

ECOLOGY OF OTTERS IN THE UPPER KHWAE YAI RIVER, THUNG YAI NARESUAN WILDLIFE SANCTUARY, THAILAND.

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ABSTRACT

The distribution and ecological separation of three otter species were investigated in Thung Yai Naresuan Wildlife Sanctuary, western Thailand. The Common Otter (*Lutra lutra*), the Smooth-coated Otter (*Lutrogale perspicillata*) and the Small-clawed Otter (*Aonyx cinerea*), were identified by tracks and faeces (spraints) along 70 km of river and stream shoreline in the sanctuary. Sixty-six sections along the river and its tributaries were searched for otter signs, and distributions of species were compared. Spraints were collected, identified and assessed for frequencies of occurrence of prey species. Signs of Common Otter were observed near all waterways while Smooth-coated and Small-clawed Otter signs were observed primarily near the main river and smaller tributaries, respectively. Otter species differed in prey selection. Spraints of the Common Otter often contained similar percentages of fish and crab (37%, 31% respectively, N = 189), whereas the Smooth-coated Otters' spraints contained primarily fish (86%, N = 115) and the Small-clawed Otters' spraints contained mainly crabs (91%, N = 108).

Keywords: otter, diet, habitat, ecology.

INTRODUCTION

Thung Yai Naresuan Wildlife Sanctuary, a part of the largest forest complex in Thailand, is composed of undisturbed forest area which is rich in biodiversity. It was designated as a world heritage site in 1991. The most important wetland in Thung Yai Naresuan Wildlife Sanctuary is the Upper Khwae Yai River that supports the most extensive and least disturbed riverine forest in Thailand (JINTANUGOOL & ROUND, 1989).

Otters, as indicators of healthy wetlands, have dramatically declined in many parts of the world (FOSTER-TURLY ET AL., 1990). In Asia, although otters have never constituted a food source nor been hunted for their pelts, they are often construed to be pests by fishermen. Many otters are killed despite protection by law. However, this is not considered the major threat to otter populations. The rapid conversion of their habitat to other land uses together with pollution of wetlands are the major threats to their survival in this region (SIVASOTHI & NOR, 1994). Until now little was known about their distribution and status in Thailand.

