoon, because of decrease in prey availability.

Otters adopt two distinctive foraging modes – piscivory and invertebrate feeding (Estes, 1989). One lineage of invertebrate feeders led to sea otters, *Enhydra lutris*, and the other led to the clawless and small-clawed otters – *Aonyx* and *Amblonyx* species. Piscivorous otters are represented by the genera *Lutra* and *Lontra* (Estes, 1989).

Otters take a large proportion of their prey from "feeding patches" which they frequent. Utilization of patchy, recurrent resources is a characteristic of many group-living, solitary hunting carnivores (Macdonald 1983). The smooth-coated otter locates food visually, catching it in its mouth (Sivasothi, 1995). Shariff (1984) observed them foraging among fallen tree trunks, rapids, fishing nets, and other obstacles in the water. They hold their heads above the water surface, moving slowly with sudden glides into the water to catch fish (Shariff, 1984).

The small-clawed otter has considerable digital movement, and uses its hands to feel for prey and conduct other manipulative behaviour (Timmis, 1979; Duplaix-Hall, 1972; Wayre, 1976). It searches under boulders and in crevices (Medway, 1983; Nowak, 1991). Timmis (1971) observed a group of ten small-clawed otters digging up shellfish and opening them by laying them out in the sun. The otter always brings its catch onto the land to be consumed (Burton, 1968). Composition of otters' diet varies according to

species of otter, time and place (Hussain, 1993). They depend on what species are available, and it is also possible that otters have preference for certain types of prey (Chanin, 1985). Fish must be available all year round if otters are to remain as permanent residents in the study area (Melquist and Hornocker, 1983).

Shariff (1985) found that spraints collected from rice fields contained only fish, whereas spraints collected from two coastal islands contained crab and crayfish. Spraints from the east coast of Malaysia contained only crabs (Wayre, 1974). The diet of the small–clawed otter was found to be mainly molluscs and crabs, and less of fish (Lekagul and McNeely, 1988; Foster-Turley, in litt). The cape clawless otter in the Tsitikama Coastal National Park, South Africa were found to feed almost entirely on crabs, octopus and suckerfish (van der Zee, 1981).

Foster-Turley (1989) studied the diet of three populations of smooth-coated otters. One mangrove population ate only mangrove fish. The second mangrove population ate both fish and marine crabs. The population residing in fresh water rice fields fed on fresh water fish and rats. Crabs are infrequently found in the spraints of the smooth-coated otter (Foster-Turley, in litt.). The diet of the smooth-coated otter along the coast of Pantai Aceh Reserve, Penang is almost entirely fish (Sivasothi, 1995). It is predominantly a fish eater and is similar in food habits to the Eurasian otter, and the North American river otter (Hussain, 1993).

In the Periyar Tiger Reserve, Kerala, fish constituted 96% of the smooth-coated otters diet. Total number of prey items encountered in the spraints varied from one to seven, most scats containing 3 - 4 items on average. Mostly small to medium sized fish (5-15 cm) were taken. Larger fish were targeted only opportunistically (Anoop, 2001). Smooth-coated otters in the Keoladeo National Park, Rajasthan, were found to be feeding almost entirely on fish (Haque and Vijayan, 1995). The same was seen in the National Chambal Sanctuary, prey sizes ranging from 4 - 46 cm in length (Hussain and Choudhury, 1998). Prey species consumption increased with their relative abundance (Hussain and Choudhury, 1998).

Objectives, hypothesis tested and methodology used for the current study

Given the existing knowledge and background information on the different species of otters, and the lack of specific study on these species found in India, particularly of smooth-coated otters, an attempt was made to study habitat choice and diet composition of the species. A preliminary study of about two months duration to document some aspects of the ecology of *L. perspicillata* occurring in the Cauvery basin was undertaken. As the study was for a very short duration and meant to be a preliminary start-up type, it was decided that the objectives of this study should be rather restricted.

Objectives

The objectives of this study were to elucidate:

1. Factors that govern the choice of habitat of *L. perspicillata* along the river banks and islands that occur in the course of the Cauvery River;

2. Diet composition of *Lutra perspicillata* in the Cauvery Wildlife Sanctuary.

Hypothesis
The following null hypothesis was tested:

Otter sites are not significantly different from non-otter sites.
Alternatively, if this null hypothesis is to be rejected, then the results should be used to propose an alternative hypothesis listing out the parameters that differentiate the preferred sites

The hypothesis was based on literature read (Hussain, 1993; Anoop, 2001) and preliminary studies carried out in the field.

Study area
The study site, Cauvery Wildlife Sanctuary (Figure1) was chosen after much preliminary

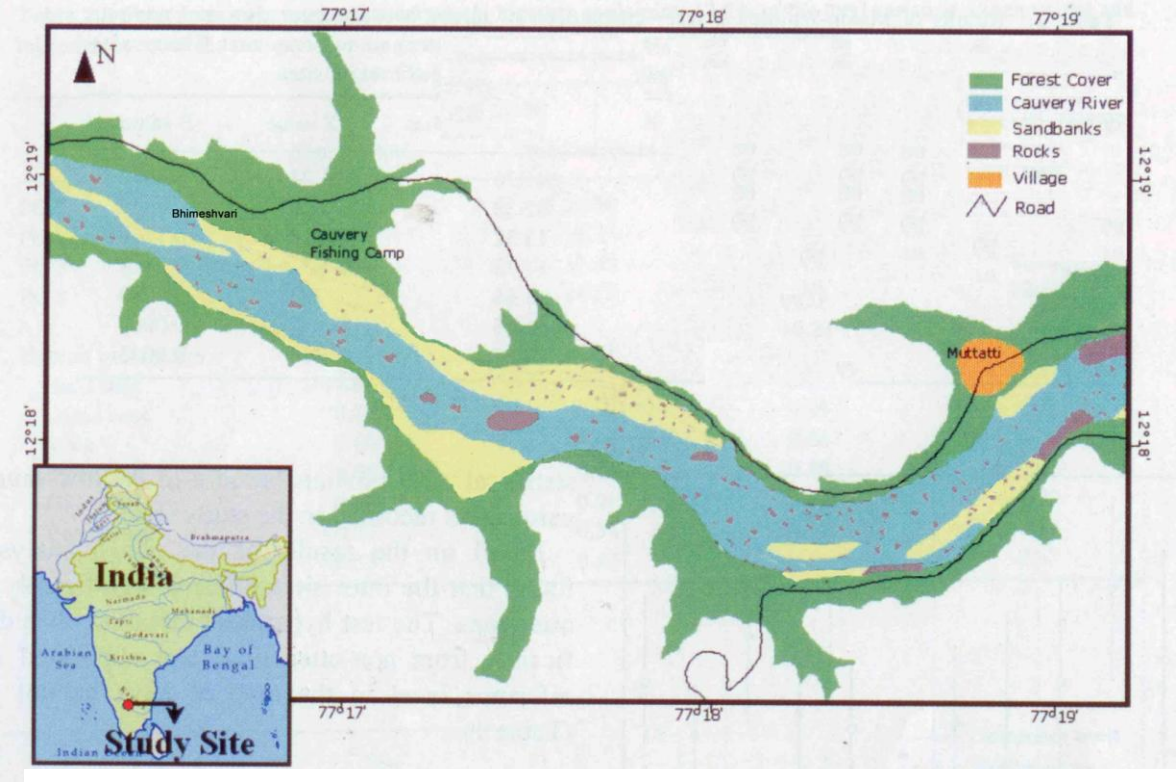


Figure 1: Map showing a part of Cauvery Wildlife Sanctuary, along the Cauvery River, land use pattern and the location of site in India

studies and reconnaissance. The sanctuary is situated about 100 km south of Bangalore, South India, and covers an area of 526.95 sq. km. The River Cauvery (Figure 2), within this sanctuary, stretches from Bhimeshvari (12°19'N, 77°17'E) to Hogenekal (12^{o}6'N, 77^{o}48'E) covering a length of about 35 km. The river is dotted with rocky boulders and sand banks all along its course.

Figure 2: River Cauvery flowing through the Cauvery Wildlife Sanctuary in Karnataka

The sanctuary is mainly a mix of dry deciduous and scrub jungle (Figures 3a, b, c and d).

Figures 3a, b, c and d: Types and status of forests found in Cauvery WLS

Dominant floral species along the river banks are *Terminalia arjuna, Dyospyros montana, Tamarindus indicus.*

The sanctuary has a rich faunal diversity including elephant (*Elephas maximus*- Figure 4a), cheetal (*Axis axis*), leopard (*Panthera pardus*), dhole (*Cuon alpinus*), otter (*Lutra perspicillata*) mugger (*Crocodylus palustris*-Figure 4b*).* In general, the middle region of


Figures 4a and b: Examples of Wildlife found in Cauvery WLS a: Asian Elephant and b: mugger crocodile

the Cauvery basin has a semi-arid climate with temperatures above 25^0C and receives average rainfall 60-100 cm annually (Jayaram, 2000). The core area chosen for the study was a 5 km stretch of the river between Bhimeshvari (12°19'N, 77°17'E) and Muttatti (12°00'N, 77°27'E). The study was conducted between January 2002 and mid-March 2002.

Methodology

Preliminary studies were undertaken in the first two weeks and spent in familiarizing with the study area, the study animals, their secondary signs, and in identifying an appropriate core area for the study where the presence of at least one resident group of otters was confirmed. Intensive studies were carried out in the core area identified over a period of 6 weeks

Habitat analysis

Assumptions made for the study:

(i) Areas marked with spraints, otter pugmarks, signs of play and scratch marks on fallen logs or tree trunks were considered as areas preferred, or used extensively by otters. Such sites were called "otter-sites". Sites chosen for sampling availability of habitat were called "non-otter sites" if they were not being used by otters.

(ii)Any burrow-like hole, or rock crevice, marked at the entrance considerably with spraints and otter pugmarks was considered a holt or den.

The entire stretch was divided into 1 km blocks and colour marked for consistency. Marks were also made at every 50 m interval. The stretch was walked every alternate day for a period of 6 weeks. Otter-sites were identified along both banks of the river. Frequency of usage of each otter site was recorded based on appearance of fresh spraints and pug marks. Fresh pugmarks are clearly different from the older marks as they have sharper outlines.

Eight islands were chosen randomly and scanned for the habitat parameters given below. Islands were scanned every alternate day for the same period by rowing down the river in a *coracle* (boat). Time of day did not matter as the study was concentrated upon secondary signs rather than actual sightings (Teplov, 1952). But the walks and boat surveys were conducted at the same time everyday and along the same route so as to avoid bias.

Otter-sites were classified using the following parameters:

1.1 Substrate type – rock or soil, type of soil, percentage of each type, estimated visually;
1.2 Canopy cover – this was quantified using a densiometer;
1.3 Vegetation cover – this was estimated visually;
1.4 Leaf litter – this was also estimated visually;
1.5 Distance from edge of water;
1.6 Presence or absence of holts;
If holts present:
1.6.1 Substrate type
1.6.2 Distance from water edge;
1.6.3 Height from water surface;
1.6.4 Vegetation around the holt;
1.6.5 River near entrance of holt;
1.6.6 Depth of river near entrance of holt;
1.6.7 Slope of bank;
1.6.8 Direction of entrance and the direction of flow of the river;
1.7 Approximate area of otter-site.

Habitat availability

Both banks of the river and the islands chosen within the study area were scanned for habitat availability. Sampling was done every 50m, within a belt of 5m from the water edge, since the preliminary study showed that most otter sites were located within 5m from the edge of the water. Habitat parameters as given above were noted in sample plots of size 5mx5m; these sites were referred to as non-otter sites.

Visitation rate by otters

The visitation rate by an otter to a particular 1 km stretch or island was calculated as *Visitation rate = total number of visits by otters / observer effort*. Number of visits by otters was taken as a cumulative of all otter sites within the 1km stretch or island.

Otter frequency

This was calculated to rule out the possibility of error in comparing visitation rates with disturbance levels, as number of visits to a stretch may depend on the number of sites, which in turn may depend on the habitat and not the level of disturbance.

