suring mandibular canine teeth and comparing them with specimens of known sex. We suggest the discriminant function presented above be used to sex striped skunks.

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FEEDING HABITS OF RIVER OTTERS IN COASTAL SOUTHEASTERN ALASKA

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Diets of river otters (*Lutra canadensis*) inhabiting freshwater lakes and streams have been described in the literature (Wilson 1954, Knudsen and Hale 1968, Modafferi and Yocom 1980, Melquist and Hornocker 1983). However, studies of feeding habits of otters living in coastal regions of North America have not been reported. Toweill (1974) discussed the diets of river otters in both coastal and inland areas of Oregon, but no separation was made between stomach contents of otters caught in coastal areas and those captured in inland locations.

This study was conducted to determine principal prey species eaten by river otters inhabiting the southern coastal region of southeastern Alaska. The study was part of a broad investigation of the ecology of river otters living in coastal Alaska.

STUDY AREA

The study was conducted in Cholmondeley Sound, located on the east side of Prince of Wales Island, 32 km southwest of Ketchikan in southeastern Alaska (55°17′N, 132°04′W). Cholmondeley Sound encompasses an area of approximately 87 km^2 and is among the protected waters of the Alexander Archipelago. It is typical of fjordlike landscapes with deep, glacier-cut valleys and a convoluted coastline. Relief is relatively subdued in the immediate and surrounding areas where most of the terrain rises from sea level to 600 m with only a few isolated mountains rising to between 900 and 1,000 m.

A maritime climate dominates the area; temperatures range from 9 to 18 C in summer and from −2 to 7 C in the winter. Annual precipitation is normally about 290 cm, most of which is rain.

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The intertidal zone of Cholmondeley Sound varies from steep bedrock to gently sloping boulder, sand, and mud beaches. Bays, islands, reefs, and points create a diverse shoreline. Tide levels fluctuate from highs of approximately +6.0 m to lows of −1.5 m.

Estuarine meadows of grasses and sedges are often found at the heads of bays and adjacent to river and stream effluents. Riparian vegetation consists primarily of red alder (*Alnus rubra*), Sitka alder (*A. sinuata*), stink currant (*Ribes bracteosum*), and salmonberry (*Rubus spectabilis*).

METHODS

During June–August 1980 and all of 1981, 272 river otter scats were collected on the study area. Date and location of collection were recorded and each scat was identified as recent (deposited <2 weeks earlier) or old (deposited between 2 and 4 weeks earlier). Recent scats were distinguished by compactness, dark color, and presence of moist, leachable particles which had not washed away or dried out. Old scats were recognized by partial breakdown as a result of weathering. Scats were ovendried in the field camp and stored in plastic bags for later analyses.

Prey remains were identified by comparison with reference specimens obtained from the University of Alaska Museum's fish and invertebrate collections. Otoliths and scales were the items most often used to identify fish remains. Otoliths that could not be identified using an otolith key (Morrow 1979) were sent to the late J. E. Fitch of San Pedro, California, for identification.

Prey items were recorded according to the number of scats in which they occurred and all the scats containing a particular item were expressed as a percentage of the total number of scats collected (frequency of occurrence). Any evidence of a prey species in a scat, even though more than one individual of a species might be present, was treated as a single occurrence. Volume calculations were made and they proved to be similar to the values obtained using frequency of occurrence (Table 1).

Seasonal changes in otter diets were determined from the analyses of 249 otter scats for which the season of deposition was known. Seasons were assigned as: winter (Dec–Feb), spring (Mar–May), summer (Jun–Aug), and autumn (Sep–Nov). Chi-square analyses were used to test for seasonal changes in diet.

RESULTS AND DISCUSSION

Fish was the predominant food found in otter scats (Table 1). Miscellaneous invertebrates, which consisted of lined chitons (*Tonicella lineata*), limpets (*Acmaea* spp.), urchins (*Strongylocentrotus* spp.), gastropods, pelecypods, isopods, amphipods, and stomatopods, occurred in 81 scats. Of these 81, 77 contained fish remains in addition to the invertebrates, 3 contained crab and fish remains, and 1 scat, containing a single snail shell, consisted of bird feathers. With the exception of crabs, no scats containing only invertebrate remains were encountered in this study. This suggests that these invertebrates were first ingested by fish, crabs, or birds that were later eaten by otters.