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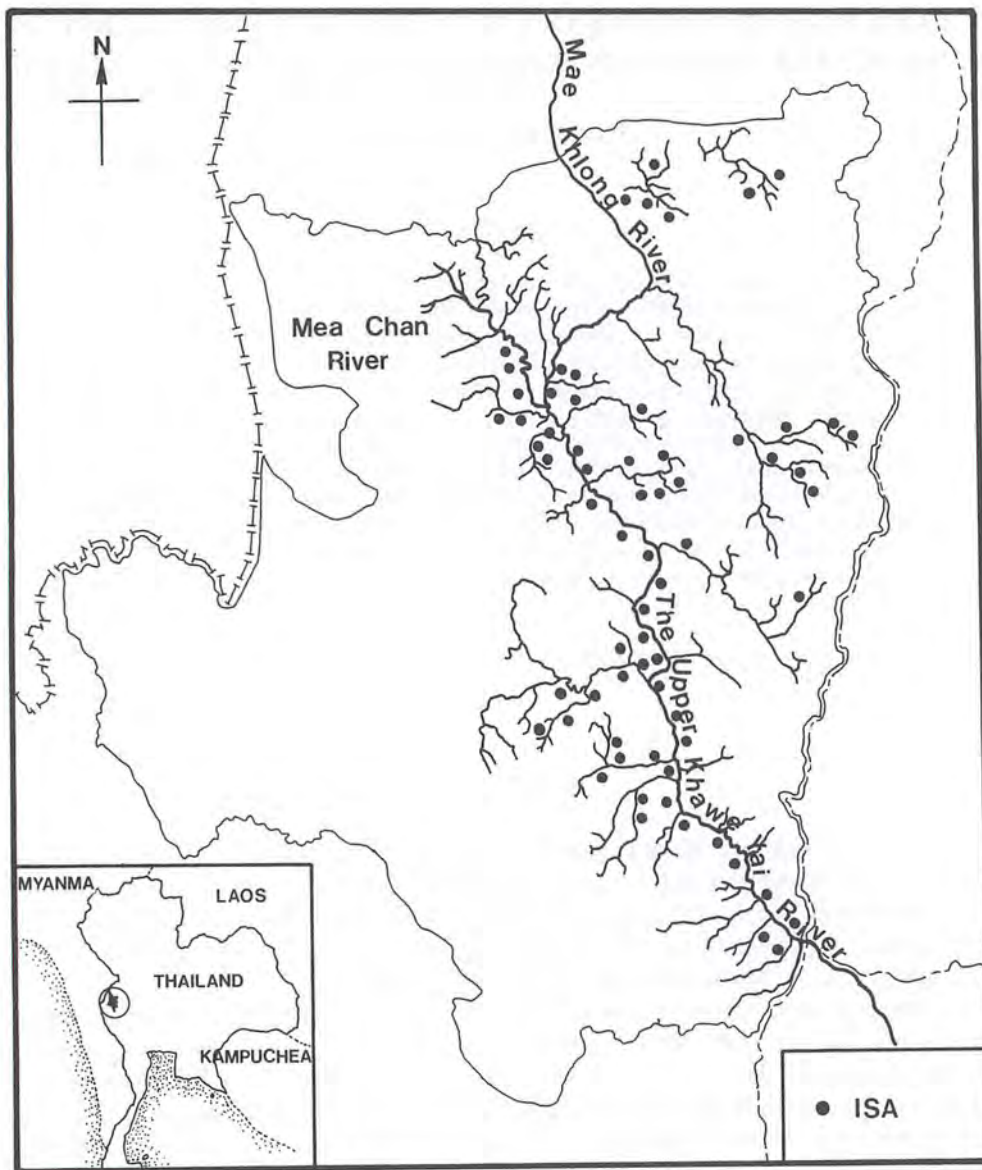


Figure 1. Sixty-six ISA distributed along the Upper Khwae Yai, Mae Klong, Mae Chan Rivers and their tributaries.

The Hairy-nosed Otter (*Lutra sumatrana*), one of the four species that occur in Thailand, has not been sighted for a long time. Similarly, Common Otter (*L. lutra*) was classified as an endangered species (TIST, 1991), but its situation was found to be less critical after more research had been conducted (KRUUK ET AL., 1994). Following the earlier study in Huai Kha Khaeng Wildlife Sanctuary, the present study was aimed at investigating which species of otters occurred in the highly diverse river system of Thung Yai Naresuan Wildlife Sanctuary. We investigated the distribution patterns and habitat and diet preferences of Common otter (*L. lutra*), Smooth-coated Otter (*Lutrogale perspicillata*), and Small-clawed Otter (*Aonyx cinerea*) in order to enhance and improve management measures for otter conservation.

STUDY AREA AND METHODS

Study Area

Thung Yai Naresuan Wildlife Sanctuary is a mountainous area of Permian limestone located between latitudes 14° 8' and 15° 49' N, longitudes 98° 33' and 99° 8' E. Dry evergreen forest and mixed deciduous forest are dominant throughout the area except on the mountain ridges, where hill evergreen forest is typical. Tracts of dry dipterocarp forest and savannah are found in the drier part of the sanctuary. The annual rainfall is 2000–2400 mm. The climate of the region is characterized by three main seasons, a wet season (May–October), a cooler, dry period (November–January) and a hot season (February–April) (NAKHASATHIEN & STEWART-COX, 1990).

Surveys were carried out along the Upper Khwae Yai River, its two branches, the Mae Khlong and Mae Chan Rivers, and smaller tributaries feeding into these main waterways. Altitude within the study site ranges from 150–400 meters. The main channels are about 30–50 m in width and are characterised by deep, fast-flowing water with frequent rapids. River banks are steep and interspersed with sandy beaches and rocky, boulder-choked sections. The tributaries range in width from 1.5 m to 30 m and contain rocky and sandy substrate. Most tributaries terminate in shallow water (0.5–3 m) at the confluence of the main river channels. Six of the larger tributaries are discontinuous with the main channels because the stream water descends below the ground prior to the channel confluence.