Otter frequency was calculated for each 1km stretch using the following relation:
Otter frequency = total number of visits by otters / number of otter sites / observer effort.
Number of visits by otters was taken as a cumulative of all otter sites within the 1km stretch.
Otter frequency was also calculated for each island, using the same formula. Number of visits by otters was taken as a cumulative of all otter sites on the island.

Disturbance levels

An index of disturbance was devised based on the observations of disturbance levels by the investigator on field, based on the perceived effect the disturbances had on the otters:

Signs of fish poaching = 3
As poaching of fish took place surreptitiously, and without regard to consequences on wildlife and the ecosystem, but purely on an economic criterion, it was considered to be the highest form of anthropogenic disturbance with respect to otters. Secondary signs included fish scales, nets, ropes, etc.

Signs of picnickers = 2
External tourists (Figures 5a and b) who come to the study area without any regard to disturbing the ecosystem were considered next highest in terms of anthropogenic disturbance. Secondary signs included alcohol bottles, plastic litter, chicken feathers, fire places, etc.

Figures 5a and b: Extent of human flow along the river

Local people and/or eco-tourists = 1.
The local people of Muttatti, having lived there for many years, have a greater regard for wildlife than external tourists. However, their movements in the study area do cause disturbance and were therefore considered as an anthropogenic disturbance. Similarly, ecotourists in the study area, though a cause some amount of disturbance, are not rated as highly as poachers or external tourists.

Disturbance levels were calculated for every 1km stretch using the following relation:

*Disturbance level = index * total no. of incidents / observer effort*

Disturbance levels were also calculated for each island using the same relation.

The number of incidents was counted with respect to number of groups, rather than individuals, as secondary signs were also counted, which can only indicate the presence of a group, and not the size of the group. It was also assumed that the presence of a group, however large, would affect the otters, and hence size of the group may not matter as much as number of groups visiting the site.

Diet composition

For this study, samples of spraint were collected in a representative manner (Anoop, 2001). Spraint samples were collected from every otter-site encountered while scanning the riverbanks and islands for studying habitat parameters. Care was taken so as to ensure the collection did not adversely impact the functionality of the spraint.

Within 24 hours of collection, each sample was soaked overnight in detergent solution, washed under tap water in an iron sieve of mesh size 1mm, and dried in shade. Each sample thus dried was stored separately in a polythene zip-lock cover, marked with date, time and location and kept aside for analysis (Anoop, 2001). Undigested prey remains like skeletal remains, scales, etc. were recovered from these spraint samples and specific prey were identified mostly upto genus level. Non-fish species were also recorded. The samples were identified at the Central Institute for Freshwater Aquaculture, Peninsular Division, Bangalore.

Studies have shown that fish length is linearly related to length of vertebrae (Hussain, 1993; Jacobsen and Hasen, 1996; Carson and Elston, 1996; Anoop, 2001). The length of vertebrae in an individual fish does not vary greatly (Anoop, 2001). This has been used to calculate length of prey taken by the otters by measuring lengths of vertebrae found in spraints (Hussain, 1993; Jacobsen and Hasen, 1996; Carson and Elston, 1996; Anoop, 2001). Anoop (2001), in his study of the diet of smooth coated otters in the Periyar Tiger Reserve, found that vertebrae length was related to fish length by the following linear relation:

*Fish length = (vertebral length * 62.407) – 6.333;* this relationship was used in the study to estimate size of prey taken by otters in the study site.

Key informant survey

Ten people who were familiar with the study area were randomly selected and interviewed. They represented various economic and working classes, ranging from the Sholiga tribals, to the local Gowdas, to the manager of the Cauvery Fishing Camp, Bhimeshvari. Questions pertaining to distribution and status of otters in the Cauvery, number of individuals seen, incidents of poaching, etc. were asked. This was done to assess the general distribution and status of otters in the area.

Data Analysis

Habitat analysis

The data were analysed using the STATISTICA '99 Edition and SPSS Standard Version packages. The data collected was run through a test for normality. Since the data was not normal, non-parametric tests were used.

Each parameter was expressed as a percentage of the total area sampled for non-otter sites and otter sites separately. A bar chart was plotted for the same to see how otter sites and non-otter sites varied with respect to the identified parameters. Further analyses were done to test the hypothesis stated earlier. Since the data was not normal, non-parametric test had to be carried out.

A Principal Component Analysis (PCA) test was done to find a structure and pattern in the data, and to differentiate between otter sites and non-otter sites based on the afore said parameters. Data of otter sites and non-otter sites were combined. Parameters with a factor loading >=0.7 were considered significantly important in contributing to a particular factor or principal component. A scatter plot using the factor scores, with the principal components along the axes, was plotted. Otter sites were marked differently from non-otter sites in order to differentiate between the two. The cluster pattern of otter sites and non-otter sites was studied. The correlation matrix showed canopy cover and leaf litter to be highly interdependent and hence leaf litter was eliminated from the data analysis.

GIS tools were used to represent variation in occurrence of otter sites with increase or decrease of a particular factor. The results of the PCA were further verified using a Mann-Whitney U test. The data was grouped as otter sites and non-otter sites. Significant difference between the two groups for each of the above mentioned parameters was tested. Box-whisker plots were used to represent the results of the Mann-Whitney U test.

The entire 5km stretch was divided into 1km stretches. Thus there were 9 such stretches including both banks of the river. Using the sample plots, an average of the percentage coverage of each kind of habitat parameter in the 1 km stretch was calculated. This was also done for each of the islands, by calculating the average percentage coverage of each habitat parameter used to define the habitat. Using these 1 km stretches and the islands, a cluster analysis was done, to verify which stretches were similar with respect to habitat.

The analysis was done using the habitat parameters and distances were computed using Euclidean distances, which is simply the geometric distance in the multidimensional space. Euclidean distances are usually computed from raw data, and not from standardized data. Since all parameters have been measured in percentages, this method was chosen. Similar sites were compared as to number of otter sites in each stretch and the cumulative visits by otters to each stretch.

Five holts were found, of which two were not being used and one was being used very infrequently. No statistical test was run on this data as the sample size was too low to determine anything.

Disturbance

Spearman's rank correlation was used to see the relationship between disturbance and

1. The visitation rate by otters to a 1 km stretch or island;
2. The number of sites in a 1 km stretch or island;
3. The otter frequency for each 1km stretch or island.

Scatter charts with a linear fit were plotted for the same. GIS tools were used to represent the frequency of usage and occurrence of otter sites with increase or decrease in disturbance levels.

Diet composition

Thirty spraint (Figures 6a and b) samples were analyzed for undigested prey remains. Each prey species was expressed as a percentage of the cumulative occurrence of all species. A pie chart was used to explain the same. The families that the fish species belonged to were also represented by a pie-chart, to illustrate most preyed upon fish families.

Figures 6a and b: Spraint sample found along the river beds

Size of prey species was estimated and the occurrence of different size classes was represented pictorially as a percentage of cumulative occurrence of all size classes through a pie-chart.

Results

Otters of the Cauvery Wildlife Sanctuary

The otter species found in the Cauvery Wildlife Sanctuary were identified as *Lutra perspicillata* (Figures 7a, b, c and d). This was confirmed by the shape of the rhinarium and nose, flat underside of tail, claws showing in clear pugmarks, measurement of pugmarks (breadth ranging from 5 cm to 11 cm, mean = 7.46 cm, standard deviation = 1.10 cm, length ranging from 5 cm to 10 cm, mean = 7.64 cm, standard deviation = 1.14 cm, n= 46) and smooth appearance of coat. Number, otter sightings, location and associated aspects are given in Appendix 2.

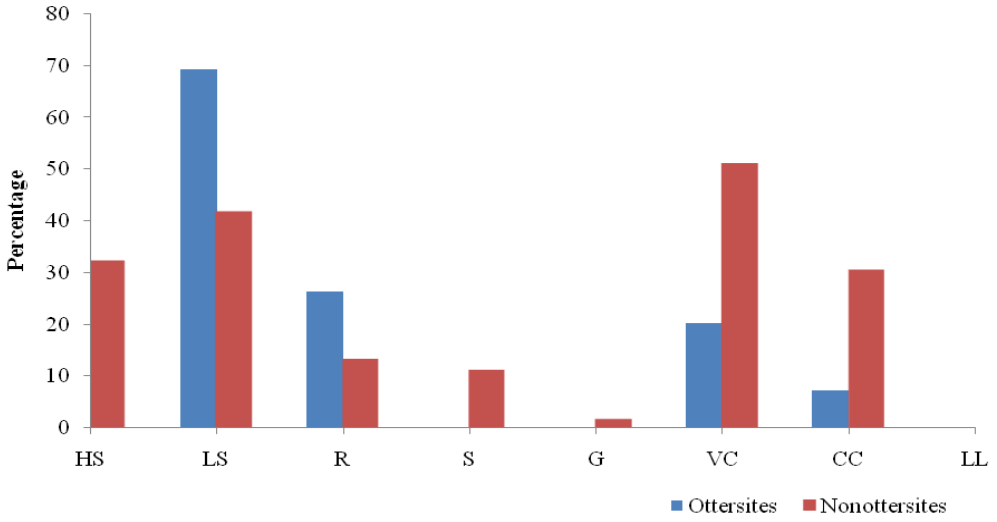
Figures 7a, b, c and d: Otter species in the Cauvery Wildlife Sanctuary identified as *Lutra perspicillata*.

Habitat analysis

A total of 23 otter sites were sampled – 11 on the riverbanks (Figure 8a) and 12 on islands (Figure 8b) and a total of 206 non-otter sites were sampled on islands as well as riverbanks.

Figures 8a and b: Examples of the locations of riverbank (a) and island (b)

Figure 9 show how otter sites (Figures 10a and b) and non otter sites vary and it is seen that habitat usage by otters in the study area was not proportionate to availability.



HS: Hard-sand, LS: Loose-sand, R: Rock, S: Stone, G: Gravel, VC: Vegetation-cover, CC: Canopy-cover, LL: Leaf-litter

Figure.9. Habitat usage by smooth coated otters in the Cauvery Wildlife Sanctuary

Figures 10a and b: otter habitat with combination of loose sand and rock 9a); otter foot-print on loose sand bed (b)

The Correlation matrix (Table 1) of the habitat parameters showed leaf litter and canopy cover to be highly correlated ($r=0.84$, $P<0.001$)

Table 1. Results of the correlation matrix of the habitat parameters

	Hard Sand	**Loose Sand**	**Rock**	**Stone**	**Gravel**	**Vegetative Cover**	**Canopy Cover**	**Leaf Litter**
Hard Sand	1.00	-0.65	-0.34	-0.20	-0.11	0.35	0.42	0.44
Loose Sand	-0.65	1.00	-0.24	-0.26	-0.04	-0.21	-0.22	-0.27
Rock	-0.34	-0.24	1.00	-0.15	-0.04	-0.36	-0.25	-0.22
Stone	-0.20	-0.26	-0.15	1.00	-0.06	0.23	-0.05	-0.04
Gravel	-0.11	-0.04	-0.04	-0.06	1.00	-0.13	-0.10	-0.07
Vegetation Cover	0.35	-0.21	-0.36	0.23	-0.13	1.00	0.25	0.27
Canopy Cover	0.42	-0.22	-0.25	-0.05	-0.10	0.25	1.00	0.84
Leaf Litter	0.44	-0.27	-0.22	-0.04	-0.07	0.27	0.84	1.00

The PCA extracted four principal factors. Factor 1 consisted of hard sand and loose sand, factor 2 consisted of rock, factor 3 was stone and factor 4 was gravel (Table 2), explaining 82.6 of the total variation. The scatter plots of factor scores represent pictorially the variation of otter points and non otter points with the habitat parameters. As mentioned earlier (see data analyses section) parameters with a factor loading >=0.7 were considered significantly important in contributing to a particular factor or principal component, factor loadings, habitat parameters contributing to each factor have been marked in bold typeface.