Small fragments of urchin exoskeletons were found in four scats and were probably ingested directly by otters while extracting the soft body parts from these invertebrates. The frequency of occurrence of urchins was probably underestimated in these results because the exoskeleton is not consumed and soft body tissues are digested. The importance of abalone (*Maliotus kamtschatkana*) and giant chitons

Table 1. Annual diet of river otters based on remains in 272 scats collected on the study area in southeastern Alaska, 1980–81.

Food item	Scats in which each food item occurred (*N*)	Frequency of occurrence (%)	Proportion of total scat volume made up by each food item (%)
Fish	261	96	86
Ammodytidae			
Ammodytes hexapterus (Pacific sand lance)	5	2	<1
Clupeidae			
Clupea harengus pallasi (Pacific herring)	3	1	<1
Cottidae	177	65	49
Artedius spp.	23	8	5
Enophrus bison (buffalo sculpin)	1	<1	<1
Hemilepidotus spp. (Irish lords)	80	29	20
Icelus spatula (spatulate sculpin)	1	<1	<1
Leptocottus armatus (Pacific staghorn sculpin)	4	1	<1
Myoxocephalus scorpius (shorthorn sculpin)	1	<1	<1
Radulinus asprellus (slim sculpin)	1	<1	<1
Rhamphocottus richardsoni (grunt sculpin)	2	<1	<1
Unidentified cottid	79	29	21
Embiotocidae			
Unidentified embiotocid (surfperches)	1	<1	<1
Gadidae	7	3	1
Microgadus proximus (Pacific tomcod)	3	1	<1
Theragra chalcogrammus (walleye pollock)	3	1	<1
Unidentified gadid	1	<1	<1
Hexagrammidae	38	14	7
Hexagrammos octogrammus (masked greenling)	1	<1	<1
H. stelleri (whitespotted greenling)	2	<1	<1
Ophiodon elongatus (lingcod)	2	<1	<1
Unidentified hexagrammid	35	13	7
Pholidae/Stichaeidae			
Unidentified pholid or stichaeid (gunnels/pricklebacks)	11	4	2
Pleuronectidae/Bothidae	11	4	2
Citharichthys spp. (sanddabs)	2	<1	<1
Soles	6	2	2
Unidentified pleuronectid/bothid	3	1	<1
Salmonidae			
Unidentified salmonid	12	4	4
Scorpaenidae			
Sebastes spp. (rockfish)	45	17	12
Unidentified fish	25	9	5
Crabs	42	15	10
Cancer gracilus	1	<1	<1
C. magister (dungeness)	15	6	5
C. oregonensis	1	<1	<1
C. productus (red)	1	<1	<1
Cancer spp.	2	<1	<1
Telmessus cheirogonus (horse)	10	4	3
Placetron wosnessenskii	1	<1	<1
Hapalogaster spp.	1	<1	<1
Unidentified crab	11	4	1
Invertebrates (other than crabs)	81	30	2
Tonicella lineata (lined chiton)	7	3	<1
Pelecypoda (clams)	25	9	<1

Table 1. Continued.

Food item	Scats in which each food item occurred (N)	Frequency of occurrence (%)	Proportion of total scat volume made up by each food item (%)
Crustacea (amphipods, isopods, decapods)	27	10	<1
Acmaea spp. (limpets)	16	6	<1
Gastropoda (snails)	30	11	<1
Strongylocentrotus spp. (urchins)	4	1	<1
Birds			
Unidentified bird	3	1	1
Mammals			
Odocoileus hemionus sitkensis (Sitka black-tailed deer)	1	<1	<1
Plant material	1	<1	<1

(*Cryptochiton stelleri*) was also underestimated because remains from their soft tissues are unidentifiable. Intact abalone shells and chiton plates and girdles were commonly found at otter feeding sites.