Species Distribution Survey

Between November 1994 and May 1995, the 70 km of river and its tributaries within Thung Yai Naresuan Wildlife Sanctuary were surveyed by bamboo raft and on foot to assess the distribution of otter species (Fig. 1). The survey method was adopted from MACDONALD (1983).

Time constraints and accessibility restricted a detailed search for otter signs along the entire waterway. Therefore, 66 sections called Intensive Search Areas (ISA) were set up, 1,000 m apart. Among 66 ISAs, 25 were along rivers and 41 were along tributaries (Fig. 1). Each ISA was visited once to survey for tracks, spraints and when possible, direct observations. In the absence of direct observation, characteristics of both tracks and

spraints were combined for accurate identification of otter species following KRUUK ET AL. (1993).

Food Study

To study food, otter spraints were collected between January 1995 and July 1996 whenever otter species could be identified. Spraint samples were collected in three different periods, winter (November–January) summer (April) and wet (June–July). Subsequent to collection, spraints were washed in a fine sieve and left to dry in the sun. Spraint contents were identified for main prey categories by 10x hand lens and dissecting microscope (10x). The prey which occupied the largest volume in a spraint was recorded as dominant. Data were then evaluated in terms of percentage of prey occurrence (% PO), percentage of dominant prey occurrence (% DPO), and percentage of relative occurrence (% RO). These indices should clearly illustrate the differences between diets of otter species (KRUUK ET AL., 1994). The relative occurrence percentage (% RO) may overestimate the importance of an incidental prey item, while underestimating the more important ones (PIERCE & BOYLE, 1991).

Seasonal comparison of diet was made for each otter species and evaluated by the relative occurrence percentage of prey items as this closely approximates the proportion of different prey items which were actually consumed (ERLINGE, 1969).

The values of % DPO, % PO and % RO were calculated for each prey species by:

$$\% \text{ DPO} = \frac{\text{No. of spraints in which prey is dominant}}{\text{Total no. of spraints}} \times 100$$

$$\% \text{ PO} = \frac{\text{No. of spraints in which prey occurs}}{\text{Total no. of spraints}} \times 100$$

$$\% \text{ RO} = \frac{\text{No. of spraints in which prey occurs}}{\text{Sum of frequencies of all prey groups in spraints}} \times 100$$

Fish vertebrae found in otter spraints were measured along their anterior–posterior axis to give an indication of size ranges of fish prey.

Fish Surveys

In order to document sizes of fish in relation to water depth, fish populations were sampled from river and tributaries of various depth and width. A dipnet was used to collect fish from the surface down to the bottom of the stream. Sodium cyanide was put into the water about 20 m upstream in front of the net. Total length of fish was measured from snout to tail tip.

RESULTS

Distribution and Habitat Preference

From tracks and direct observations, three species of otter, Common, Smooth-coated and Small-clawed, were found along the Upper Khwae Yai River (Fig. 2). The Common Otter had the widest distribution. It was found at high frequency along both the river and tributaries (Table 1). Smooth-coated Otters were distributed more along the lower part of the river, whereas Small-clawed Otters were found more along tributaries, but the distributions of these species overlapped considerably. However, each species had its preferred habitat. The Smooth-coated Otter preferred rivers where the depth of water ranged from 2–10 m (mean = 4.8 ± 2.3 , N = 9) (Tables 1 and 2). The Small-clawed Otter preferred tributaries where the depth ranged from 0.2–1.5 m (mean = 0.8 ± 0.5) (Tables 1 and 2), and the Common Otter showed equal preference for both rivers and tributaries, but was found in shallower water more than the other two species (Tables 1 and 2). However, this result may be biased by the small sample size of the Small-clawed Otter, which was found in only four ISAs. In addition, there might have been other physical characteristics of the river bank that influenced its occurrence.