Table 2. Factor loadings (Varimax normalized) (Marked loadings are > .700000), and e*igen values and related aspects.*

Factors	Eigen values	% total variance	Cumulative eigen values	Cumulative %
1	2.2	27.9	2.2	27.9
2	1.3	16.5	3.5	44.4
3	1.2	15.2	4.8	59.6
4	1.1	13.6	5.9	73.2
Habitat Parameters	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
Hard sand	***0.87***	0.31	0.19	0.04
Loose sand	***-0.89***	0.28	0.33	0.04
Rock	0.04	***-0.92***	0.03	0.11
Stone	-0.04	0.08	***-0.95***	0.01
Gravel	0.00	-0.08	0.02	***-0.7769***
Veg-cover	0.33	0.58	-0.40	0.18
Canopy-cover	0.51	0.44	0.21	0.13
Expl.Var	1.91	1.56	1.24	1.13
Prp. Total	0.24	0.20	0.15	0.14

Figure 11 shows two major clusters. Cluster II comprises mainly of non-otter sites. They are all clustered around relatively low percentage of loose sand, high percentage of hard sand and low percentage of rock. Cluster I comprises many of the sites used by the otters (52%). These are clustered around relatively low percentage of rock and loose sand and

high percentage of hard sand. Thus otter sites seem to be significantly different from non-otter sites with respect to hard sand and loose sand and not significantly different with respect to rock. However some otter sites (29%) seem to fall in the region of low percentage of hard sand, and high percentage of loose sand and rock.

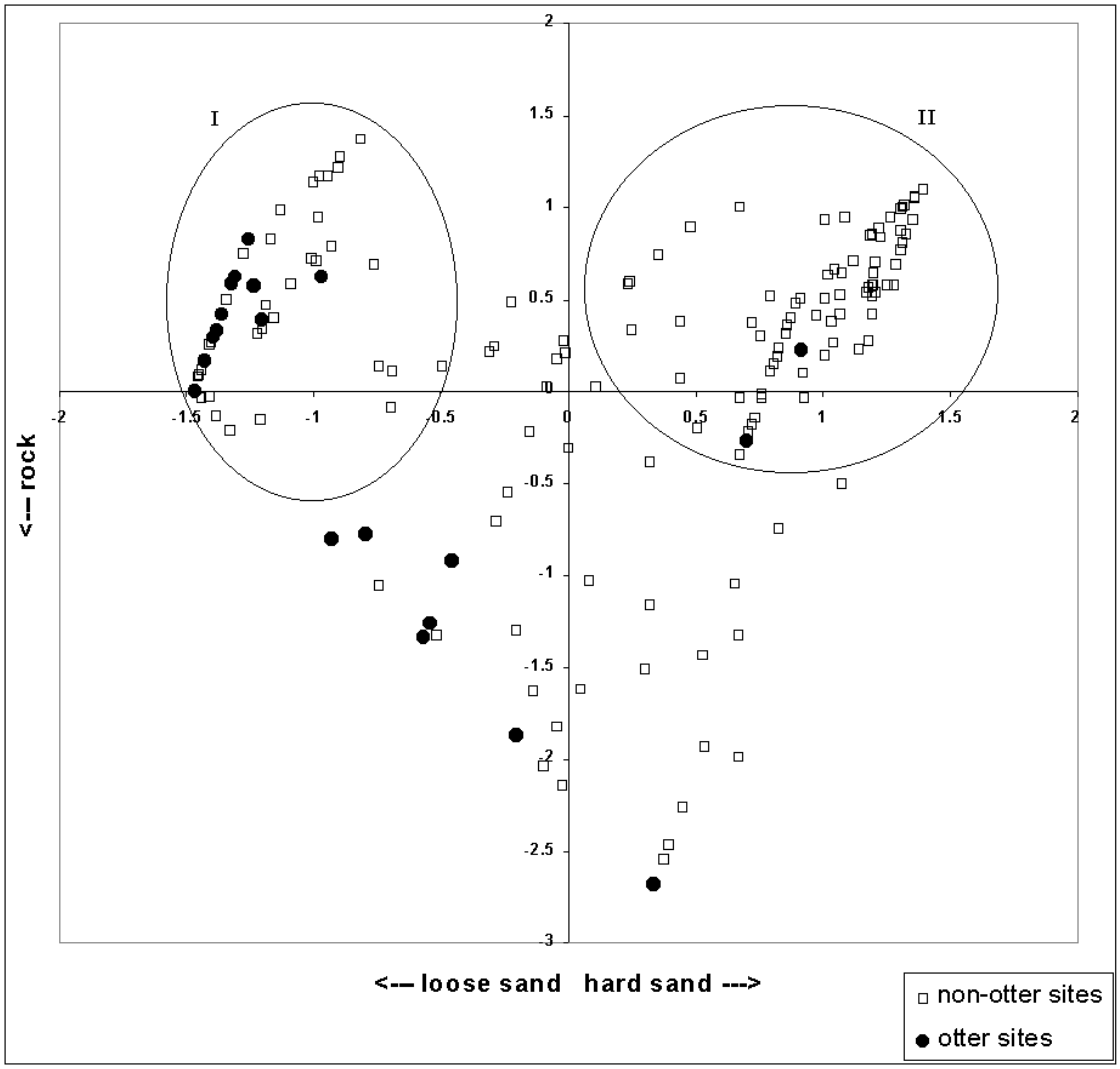


Figure 11: Factor 1 versus Factor 2

Figure 12 shows two clusters. All the otter sites and a large number of non-otter sites form a large cluster II. This represents relatively low percentage of stone and gravel. Cluster I is comprised of only non-otter sites, representing high percentage of low gravel and high percentage of stone. Thus the otter sites are not significantly different from otter sites with respect to gravel, but may be significantly different with respect to stone.

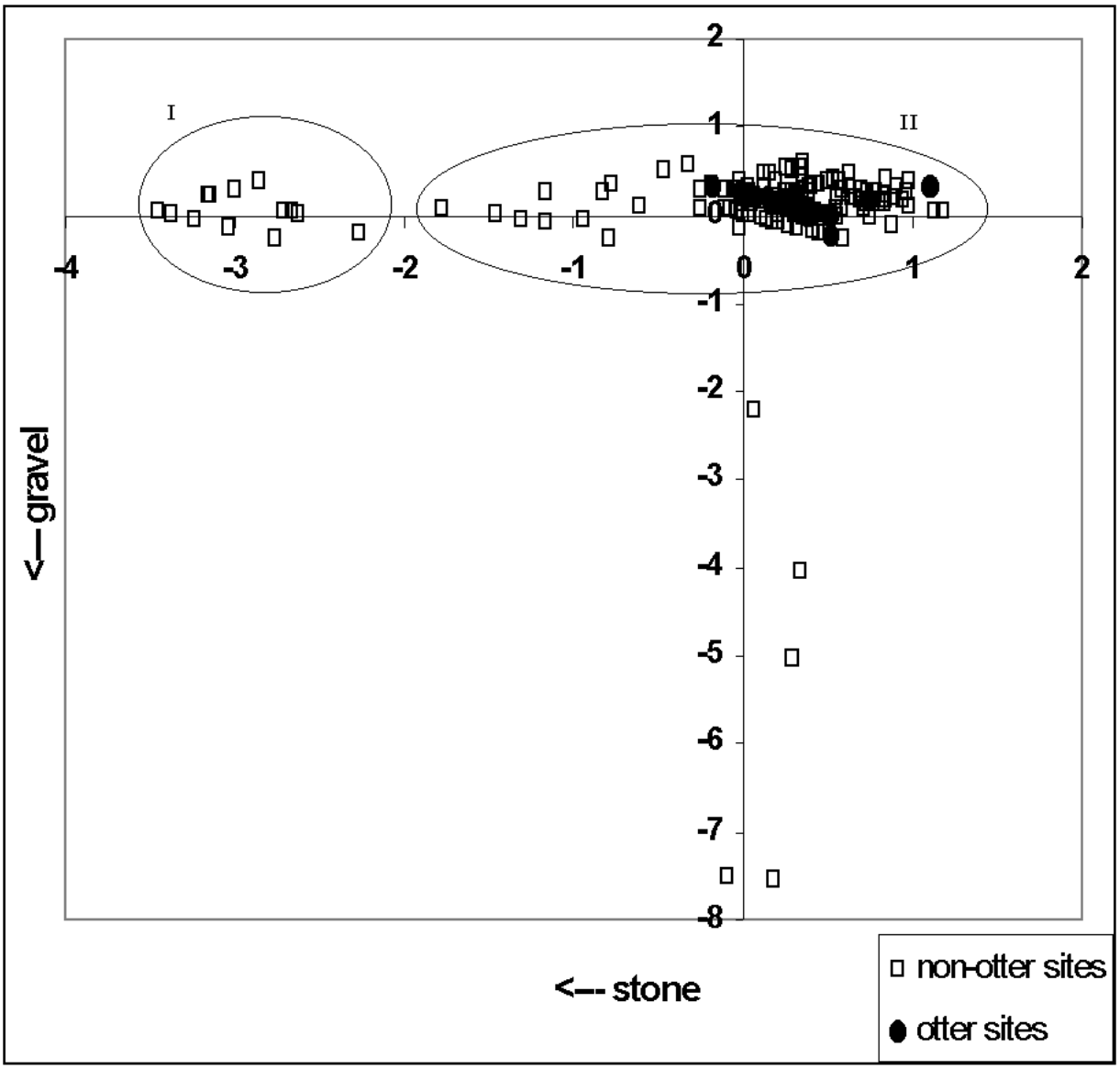


Figure 12: Factor 3 versus Factor 4

Results presented through GIS showed (Figure 13) that the otter sites were placed in areas high percentage of loose sand (Figures 14a, b, and c) and low percentage of hard sand.

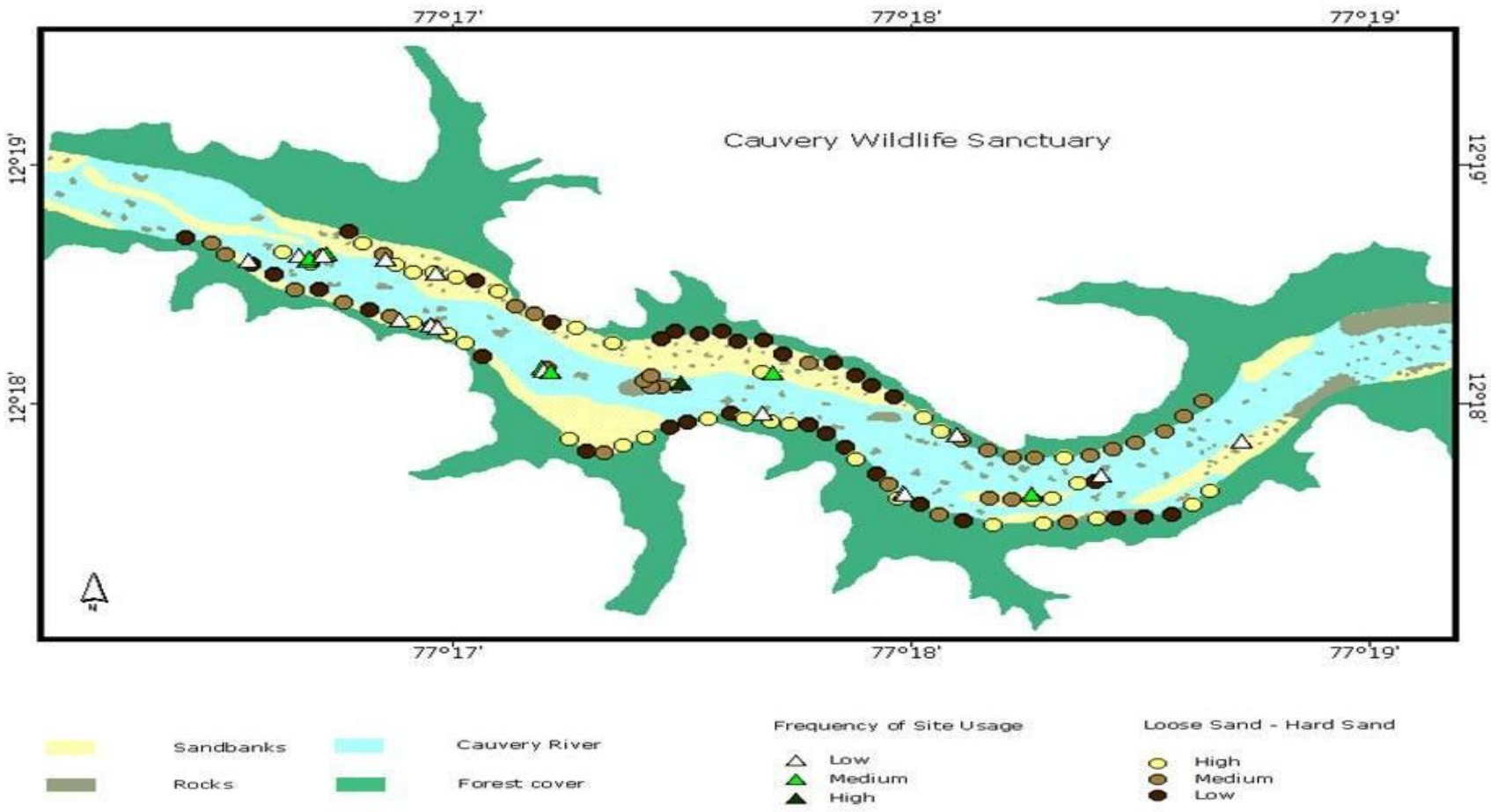
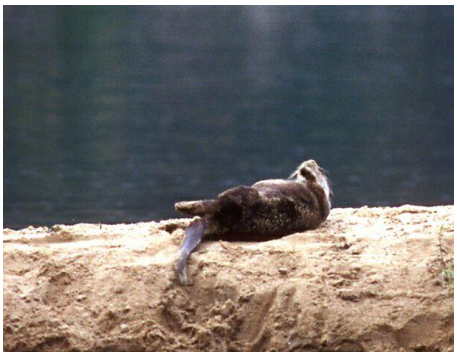