Spraints and Spraint Sites

Spraint sites of the three otter species can be grouped into three major types, i.e. log, stream bank and rock. Percentages of spraints found are given in Table 3. The Small-clawed and Smooth-coated Otters seemed to use stream banks most. However, it should be noted that Small-clawed Otters used areas of the stream bank which were shaded by trees, whereas Smooth-coated Otters used both shaded stream banks and open, sandy beaches. Both the Small-clawed and Smooth-coated Otters used rocks as an alternative spraint site. Common Otters mostly used rock, with logs being their most common alternative. Rocks used as a spraint site by the three species differed in size and location.

Table 1. Occurrence of otter tracks found in 25 ISAs along river and 41 ISAs along tributaries. The figures in parentheses show the occurrence percentage of otter tracks.

Species	Occurrence of tracks found along	
	River (N = 25)	Tributaries (N = 41)
Small-clawed Otter	6 (24%)	24 (58.5%)
Common Otter	12 (48%)	22 (53.7%)
Smooth-coated Otter	14 (56%)	3 (7.3%)

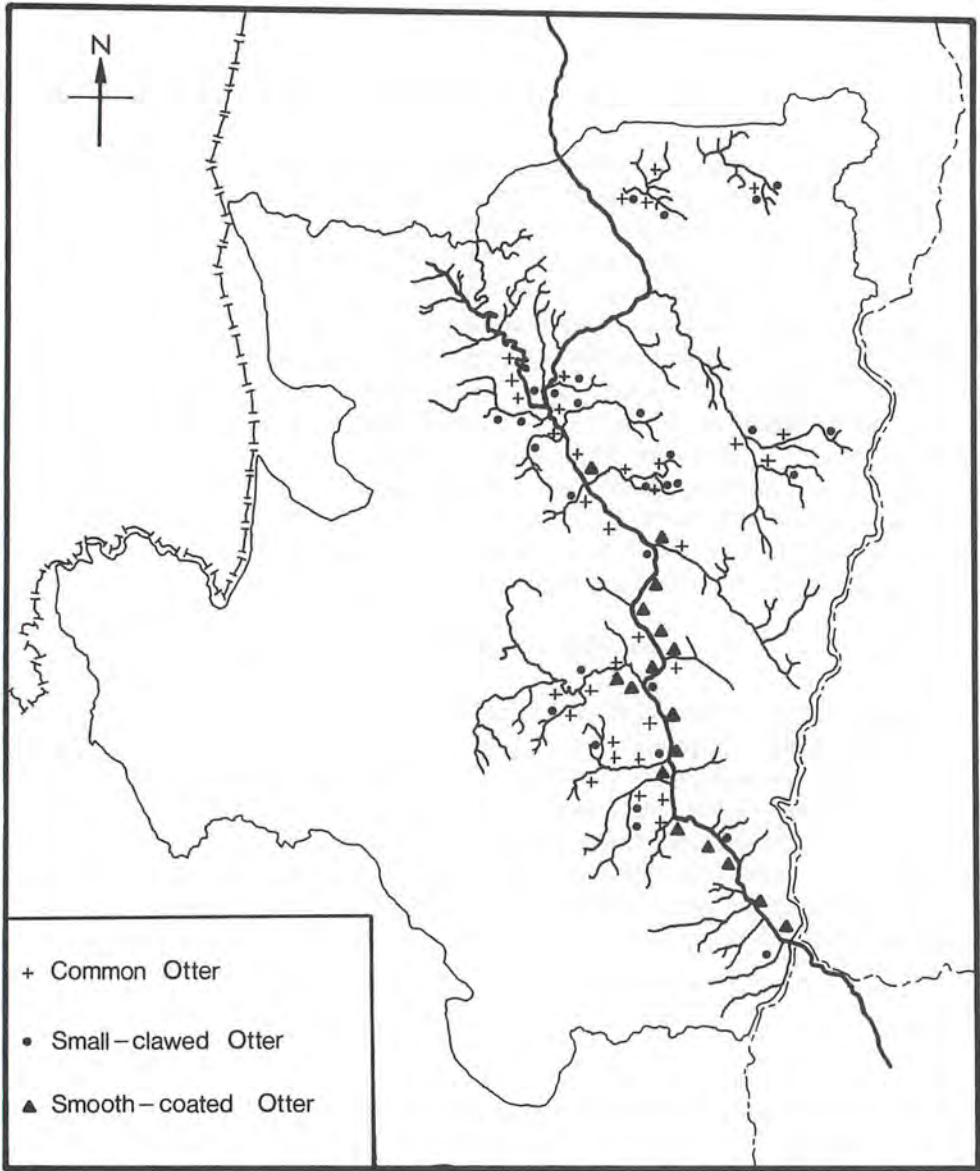


Figure 2. Distributions of otter tracks found in 66 ISA along the Upper Kwae Yai River and its tributaries in Thung Yai Naresuan Wildlife Sanctuary. ▲ = *Lutrogale perspicillata*, + = *Lutra lutra*, ● = *Aonyx cinerea*

Table 2. Width and depth of waterway where three otter species were found along the Upper Khwae Yai River in Thung Yai Naresuan Wildlife Sanctuary.

Otter species/ ISA	ISA No.	Width (m)			Depth (m)		
		Range	Mean	SD	Range	Mean	SD
Small-clawed Otter							
River	4	10-30	18.7	7.5	1-10	4.75	2.46
Tributary	19	1-15	5.85	5.12	0.2-1.5	0.8	0.5
Smooth-coated Otter							
River	9	8-30	20.38	7.95	2-10	4.77	2.3
Tributary	3	8-10	9.33	1.15	0.5-1	0.83	0.14
Common Otter							
River	9	10-30	17.5	7.6	0.5-10	2.93	2.94
Tributary	14	2-15	8.5	6.10	0.3-2	0.89	0.38

Table 3. Percentages of spraints of three otter species found on various objects or locations.

Otter Species	Spraint Site		
	Log (%)	Stream bank (%)	Rock (%)
Small-clawed Otter (N = 41)	7.3	58.5	34.2
Smooth-coated Otter (N = 41)	0	58.5	41.5
Common Otter (N = 124)	31.5	10.5	58.0

The Small-clawed Otters used a very large rock (boulder) located either near or away from the stream bank, whereas the Smooth-coated Otters used boulders located by the stream bank only. The Common Otters, in contrast, used smaller rocks which were partially submerged in the stream.

Diet

Diversity of food

Food of the three otter species comprised various species of crab, shrimp, fish, frogs, snakes, molluscs and insects. The diet was classified into six major groups: crab, shrimp, fish, frog, snake and other. Many types of food were eaten by all three species of otters.

Food preferences of the three species are indicated as occurrence percentage (PO x 100) and percentage dominant occurrence (DPO x 100) (Table 4). They seemed to specialize in different types of prey. Small-clawed Otter fed almost exclusively on crabs (with 99% PO and 91% DPO). In contrast, Smooth-coated Otter fed mostly on fish (92% and 86%, respectively). Among the three species, Common Otters seemed to be most generalist in taking prey. They fed on various groups of prey in relatively similar percentages, with a slight preference for fish (56% and 36%, respectively). The differences were significant (χ^2 - test as shown in Table 4).

Seasonal variation in diet

Table 5 shows no clear seasonal change in prey specialities, except that all three species of otters fed mostly on fish in the wet season, perhaps due to an abundance of fish during flooding.

Table 4. Percentages of prey occurrence (%PO) and dominant prey occurrence (%DPO) found in spraints of the three otter species studied in the Upper Khwae Yai River in Thung Yai Naresuan Wildlife Sanctuary. Ac = *Aonyx cinerea*, Lp = *Lutra perspicillata*, Il = *Lutra lutra*.