Figure 13: Habitat usage pattern by smooth coated otter



Figures 14a, b and c: Examples of otter sites placed in areas of high percentage of loose sands

The mean percentage of hard sand in otter sites and non-otter sites were found to be significantly different (U = 1557.5, Z = -4.115, p<<0.05 – Table 3; Figure 15).

Table 3: Results of Mann-Whitney U test for the habitat parameters

Parameters	**U value**	**Adjusted Z value***	**P– level***
Hard sand	1557.5	-4.11	0.000039
Loose sand	1374.5	4.66	0.000003
Rock	2280.5	1.91	0.0559
Stone	2254.5	-2.33	0.0195
Gravel	2646.0	-0.91	0.365

- Z values and p-values have been adjusted for ties.

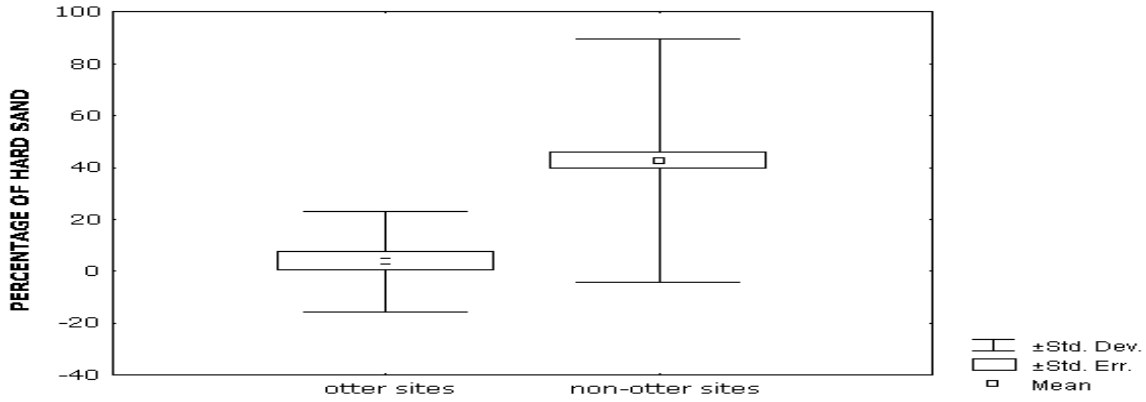


Figure 15: Hard sand composition of otter and non-otter sites

The mean percentage of loose sand (Figure 16) of otter sites and non-otter sites was found to be significantly different ($U = 1374.5$, $Z = -4.658$, $p << 0.05$).

Figure 16: Loose sand composition of otter and non-otter sites

The mean percentage of rock (Figure 17) in otter sites and non-otter sites was found to be not significantly different ($U = 2280.5$, $Z = 1.91$, $p > 0.05$)

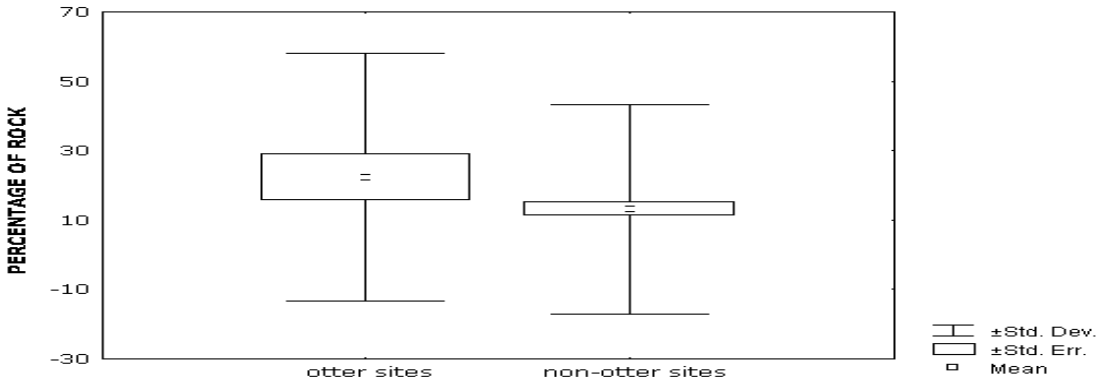


Figure 17: Percentage of rock in otter sites and non-otter sites

The mean percentage of stone (Figure 18) in otter and non-otter sites was found to be significantly different (U = 2254.5, Z = - 2.335, $p < 0.05$).

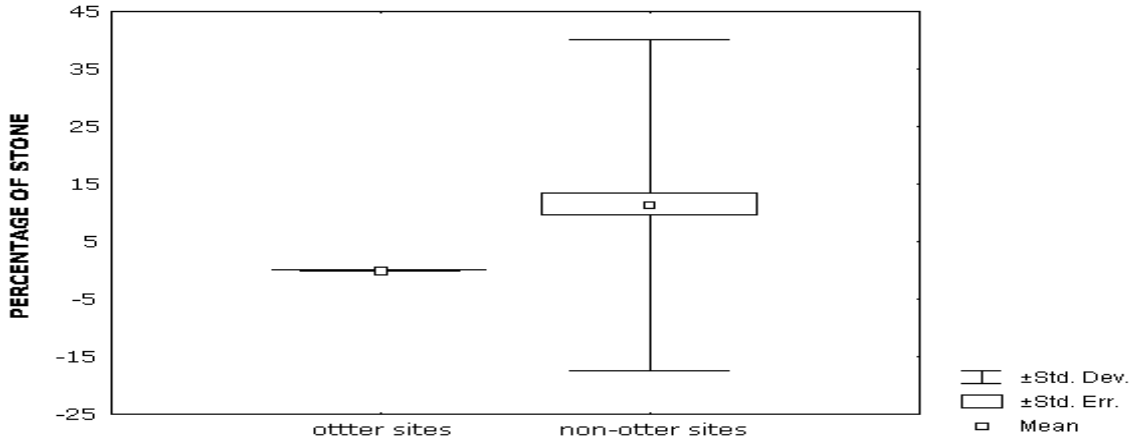


Figure 18: Percentage of stone in otter sites and non-otter sites

The mean percentage of gravel (Figure 19) in otter and non-otter sites was found to be not significantly different (U = 2632.5, Z = -0.908, $p > 0.05$).

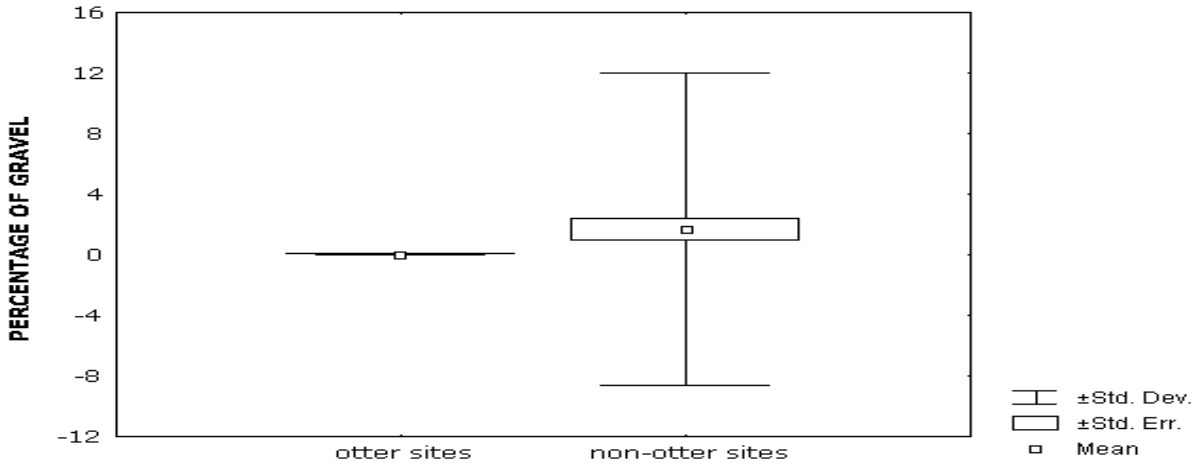


Figure 19: Gravel composition of otter and non-otter sites

It appeared that similar stretches had similar number of otter sites. Stretches with moderate to high percentage of loose sand, low percentage of hard sand, and moderate to high percentage of rock had moderate to high number of otter sites. The PCA showed such habitats to be preferred by otters. In comparison, relatively low numbers of otter sites were found in stretches with low percentage of loose sand, and moderate to high percentage of high sand (the PCA showed such habitats to be not preferred by otters).

Visitation rates to these stretches by otters varied, though in general low visitation rates were observed in poor habitats, and moderate to high visitation rates in preferred habitats.

Holts

It was observed that all the holts found within the study area were dug in loose sand on the river banks. All had thick vegetation (Figures 20a, b and c) around them, mainly the grass *Arundo donax* (see Appendix 3 check-list of. vegetation found in the study area) One was dug under the roots of the tree *Diospyros montana*. Number of entrances for holts varied from two to four. Size of entrances varied from 28cm to 130cm in width (mean = 53cm, std. dev. = 28.28 cm, n=11) and 20 cm to 51cm in height (mean = 35.73 cm, std. dev. = 7.69 cm, n=11). One of the holts was within a stand of impenetrable *Arundo donax*, and no holt entrances were visible.

Figures 20a, b and c: Examples of holts surrounded by thick vegetations

It was however assumed to be a holt as otter pugmarks always led within the stand of grass, and on one instance otters were actually seen going into the stand of grass. It was assumed that the place was being used as a holt, as the frequency of usage was quite high. All holts found were located on islands. Two holts were found about 2 km downstream from the study site. Both were located in rock crevices and marked at the entrance with old spraints.

Disturbance levels

Varied levels of disturbance along the river were observed (Figures 21a, and b) It was found that there was a high negative correlation between the disturbance level and visitation rate (Figure 22) by otters (r = - 0.711), but no correlation between number of


Figures 21a and b: Levels of tourist and picnickers flow along the river

otter sites and disturbance levels (r = - 0.305) .