	% PO / % DPO			χ^2 (df = 2) ¹	χ^2 (df = 1) ¹		
	Small-clawed Otter (N = 108)	Smooth-coated Otter (N = 115)	Common Otter (N = 189)		Ac : Lp	Ac : Ll	Lp : Ll
Crab	99.1/90.8	14.8/5.2	37.6/31.8	90.03**	76.2**	28.4**	19.04**
Shrimp	20.4/4.6	10.4/0.9	25.9/16.9	18.9**	2.56 _{ns}	7.03**	14.49**
Fish	12.0/0.9	92.2/86.1	56.1/36.5	88.84**	83.33**	33.81**	20.04**
Frog	13.9/1.9	22.2/5.2	22.2/13.7	10.86**	1.61 _{ns}	9.09**	3.84**
Snake	0.9/0.9	2.6/2.6	1.1/1.1	1.15 _{ns}	ns	ns	ns
Other	4.6/0.9	0/0	0/0	1.86 _{ns}	ns	ns	ns

¹H₀: Occurrence percentages of dominant food categories in spraints do not differ.

Table 5. Seasonal occurrences of animal prey in diet of Small-clawed, Smooth-coated and Common Otters.

Otter species	% Relative occurrence in diet						
	Crab	Shrimp	Fish	Frog	Snake	Other	
Small-clawed	Winter (N = 28)	66.7	4.8	4.7	23.8	0	0
	Wet (N = 30)	71.4	0	21.4	7.1	0	0
	Summer (N = 50)	62.5	25.3	2.5	2.5	1.3	6.3
Smooth-coated	Winter (N = 28)	14.3	4.7	54.8	23.8	2.4	0
	Wet (N = 57)	1.4	2.8	76.4	19.4	0	0
	Summer (N = 30)	20.0	16.0	56.0	4.0	4.0	0
Common	Winter (N = 53)	14.1	12.9	32.9	37.7	2.4	0
	Wet (N = 82)	30.5	7.6	55.2	6.7	0	0
	Summer (N = 54)	33.8	37.5	25.0	3.7	0	0

However, the Smooth-coated Otter, which lived in the river and was a fish specialist, fed more on crabs in summer than at other times (Table 5). It is interesting to note that frogs and shrimps in the diet were high in winter and summer, respectively for all three species (Table 5).

Small-clawed Otter: Crabs were the most important food item in the diet of Small-clawed Otters, throughout the year (Table 5). The proportion of crabs taken did not vary significantly with season. There were, however, significant seasonal differences in the amount of shrimp, fish and frogs taken ($\chi^2 = 39.99$, $df = 2$, $P < 0.01$; $\chi^2 = 22.4$, $df = 2$, $P < 0.01$; $\chi^2 = 22.6$, $df = 2$, $P < 0.01$, respectively) (Table 5). Other food items such as snakes, insects and molluscs were present in spraints in low percentages, and only during the summer (Table 5).

Common Otter: There was seasonal variation in the diet of the Common Otter. Fish was the major food, especially during the wet season, but frogs became the main alternative food in the winter (Table 5). In summer, shrimp and crabs were the main component which made up to 70% of the total residue (Table 5). There were significant seasonal differences in the amounts of crabs, fish, frogs and shrimp ($\chi^2 = 13.01$, $df = 2$, $P < 0.01$; $\chi^2 = 44.18$, $df = 2$, $P < 0.01$; $\chi^2 = 8.52$, $df = 2$, $P < 0.05$, respectively) (Table 5).

Smooth-coated Otter: Fish was the most important component of the diet in all seasons (Table 5). Fish were taken most during the wet season, but there was no significant difference in fish prey occurrence between seasons. Frogs were the second most frequent prey item in winter and the wet seasons, with no significant seasonal variation between them ($\chi^2 = 0.45$, $df = 2$, $P > 0.05$); however, there were significant differences between both winter and the wet season and summer ($\chi^2 = 14.10$, $df = 2$, $P < 0.01$; $\chi^2 = 10.14$, $df = 1$, $P < 0.01$, respectively) (Table 5). Frogs were replaced by crabs and shrimp in the summer diet. Other prey items, such as other crustaceans and snakes, occurred in low frequencies (Table 5).

Surveys of fish

Captured fish were classified by length into three groups, i.e. small (<5–10 cm), medium (>10–25 cm) and large (>25 cm). Predictably, smaller fish were found in shallower streams and larger-sized fish were found in deep streams or in rivers (Table 6).

Size of fish in diet

According to WISE (1980), there is a direct and close relationship between the size of a vertebra and the total length of the fish it came from. Frequencies of sizes of fish vertebral length found in spraints of the three otter species are presented in Figure 3. Both Small-clawed and Common Otters fed on small-sized fish, which were mainly found in the smaller tributaries (Table 6). Smooth-coated Otters, the fish specialists, fed on a range of fish size, but appeared to prefer medium to large-sized fish (Fig. 3), which were found in deeper tributaries and the main river.

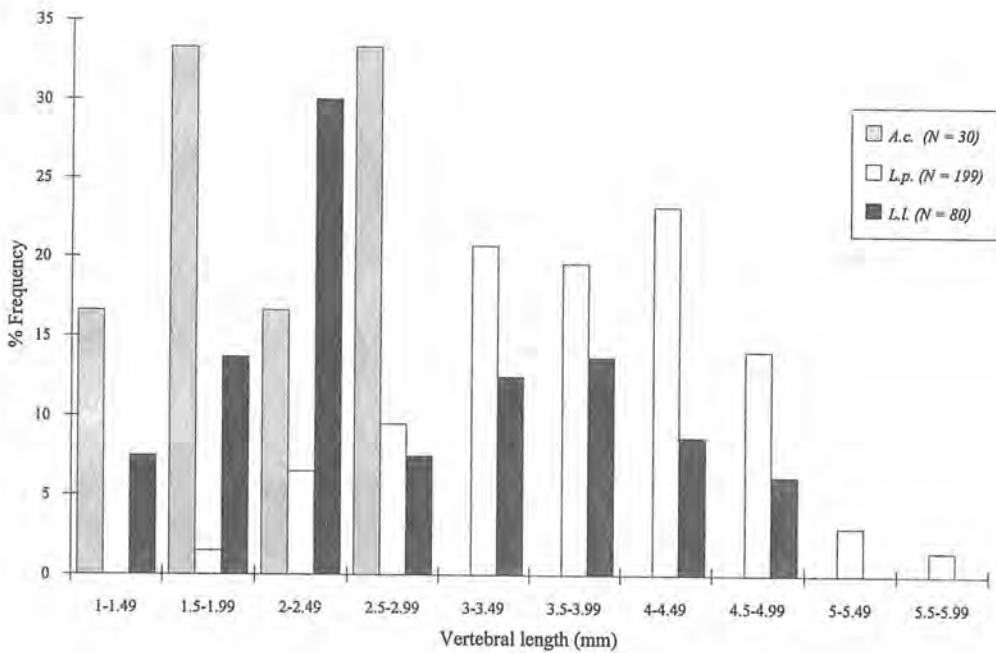


Figure 3. Percentages of frequency of various sizes of fish vertebrae found in spraints of three otter species studied along the Upper Khwae Yai River in Thung Yai Naresuan Wildlife Sanctuary. Ac = *Anoxy cinerea*, Lp = *Lutra perspicillata*, Ll = *Lutra lutra*.