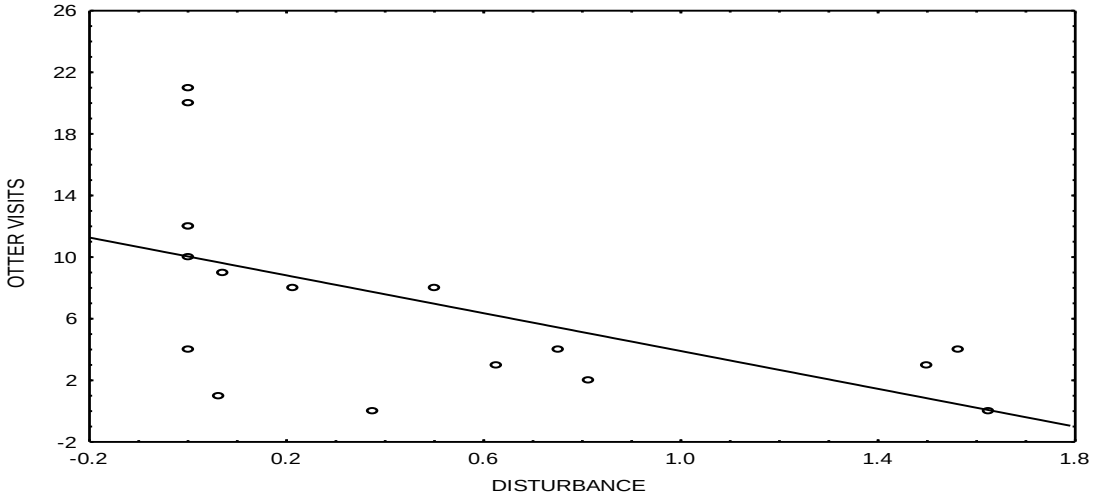


Figure 22: Otter visits versus disturbance

In order to rule out the high visitation rate due to high number of otter sites (Figure 23), disturbance was correlated with otter frequency (Figure 24). It was found that correlation, though negative, was not significant, r = - 0.56.

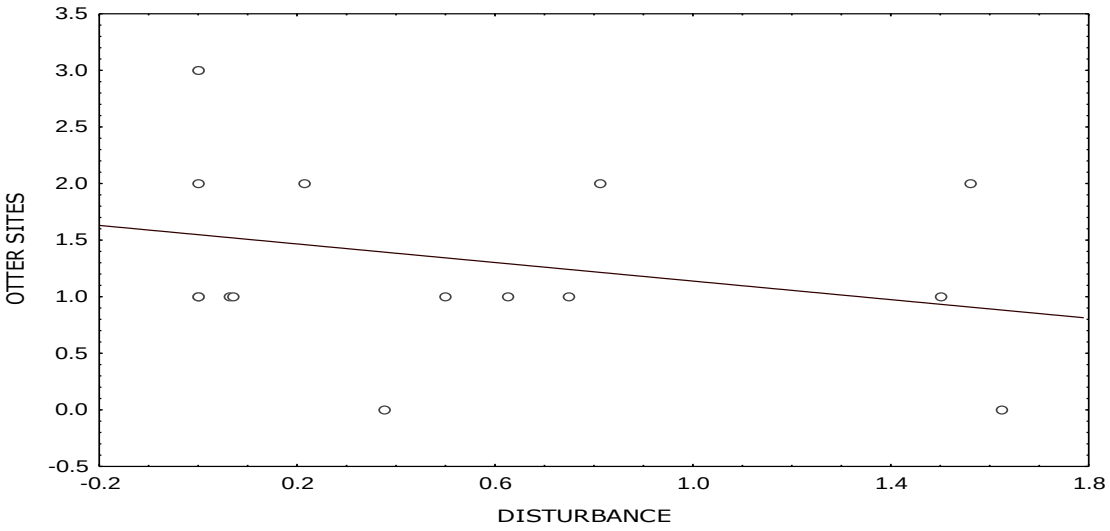


Figure 23: Otter sites versus disturbance

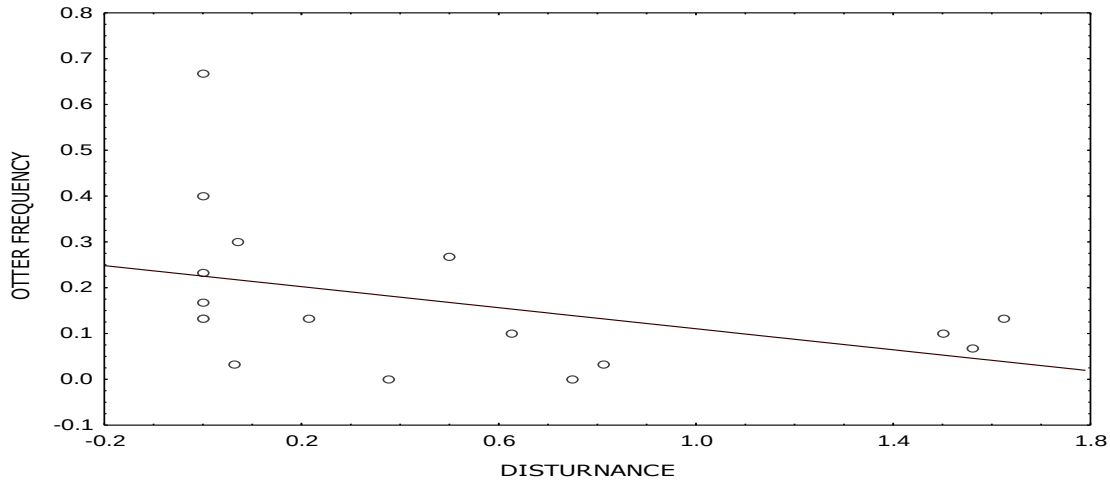


Figure 24: Otter frequency versus disturbance

The Results presented the through GIS show (Figure 25) that otter sites were placed in areas of fewer disturbances, and frequency of usage of otter sites was low in areas of high disturbance.

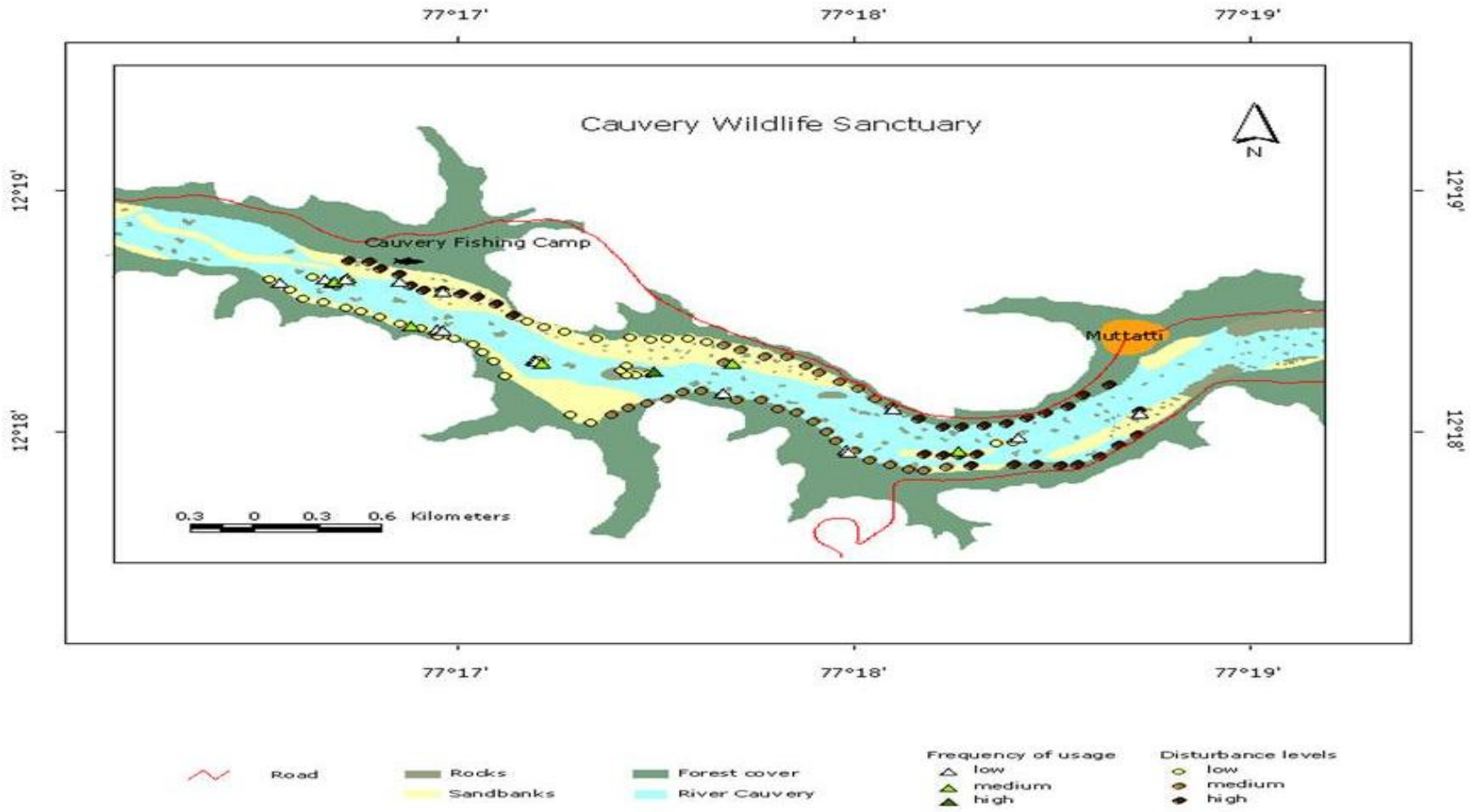
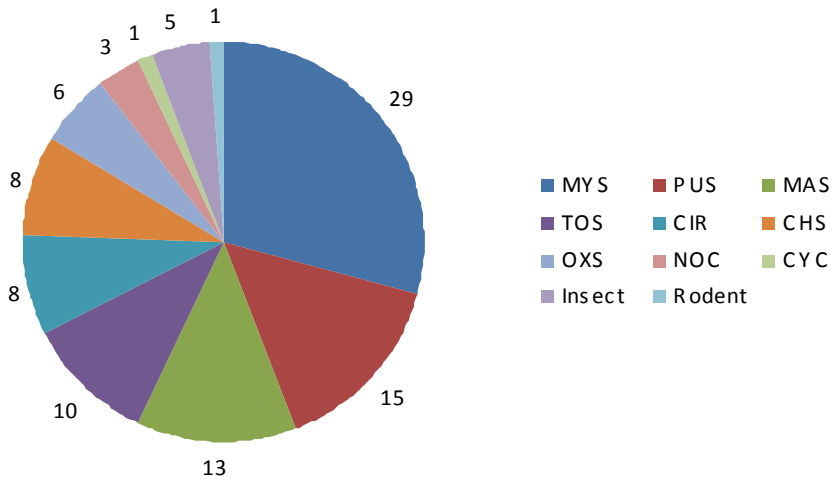


Figure 25: Disturbance affecting frequency of usage of otter sites

Diet composition

The species that was taken the most was *Mystus spp* (Figure 26). *Puntius spp., Mastacembalus spp. and Tor spp.* seemed to be the next most consumed species of fish. The check-list of major fish species found in the study area is given in the Appendix IV.



MYS: Mystus spp, PUS: Puntius spp, MAS: Masatcembalus spp; TOS: Tor spp, CIR: Cirrhinus reba, CHS: Channa spp; OXS: Oxygaster spp, NOC: Notopterus spp, CYC: Cyprinus carpio

Figure.26: Diet composition of smooth-coated otter in the Cauvery Wildlife Sanctuary

The families Bagaridae and Cyprinidae (Figure 27) were found to occur most in the spraints.

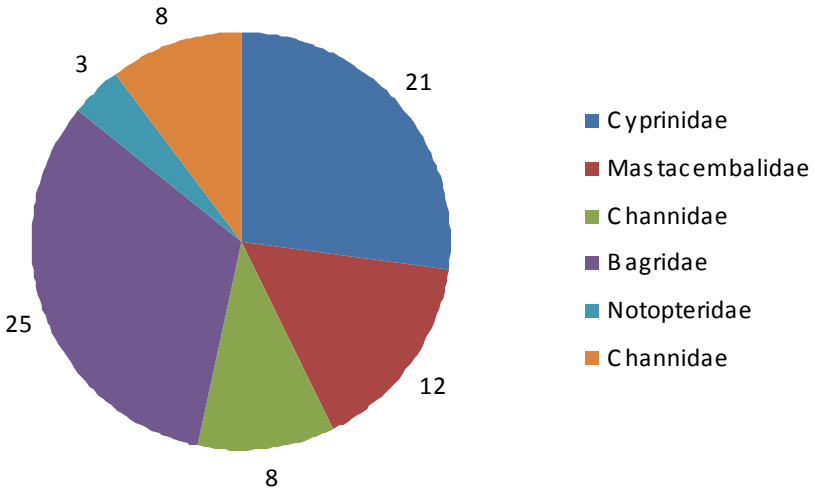


Figure 27: Fish families preyed upon by smooth-coated otters in the Cauvery Wildlife Sanctuary

Prey species within the size classes 10.00-14.99 cm (Figure 28) and 15.00-19.99 cm were taken the most in comparison with other size classes. It seems that the otters prey on small to medium sized fishes.

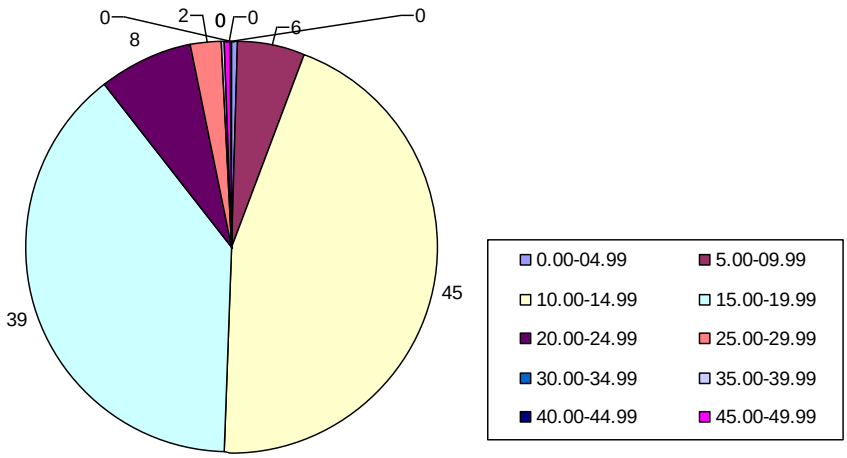


Figure 28: Size classes of prey taken

Discussion

Habitat analysis

It was found that, in general, the otter sites differed significantly from non-otter sites. This was also the case in Periyar Tiger Reserve (Anoop, 2001). In this study, since most otter sites were used as grooming sites, they had a high percentage of loose sand. The importance of grooming has been mentioned in chapter 2. Anoop (2001) also found grooming sites in Periyar to have high sand content. On the River Chambal, however, Hussain (1993) found that the otters preferred rocky areas. In the study site otter sites were not significantly different from non-otter sites with respect to percentage of rock covering the area. There was also a significant difference with respect to stone, and no significant difference with respect to gravel. The study site itself had a very low percentage of gravel. Otters did choose sites with no stone and gravel, hence otter sites and non-otter sites clustered together showing no significant difference as far as these two parameters were concerned.

In the study site holts were found to be mainly dug in sand. Holts in rock crevices were only found outside the study area. This could be because the study area generally had a higher percentage of sand than rock. All holts were located in areas having dense vegetation. The importance of bank side vegetation has been stated in many studies (Chapter 2, this report). In this study bank side vegetation seemed to be important only in case of holt placements, and not for grooming or "toilet" sites. Vegetation cover could probably hinder the act of grooming. Thus, it would be necessary for the otter to select a site with sparse to no vegetation, and high percentage of loose sand for grooming. It was also observed on the field that otter sites were located in areas of low canopy cover. This could again be related to grooming and basking behavior.

It was seen that most grooming sites also had a small percentage of rock, and the spraints were usually deposited on the rock. Spraining location almost never changed. Such site fidelity was observed by Anoop (2001) in his study in the Periyar Tiger reserve, and Kruuk et al. (1995) in Shetland. This has also been observed in captive otters (Claus

Reuther pers. com.). Spraints were usually deposited on a level slightly higher than the grooming sites. Marking on conspicuous objects or places has been observed before (Gorman et al., 1978). Such behaviour is typical of many carnivores.

The null hypothesis that there is no difference between sites preferred by otters and those that are not is rejected as otter sites differed significantly from non-otter sites with respect to major factors involved in site selection by otters.

It was also seen that similar sites had similar number of otter sites, and similar visitation rates by otters, with moderate to high number of sites and visits in preferred habitats and low number of sites and visits in "poor" habitats.

Though, sites were largely located in areas of less anthropogenic disturbance, the number of sites in a stretch did not seem to be affected by the level of disturbance in the stretch. Rather it was the visitation rate that was affected negatively. We could conclude that otters choose their sites based more on habitat parameters rather than the level of anthropogenic disturbance; their daily visits to these sites could however be influenced by the level of disturbance in the vicinity.

In areas of high disturbance, otters are mostly nocturnal (Foster-Turley, 1992). Otters in the study site were seen up to 1045 hours, and not earlier than 1445 hours. They were not sighted in the late mornings and early afternoons. Interviews with local people revealed the same. It has been observed that the smooth-coated otter is less sensitive to the presence of man than other otter species (Shariff, 1984, 1985; Foster-Turley, 1992; Anoop, 2001). It is possible that, though the otters in the Cauvery Wildlife Sanctuary generally avoided regions of high disturbance, they were nevertheless habituated enough to be diurnally active.

Diet

The diet of the smooth-coated otters in the Cauvery Wildlife Sanctuary consisted mainly of fish. Though insects were found in a few spraint samples, no crustacean or bird remains were found. Rodent remains were found in only one sample. It is assumed that the insects were the prey of the fish taken by the otters, and were not directly their prey. Hussain (1993) and Anoop (2001) also found that the diet of the smooth-coated otters was mainly fish. Smooth-coated otters are known to be piscivorous (see Chapter 2 of this report). The species most preyed upon were *Mystus spp., Puntius spp., Mastacembalus spp.* and *Tor spp.*

The families Bagridae and Cyprinidae occurred the most in the spraints. The size classes most preyed upon were 10 – 14.99 cm and 15 – 19.99 cm; the prey sizes varied from 4.6 cm to 49.9 cm. This appears to be somewhat larger than reports from Periyar, where the size class most represented in spraints was 5 – 15 cm (Anoop, 2001). Similar data was reported from the National Chambal Sanctuary with prey sizes ranging from 4 - 46 cm in length (Hussain, 1993). In this study, it was found that total number of fish species in each sample varied from 1 to 5 (mean = 2.74, n=30). This is not too different from the study conducted by Anoop (2001) in Periyar, wherein spraints contained 1 to 7 prey

species, average being 3 –4. However, in the National Chambal Sanctuary, Hussain (1993) found that not less than 11 prey species were used in a given month.

It may be said that otters in the Cauvery Wildlife Sanctuary preyed on small to medium fishes. In most studies it was found that, prey species consumption increased with their relative abundance (Hussain and Choudhury, 1998). Hussain (1993) did find some degree of prey preference did occur in the River Chambal. This could not be tested in the current study as measuring availability of prey species was beyond the scope of this study. At present, it cannot be stated whether otters in the study site were selective in prey consumption or not. Further studies on smooth-coated otters in the Cauvery ecosystem would establish this.

Interspecific competition

The other piscivorous animals in the study site included muggers and a large number of piscivorous birds, like Cormorants, Darters, Egrets, Grey Headed Fishing Eagle, Brahminy Kite, Pariah Kite, Kingfishers, etc. There is a possible dietary overlap among the various piscivorous species, including otters. This cannot be verified as an estimation of the prey of these species was beyond the scope of this study.

Conservation implications

Commercial fishing is been banned within the sanctuary. Incidents of illegal fishing within the sanctuary itself are infrequent. Thus, at present, prey species of otters are in no danger of extinction or depletion. However, until about two years ago, dynamite fishing was rampant in the area (Sunder Rajan, Susheel, pers. comm.), which, while killing a large number of fish at one go, also killed otters in the vicinity. It is now under control in the sanctuary and its vicinity, but it is not clear whether this activity carries on elsewhere on the river.

The otters in the Cauvery Wildlife Sanctuary seem to prefer visiting areas under less anthropogenic pressure. Though it is possible that they may be habituated to an extent, human disturbance has been known to affect otters adversely (Hussain, 1993; Foster-Turley, 1992). The study site, though a protected area as under the Wildlife (Protection) Act, 1972, is under high anthropogenic pressure, especially during weekends. The Hanuman temple at Muttatti attracts tourists from surrounding towns and cities.

One otter site, close to Muttatti, was also the point where people were ferried across the river. Being a sandy bank, tourists used the area as a picnic spot, and in the process trampled the otter site, thereby adversely impacting the functionality of spraints. Alcohol bottles are a common site along the banks of the river. This could cause harm to animals depending on the river.

Poaching of otters is higher in regions along the northern border of India (Appendix V). There are reports of poaching of otters in the Palni Hills, Tamil Nadu, India, by the Bagur tribals from Haryana, India (Meena, 2002). Otter skin is used for making drums, the meat is eaten, and the oil extracted from its fat is used for medicine (Meena, 2002). In the study area, poaching of otters has not been recorded for almost a decade. Interviews with

the locals revealed that otters were earlier poached for pelts and fat, which was used as a cure for a particular bovine disease. With the increase in development, and better veterinary facilities being made available to the local people, they now depend on allopathic cures.

Status of otters

The key informant survey conducted indicated that the otter population in the region was stable. However, this is yet to be scientifically proven, and can form the basis for further research.

Constraints during the study

A study on availability of prey species of the otters in the Cauvery Wildlife Sanctuary was not attempted due to lack of time and equipment. It is possible that in some places secondary signs may not have been left behind by the otters, as the substrate may have been unsuitable to reveal a pug mark. Due to the water level decreasing drastically, not all parts of the river were navigable and so all islands could not be sampled. Logistical difficulties prevented extending of sampling.

References

Anoop, K. R., 2001. Factors affecting habitat selection and feeding habits of smooth coated otter (*Lutra perspicillata*) in Periyar Tiger reserve, Kerala. MSc thesis. Wildlife Institute of India, Dehra Dun.

Banks, E., 1931. A popular account of the mammals of Borneo. J. Malay. Brch R. Asiat. Soc. 9(2):60-61.*

Barabash Nikiforov, I. I., 1947. Kalan (the sea otter). Soviet ministry RSFSR. Trans. From Russian by Israel Programme for Scientific translation. Jerusalem, Israel, 1962.*

Blanford, W. T., 1888. The fauna of British India including Ceylon and Burma. Mammalia. I. Taylor and Francis, Lond., 617pp.*

Burt, W. H., 1943. Territoriality and home range concepts as applied to mammals. J. of Mammal. 24:346-352.*

Burton, M., 1968. Wild animals of the British Isles: the otter. Warne, F. and Co. Ltd. London, England. Pp. 131-136.

Cantor, T., 1846. Catalogue of mammalia inhabiting the Malayan Peninsula and islands. J. Asia. Soc. Beng., 15:171-203, 241-279.*

Carson, D. N. and Elston, D. A., 1996. Errors associated with the otter (*Lutra lutra*) faecal analysis. II. Estimating prey size distribution from bones recovered in spraints. J. Zool. Lond. 238:319-332.

Channin, P., 1985. The natural history of otters. Christopher Helm, Lond., 179pp.