Table 6. Percentages of occurrence frequency of various fish sizes captured from different depths of waterways. A, 1.5 m width, 20 cm depth; B, 5 m width, 50 cm depth; C, 15 m width, 70 cm depth; D, 30 m width, 2 m depth

Fish size	% Occurrence frequency of fish			
	Tributary A (N = 80)	Tributary B (N = 83)	Tributary C (N = 108)	River (D) (N = 140)
Small	90	61.5	42.5	29.3
Medium	10	38.5	55.6	59.3
Large	0	0	1.9	11.4

DISCUSSION

Distribution and Habitat Preference

The three otter species were found to be sympatric in Huai Kha Khaeng Wildlife Sanctuary. This finding differs slightly from KRUK ET AL. (1994) who studied sympatric otters in the Huai Kha Khaeng and found that Common Otter was dominant in fast-flowing sections of the upper part of the river, the Smooth-coated Otter in the lower sections of the river where the water meanders slowly, and the Small-clawed Otter mostly in the middle sections of the river. These differences, although slight, may be due to differences in physical characteristics of the Huai Kha Khaeng and the Upper Khwae Yai Rivers, the former of which is wider and flatter with a slow current, and with more patches of sandy beach than the latter (pers. obs.). Therefore, there should be more niche space and diversity in Huai Kha Khaeng. In addition, the discontinuity of waterways between the main channel and some large tributaries is, perhaps, an important factor that may have limited the distribution of Smooth-coated Otters.

The distribution found in this study and in KRUK ET AL. (1994) suggest that habitat preferences of these three otter species are influenced by competition avoidance. The dominance of Smooth-coated Otters over the others in the river may be due to its larger size; Smooth-coated > Common > Small-clawed Otters (LEKAGUL & MCNEELY, 1977). The Common Otter would have to adjust itself to using either the river or the tributaries to fully avoid interacting with either the Smooth-coated Otters in the river or the Small-clawed Otters in the tributaries. Therefore, this species is found along the entire waterway. This is supported by DIAMOND (1978) who suggested that sympatric species can coexist if they are segregated ecologically through partitioning of resources.

Diet Preferences

Differences in diet were obviously related to habitat characteristics. Although both Small-clawed and Common Otters fed on crabs, Common Otters shifted to other prey species in different seasons. Besides having different feeding manners, the three species also differ in the structure of their paws. Small-clawed Otters have developed considerable digital movement and have very sensitive forepaws which they use as hands to feel for prey under boulders and in shallow water. The other two species locate prey visually or with their vibrissae (TIMMIS, 1971). Therefore, the Small-clawed Otter is better adapted to catching crustaceans than is the Common Otter. Both were found to inhabit all except the smallest and shallowest tributaries, where only Small-clawed Otter tracks were found. As a crustacean feeder, the Small-clawed Otter should utilize a small stream more effectively than the Common Otter, and with tactile sensitive forelimbs (TIMMIS, 1971), they should have less trouble in murky water. With this anatomical adaptation, it is likely that the Small-clawed Otter is able to adapt to human settlements better than the other species. In support of this, some tributaries near Karen villages where domestic buffalo graze along the river banks, muddying the water, had only Small-clawed Otter signs.

Smooth-coated and Common Otters seemed to be closely related in their ecology. Both are piscivorous, but the Common Otter is less so. Its major diet varied more with

season, perhaps depending on the relative populations tend to move away from the main river when the water level is high. In winter, Common Otters turned more to frogs for the same reasons. In Europe, ERLINGE (1969) found that Common Otters were primarily piscivorous, but they also showed flexibility in prey utilization (EWER, 1973). Furthermore, the fish vertebrae found in their spraints indicated that Smooth-coated Otters take larger fish than Common Otters. ROBERTS ET AL. (1991) suggested that in the deeper water there will be bigger and more numerous leaf-eating fish than in shallow streams. Fish sampling in this study also showed a higher frequency of large fish in the river than in the tributaries, which corresponds with the distribution of the species.

My findings contrast with those of KRUIK ET AL. (1994) who found that in the Huai Kha Khaeng River, frogs were the main food of the Common Otter. In winter frogs were the major food item in both areas.

The coexistence of these three similar carnivorous otters in the Upper Khwae Yai River reflects the diversity of habitats which maintain the high biodiversity of the sanctuary. If a proposal for a hydro-electric dam had been successful for this area in 1988, the undisturbed river system would have been destroyed, with a great loss to the natural world.

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