Chehebar, C. E., 1985. A survey of the southern river otter *Lutra provocax* Thomas in Nahuel Huapi National Park, Argentina. Biol. Consv., 32:299-307.*

Corbet, G. B. and J. E. Hill, 1986. A world list of mammalian species. London, British museum (natural history). *

Costa, D. P. and Kooyman, G. L., 1982. Oxygen consumption, thermoregulation, and oil the effect of fur oiling and washing on the sea otter, *Enhydra lutris*. Can. J. Zool. 60:2761-2767.

Crawford, A. K., Jones, A. and McNulty, j., 1979. Otter survey of Wales. SPNC, Lincoln.

Desai, J. H., 1974. Observation on the breeding habits of the Indian smooth otter *Lutra perspicillata* in captivity. Int. Zoo Yb. 14:123-124.*

Duplaix, N., 1980. Observations on the ecology and behaviour of the Giant river otter *pteronura brasiliensis* in Suriname. Rev. Ecol. (terre vie)., 34:495-620.*

Duplaix-Hall, N., 1972. Notes on maintaining river otters in captivity. Int. Zoo. Yb., 12:178-181.*

Durbin, L. S., 1996. Some changes in the habitat use of a free ranging female otter *Lutra lutra* during breeding. J. Zool. Lond. 240: 761-810.

Durbin, L. S., 1998. Habitat selection by five otters *Lutra lutra* in rivers of Northern Scotland. J. Zool. Lond. 245:85-92.*

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

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

Erlinge, S., 1972. Interspecific relations between the otter *Lutra lutra* and mink *Mustela vison* in Sweden. Oikos. 23:327-335. *

Estes, J. A. and Jameson, R. J., 1988. A double survey estimate for sighting probability of sea otters in California. J. Wildl. Mgmt. 52:70-76.*

Estes, J. A., 1989. Adaptations for aquatic living by carnivores. In : Carnivore Behaviour, Ecology and Evolution. Gittleman, J. L. (ed.). Chapman and hall, London. pp 242–282.

Ewer, 1973. The carnivores. Cornell Univ. Press, N.Y., 494pp.

Foster-Turley, P. 1989. The role of protected areas in otter conservation. In: Intl. Conf. Natl. Pks. Protected areas, 13 –15 November, 1989. Dept. Wildl. Natl. Pks., 1989. 23p.*

Foster-Turley, P., 1992. Conservation aspects of the ecology of asian small clawed and smooth otter of the Malay Peninsula. IUCN otter specialist group bulletin, 7: 26-29.*

Foster-Turley, P. and C. Santiapillai, 1990. Action plan for Asian otters. In: Foster-Turley, P., S. Macdonald and C. Mason (ed.), 1990. Otters: An Action Plan for their Conservation. IUCN/SSC Otter Specialist Group. Pp. 52-63. *

Furuya, Y., 1976. Otters in Padas Bay, Sabah, Malaysia. J. Mamm. Soc. Japan. 7:34-43.*

Gentry, R. L. and Peterson, R. S., 1967. Underwater vision of the sea otter. Nature. 216:435-436.*

Gittleman, J. L., 1986. Carnivore life history patterns: allometric, ecological and phylogenetic associations. Amer. Nat. 127:744-771.*

Gorman, M. l., Jenkins, D. and Harper, R. J., 1978. The anal scent sacs of the otter *Lutra lutar*. J. zool. Lond. 186(4):463-474.

Gould, s. j. and Vrba, E., 1982. Exaptation – a missing term in the science of form. Paleobiology. 8:4-15.*

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

Hamilton, W. J. and Eadie, W. R., 1964. Reproduction in the otter, *Lutra canadensis*. J. Mamm. 45:242-252.*

Haque, M. N. and Vijayan, V. S., 1995. Food habits of the smooth Indian otter *Lutra perspicillata* in Keoladeo National Park, Bharatpur, Rajasthan. Mammalia. 59(3):345-348.

Harris, C. J., 1968. Otters: A study of the recent lutrinae. Weidenfeld and Nicholson Lond., 397pp.*

Hillegaart, V., Sandegren, F. and J. Osmann, 1981. Area utilisation and marking behaviour among two captive otter pairs (*Lutra lutra* L). otters, 1:64-74.*

Hiscock, R., 1990. Report on the sighting of a large otter in singapore. The Pangolin, 3:22.*

Hornocker, M. G., Messick, J. P. and Melquist, W. E., 1983. Spatial strategies in three species of Mustelidae. Acta Zoologica Fennica. 174:185-188.*

Hussain, S. A. and Choudhury, B. C., 1995. Seasonal movement, homerange and habitat use by smooth coated otters in National Chambal Sanctuary, India. In: International otter

Colloquium, Pietermaritzberg 1993 (Reuther, C. and Rowe-Rowe, D., eds.); Aktion Fischotterschutz Hankensbuttel, Habitat. 11:45-55.

Hussain, S. A. and Choudhury, B. C., 1996. Identification Manual for Indian Wildlife, Species and Derivatives in Trade. Eds. Malik and Menon, WWF – India (Prepared by TRAFFIC – India), New Delhi. Copyright WWF- India / Ministry of Environment and Forests, Government of India. Wildlife Fund for Nature – India. Sec. M-O-141.1 – 141.3.

Hussain, S. A. and Choudhury, B. C., 1997. Status and distribution of smooth coated otters *Lutra perspicillata* in national Chambal Sanctuary. Biol. Cons. 80:199-206.

Hussain, S. A. and Choudhury, b. C., 1998. Feeding ecology of smooth coated otter *Lutra perspicillata* in the National Chambal Sanctuary, India. In: Behaviour and Ecology of riparian mammals. Nigel Dunstone and Martyn Gorman (ed.). Cambridge Univ. Press. Pp.391.

Hussain, S. A., 1993. Aspects of the ecology of smooth coated Indian otter *Lutra perspicillata*, in National Chambal Sanctuary. PhD thesis. Aligarh Muslim University, Aligarh.

Jacobsen, L. and Hasen, H. M., 1996. Analysis of otter (*Lutra lutra*) spraints: part1: comparison of methods to estimate prey proportions. Part 2: estimation of the size of prey fish. J. Zool. Lond. 238:167-180.

Jameson, R. J., 1983. Evidence of birth of a sea otter on land in central California. California fish game. 69:p122-123.*

Jayaram, K. C., 2000. (ed.).Kaveri Riverine System: An Environmental Study. Madras Science Foundation, Chennai. Pp. 1-6, 131-144.

Jenkins, D. and Harper,R. J., 1980.ecology of otters in Northern Scotland II. Analysis of otter (*Lutra lutra*) and mink (*Mustela vison*) faeces from Deeside, N. E. Scotland. J. Zool. (Lond.). 187: 235-244. *

Kano, T.,1972. Distribution and adaptation of the chimpanzee on the Eastern shore of Lake Tanganyika. Kyoto Univ. Afr. Study., 7:37-129.*

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

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

Kruuk, H. and Balharry, D., 1990. Effects of sea water on thermal insulation of the otter, *Lutra lutra*. J. Zool. Lond. 220:405-415.

Kruuk, H. and Conroy, j. W. H., 1987. Surveying otter *Lutra lutra* populations: a discussion of problems with spraints. Biol. Conserv. 41(3): 179-183.*

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

Kruuk, H., 1992. Scent marking by otters (*Lutra lutra*): Signalling the use of resources. Behavioural Ecology, 3 (2):133-140.

Kruuk, H., 1995. Wild otters. Predation and population. Oxford Univ. Press, Oxford. xi + 290pp.*

Kruuk, H., B. Kanchanasaka, S. O'Sullivan and S. Wanghongsa, 1993. Identification of tracks and other signs of three species of otter, *Lutra lutra, L. perspicillata* and *Aonyx cinerea.* Nat. hist. Bull. Siam. Soc., 41:23-30.*

Kruuk, H., Kanchanasaka, B., O'Sullivan, S. and Wanghongsa, S., 1994. Niche separation in three sympatric otters *Lutra perspicillata, Lutra lutra* and *Aonyx cinerea* in Huai kha Khaeng, Thailand. Biol. Consv. 69(1):115-120.

Kruuk, H., 1992. Scent marking by otters (*Lutra lutra*): Signalling the use of resources. Behavioural Ecology, 3 (2):133-140.

Laidler, K. and Laidler, E., 1983. The river wolf. London: George Alan and Unwin.*

Lekagul, B. and J. A. Mcneely, 1988. Mammals of Thailand. Second edition. Darnsutha press, Thailand, 758pp.*

Lenton, E. J., Chanin, P. R. F. and Jefferies, D. J., 1981. Otter survey of England 1977-79. Nature Conservancy Council, London.*

Leslie, G., 1971. Further observation on the oriental short clawed otter, *Amblonyx cinerea*, at Aberdeen Zoo. Int. Zoo. Yb., 11:112-113.*

Macdonald, D. W., 1983. The ecology of carnivore social behaviour. Nature. 301:379-380.*

Macdonald, S. M. and Mason, C. F., 1980. Observations on the marking behaviour of a coastal population of otters. Acta Theriologica, 25 (19): 245-253.

Macdonald, S. M. and Mason, C. F., 1985. Otters, their habitat and conservation in north-east Greece. Biol. Cons. 31: 177-191. *

Macdonald, S. M. and Mason, C. F., 1987. Seasonal marking in an otter population. Acta Theriologica. 32, 27: 449-462.

Makwana, S. C., 1978. Field ecology and behaviour of the rhesus macaque (*Macaca mulatta*): group composition, home range, roosting site, and foraging routes in the Asarori forest. Primates. 19:483-492*.

Maruhashi, T., 1982. An ecological study of troop fissions of Japanese monkey (M*acaca fuscata yakui*) in Yakushima island, Japan. Primates. 23:317-337.*

Mason, C. F. and Macdonald, S. M., 1983. Some factors influencing the distribution of otters (*Lutra lutra*). Mammal review.13(1):1-10.

Mason, C. F. and S. M. Macdonald, 1986. otters: ecology and conservation. Cambridge Universty Press, Cambridge. pp 236.*

Medway, L., 1983. The wild mammals of Malaya (Peninsular Malaysia) and Singapore. Second edition reprinted with corrections. Oxford Univ. press, Kuala Lampur, 131pp.*

Meena, V., 2002. Otter poaching in Palni Hills. Zoos Print Journal. 17(2):696-698.

Melisch, R. and Kusumawardhini, L. Asmoro, P. B. and Lubis, I. R., 1996. The otters of West Java – a survey of their distribution and habitat use and a strategy towards a species conservation programme. PHPA/Wetlands Intl. – Indonesia programme, Bogor.*

Melquist, W. E. and M. G. Hornocker, 1983. Ecology of river otters in West central Idaho. Wldlife Monographs, 83:60p.*

Nagulu, V., 1992. News from India. IUCN otter specialist group bulletin, 7:41-42.*

Neville, M. K., 1968. Ecology and activity of Himalayan foothill Rhesus monkeys (*Macaca mulatta*). Ecology. 40:110-123.*

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

Nor, B. H. M., 1990. A survey of the distribution of otters in Pulau Pinang and Perlis. J. Wildl. Natl. Parks., 9: 53-58.*

Nor, B. H. M., 1990. Observation on the parental investment by small clawed otter in captivity. J. Wildl. Natl. Parks., 9:47-52.*

Nowak, R. M., 1991. (ed.) Walkers mammals of the world. Fifth editon. The John Hopkins University Press, Baltimore and London, 2:1135-1143.*

Pardini, R., 1998. Feeding ecology of the neotropical river otter (*Lontra longicaudis*) in an atlantic forest stream, south-eastern Brazil. J. Zool. Lond. (Lond.)245:385-391.*

Perrin, M. R. and Carrugati, C., 2000. Food habits of co-existing cape clawless otter and spotted necked otter in the Kwa Zulu – Natal Drakensberg, South Africa. S. Afr. J. Wildl. Res. 30(2): 85-92.*

Perrin, M. R., and Carranza, D'Inzillo Ilaria, 2000. Habitat used by spotted necked otters in Kwa Zulu – Natal Drakensberg, South Africa. S. Afr. J. Wildl. Res. 30(1).*

Pocock, R. I., 1921. On the external characters of some species of Lutrinae (otters). Proc. of Zool. Soc. London. pt. 3, pp 535-546.*

Pocock, R. I., 1939. Notes on some British Indian otters with description of two new species. J. of Bombay Nat. Hist. Soc. Vol. 41:514-518.

Pocock, R. I., 1941. The fauna of British India, including Ceylon and Burma. Mammalia.2. Taylor and Francis, Lond., 503pp.*

Pocock, R. I., 1949. The fauna of British India, including Ceylon and Burma. Volume 2, mammals. Taylor and Francis, London 2:265-317.*

Prater, S. H., 1998. The book of Indian animals. Eleventh impression. Bombay Natural History Society. Oxford University Press, Calcutta, Chennai, Delhi, Mumbai. Pp. 146 – 154.

Procter, J., 1963. A contribution to the natural history of the spotted necked otter *(Lutra maculicaullis*) in Tanganyika. E. Afr. Wildl. J. 1:93-113.*

Rabb, G. R., 1990. Foreword. In: Foster-Turley, P., S. Macdonald and C. Mason (ed), 1990. Otters: An Action Plan for their Conservation. IUCN/SSC Otter Specialist Group. Pp. iii. *

Rajamani, R., 1994. Foreword. In: Kaveri Riverine System: An Environmental Study. Ed. K. C. Jayaram. The Madras Science Foundation, Chennai. Pp v.

Reuther, A., 1991. Otters in captivity – review with special reference to *Lutra lutra* in C. Reuther, and R. Rochert (eds.), Proc. V. Intl Otter Colloq., Hankensbuttel, 1989. Habitat, 6:269-307.*

Reuther, C., 1999. From the Chairman's desk. IUCN Otter Spec. Group Bull. 16(1): 3-6.

Reynolds, J. C. and N. J. Aebischer , 1991. Comparison and quantification of carnivore diet by faecal analysis: a critique with recommendations based on a study of the fox *Vulpes vulpes*. Mammal Rev. 21(3): 97-112.*

Riedman, M. and Estes, J. A., 1988. Biology of the sea otter: a review. Unpublished ms. Available from J. A. Estes. Institute of marine sciences, UCSC.

Rowe-Rowe, D. T., 1978. Biology of two otter species in South Africa. In: N. Duplaix, ed. Otters: proceedings of the first meeting of the otter specialist group, pp. 130-139. Morges, Switzerland: IUCN.*

Rowe-Rowe,D., 1977. Food ecology of otters in Natl. South Africa. Oikos, 28:210-219.*

Rowe-Rowe, D., 1992.Survey of South African otters in freshwater habitat, using sign. S. Afr. J. Wildl. Res., 22(2): 49-55.*

Sandegren, F. E., Chu, E. W. and Vandever, J. E., 1973. Maternal behaviuor in the California sea otter. J. Mamm. 54:668-679.*

Sanderson, G. C., 1966. The study of mammal movements – a review. J. of Wildl management. 13(1): 215-235.*

Shariff, S. M., 1984. Some observations on otters at Kuala Gula, Perak and National Park, Pahang. J. Wildl. Pks., 3:75-88.*

Shariff, S. M., 1985. The occurrence of otters in the rice field s and coastal islands; and the comparison of these habitats. J. Wildl. Pks., 4:20-24.*

Sivasothi, N., 1995. The Status of Otters (Carnivora: Mustelidae: Lutrinae) in Singapore and Malaysia, and the Diet of Smooth coated Otter (*Lutrogale perspicillata*) in Penang, West Malaysia. MSc thesis. National University of Singapore, Singapore.

Stephenson, A. B., 1977. Age determinationand morphological variation of Ontario otters. Canadian J. Zool. 55:1577-1583.*

Tabor, J. E. and Wight, H. M., 1977. Population status of river otter in Western Oregon. J. Wildl. Mgmt. 41:692-699.*

Talwar, P. K. and Jhingran, A. G., 1991. Inland Fishes of India and adjacent countries. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Calcutta, Bombay.

Tarasoff, F. J., 1974. Anatomical adaptations in the river otter, asea otter and harp seal with reference to thermal regulation. In: functional anatomy of marine mammals.

Harrison, R. J. (ed.). London and New York: Academic press. 2:111-142.Scholander, P. f., Walters, V., Hock. R. and Irving, L., 1950. Body insulation I some arctic and tropcal mammals and birds. Biol. Bull. Mar. Biol. Lab. Woodshole. 99:225-236.*

Teplov, V. P., 1952. Taking a census of otter, sable, marten and small mustelids. In: Methods of determining the numbers and geographical distribution of terrestrial vertebrates. Institute of Geography, Academy of Sciences of the USSR, pp. 165-72. Publishing House of the Academy of Sciences of the USSR, Moscow, 342 pp.

Thomas, O., 1889. Preliminary notes on the characters and synonymy of the different species of otter. Proc. Zool. Soc. Lond. 1889:190-200.*

Tiler, C., Evans, M., Heardman, C. and Houghton, S., 1989. diet of the smooth Indian otter (*Lutra perspicillata*) and of fish eating birds; a field survey. J. Bombay Nat. Hist. Soc. 86(1):65-70. *

Timmis, W. H., 1971. Observations on breeding the oriental short-clawed otter, *Amblonyx cinerea*. *Int. Zoo Yb*., 11:109-11.*

van der Zee, D., 1981. Prey of the cape clawless otter *Aonyx capensis* in the Tsitsikama coastal national park, S. Africa. J. Zool. Lond. 194:467-468.

Wayre, P., 1974. Otters in west Malaysia with observations on their status , distribution and habits. IUCN and World Wildl. Fund, Malaysia. Booklet 15:15-38. LOC/X.*

Wayre, P., 1978. the status of otter in Malaysia, Sri Lanka and italy. *In: OTTERS (N. Duplaix Ed.), Proc. 1st Working Meeting Otter Spec. Group 1977, IUCN Publ. New Ser*. 152-155. *

Wayre, P., 1980. Report of council 1980 – Breeding otters: J. Otter Trust 1980: 6-8.*

Wise, M. H., 1980. The use of fish vertebrae in scats for estimating prey size of otters and mink. J. Zool. Lond (Lond.). 192(1):25-31.

Wise, M. H., Linn, I. J. and Kennedy, C. R., 1981. a comparison of the feeding biology of mink *Mustela vison* and otter, *Lutra lutra*. J. Zool. (Lond.). 195(2): 181-213. *

Woodward, R., 1981. On-the-rocks-birth of a sea otter pup. The otter raft no. 25 Carmel, Calif.: Friends of the sea otter.*

Yoshiba, K., 1968. Local and intertroop variability in ecological behaviour of common Indian langur. In Primates: studies in adaptation and variability. P. C. Jay (ed.), Holt, Rinehart and Winston, New York. Pp. 217-242.*

(* cross references)

Appendix I: Otter species and conservation status of the world

Scientific name	Common name	Distribution	Red list category
Amblonyx cinereus	Small-clawed otter	Asia	Lower risk
Aonyx capensis	Cape clawless otter	Africa	Lower risk
Aonyx congica	Congo clawless otter	Africa	Not evaluated
Enhydra lutris	Sea otter	N. America, Asia	Endangered
Lontra Canadensis	N. American river otter	N. America	Lower risk
Lontra feline	Marine otter	Latin America	Endangered
Lontra longicaudis	Neotropical otter	Latin America	Data deficient
Lontra provocax	Southern river otter	Latin America	Critically endangered
Lutra lutra	Eurasian otter	Africa, Asia, Europe	Vulnerable
Lutra maculicollis	Spotted-necked otter	Africa	Vulnerable
Lutra perspicillata	Smooth-coated otter	Asia	Vulnerable
Lutra sumatrana	Hairy-nosed otter	Asia	Data deficient
Pteronura brasiliensis	Giant otter	Latin America	Vulnerable

(Reuther, 1999).

Appendix II: Sightings of otter during the study period

Date	Time	Number	Place	Activity
07/01	10:45	1	Garmati	Swimming
12/01	8:10	1	Garmati island	Walking
21/01	14:35	1	Thirunaimodu	Swimming
24/01	9:05	4	Leopard pool	Swimming
25/01	7:48	2	Garmati island	Walking
30/01	7:53	1	Garmati to Thriunaimodu	Swimming
30/01	7:56	Group	Thirunaimodu	Swimming
03/02	7:45	1	Garmati island	Grooming
06/02	6:42	3	Bhimeswari	Eating fish
10/02	7:15	1	Garmati island	Grooming
10/02	8:40	7	Garmati island	Swimming, bipedalism
21/02	8:04	2	Inchi Munchi	Diving
23/02	7:31	3	Garmati island	Grooming
26/02	9:28	1	Garmati island	Grooming
12/03	15:41	3	Inchi Munchi	Diving, playing

Appendix III: Plant species found along the banks of the river and islands in the study site

Sl. No.	Plant species
1	*Diospyros montana*
2	*Rotula aquatica*
3	*Cyperus niveus*
4	*Arundo donax*
5	*Terminalia arjuna*
6	*Acacia chundra?*
7	*unidentified grass*
8	*Pancratum parvum*
9	*Homonoia riparia*
10	*Polygonia glabrum*
11	*Madhuca latifolia?*
12	*Pongamia pinnata*
13	*Cynodon dactylon*
14	*Vitex sp*
15	*Chomelia asiatica?*
16	*Mangifera indica*
17	*Erythroxylon monogynum*
18	*Atalantia sp*
19	*Tamarindus indicus*
20	*Mimosa pudica*
21	*Syzygium sp*

Appendix IV: Checklist of major fish species found in the study site

>250g:

Species	**Family**
Tor khudree	Cyprinidae
Tor musullah	Cyprinidae
Channa marulius	Channidae
Oreochromis mossambicus	Cichlidae
Puntius carnaticus	Cyprinidae
Notopterus notopterus	Notopteridae
Mystus cavasius	Bagridae
Cyprinus carpio	Cyprinidae
Cirrhinus reba	Cyprinidae
Catla catla	Cyprinidae
Silonia childreni	Schilbeidae

<250g:

Species	**Family**
Hela spp	Cyprinidae
Salmastoma spp	Cyprinidae
Puntius ticto	Cyprinidae
Puntius sophore	Cyprinidae
Parhiciosoma daniconius	-
Darico aequipinnatus	-
Ambassis ranga	Ambassidae

Note: This is not a comprehensive list. It lists only those species that are found most within the study area (Sunder Rajan, Susheel, Dr. Krishna Rao, pers. comm.; Jayaram, 2000; Talwar and Jhingran, 1991).

Appendix V: Illegal trade in otter pelts; seizure of otter skins by custom officials

Sl. no.	Year	Place	Numbers
1	1988	Delhi	637
2	1993	Delhi	128
3	1994	Srinagar (J&K)	27
4	1994	Delhi	26
5	1996	Rajasthan	402
6	1997	Rampur (U.P)	513
7	1997	Satna (M.P)	21
8	1997	Kolkatta (W.B)	3
9	1997	Delhi	5
10	1997	Naushera (J&K)	600
11	1999	Haridwar (U.P)	6
12	1999	Hoshangabad (M.P)	72
13	1999	Ghaziabad (U.P)	17
14	1999	Mardoi (U.P)	250
15	2000	Haldwani (U.A)	15
16	2000	Siliguri (W.B)	81
17	2000	Haldwani (U.A)	9

Not included in this data are seizures in Nepal, which are substantial. The largest demand is from Tibet (Ashok Kumar, pers. comm.).

This study was an attempt to reveal factors that establish the choice of home area of the smooth coated otter, *Lutra perspicillata*, along the river banks and islands, and its diet composition, in the Cauvery Wildlife Sanctuary, Karnataka, southern India. This study has categorised the preferred habitat and diet composition of otters, which are of importance to their conservation.

nityata

ANCF
ASIAN NATURE CONSERVATION FOUNDATION
www.asiannature.org