Soft body parts of prey are usually not identified in studies of carnivore diets, a shortcoming that has not been adequately addressed. Techniques are needed to better quantify consumption of soft tissues directly or improve estimates of soft tissues based on identifiable remains. One approach would be to examine stomach contents of otters collected by shooting because soft tissues might still be present in their stomachs. Toweill (1974) examined stomachs of otters caught in traps for soft tissues, but some passage of soft tissues occurred while the otters were confined. Erlinge (1968) reported that food items with a large proportion of hard material tended to be overestimated and large fish or fish without scales tended to be underestimated in the diets of captive otters (*L. lutra*). He concluded that frequency of occurrence values gave a reasonably accurate account of the relative importance of different food categories.

Starfish (*Pisaster ochraceus*) legs were found on four occasions at otter use areas and, on one occasion, seven otters feeding together were observed eating starfish on rocks adjacent to salt water. Because remains of the calcareous skeletal structures found in starfish should be recognizable in scats, their absence from this sample probably reflects the infrequent use of this prey item.

Birds were found in three scats. Although identification of the bird species was not possible, they were probably alcids; possibly common murres (*Uria aalge*) or murrelets (*Brachyramphus* spp.).

Mammals are generally unimportant as food for North American otters (Wilson 1954, Knudsen and Hale 1968, Melquist and Hornocker 1983). In this study, a single scat contained deer hair. The scat was collected in May and it is possible that an otter found a deer carcass and fed on it. Otter hair was observed in a few scats, probably the result of grooming (Greer 1955, Melquist and Hornocker 1983).

Plant material, believed to be grass, was found in one scat which was collected in July.

Eleven families of fish were identified in otter scats (Table 1). Cottids (sculpins) were the most commonly eaten fish, occurring in 65% of the scats. Most cottid species are found in shallow water and may be abundant in the intertidal zone

Table 2. Chi-square results of seasonal changes in the use of important fish families eaten by river otters in southeastern Alaska, 1980–81.

Food item	Winter[a] O	Winter[a] E	Spring O	Spring E	Summer O	Summer E	Autumn O	Autumn E	χ^2	df	
Hexagrammidae	1	2.45	3	5.35	12	9.78	21	19.42	2.98	3	
Scorpaenidae	0	2.84	15	6.22	17	11.37	11	22.57	29.12	3	**
Cottidae	16	10.90	21	23.86	42	43.64	86	86.59	8.78	3	*
Hemilepidotus	14	5.09	6	11.14	17	20.36	40	40.40	27.16	3	**
Other cottids	3	6.88	16	15.04	27	27.50	58	54.58	4.34	3	
N scats	16		37		67		129				

[a] O = observed; E = expected.
* 0.025 < P < 0.05; ** P < 0.001.

(Hart 1973). The abundance and species diversity of cottids living along the coast of the study area, in combination with their relative ease of capture, probably account for their high frequency of occurrence in the scats.

Eight genera of cottids were identified including Irish lords (*Hemilepidotus* spp.), which occurred in 29% of all scats. Irish lords were easily identified in scats by the presence of their cycloid scales positioned on raised papillae (Hart 1973). Red (*H. hemilepidotus*), brown (*H. spinosus*), and yellow (*H. jordani*) Irish lords could often be identified to species using otoliths found in otter scats.

Four species of the genus *Artedius* occur on the study area and although all are probably eaten by otters, identification to species was not possible. Collectively, species of *Artedius* occurred in 29% of the scats. The remaining seven species of cottids identified were found in only 4% of the scats; however, this value is probably low because some of the unidentified cottids were undoubtedly members of these species.

Salmonids occurred in 4% of the scats. All 12 scats containing salmonid remains were collected during September and October when pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) were spawning in streams on the study area.

In addition to salmon, carcasses of rockfish, lingcod, flounder, sculpin, and walleye pollock (*Theragra chalcogrammus*) were found around otter use sites on the study area. No remains of fish carcasses with a length of <30 cm were found during this study suggesting that smaller fish are generally eaten completely.

Pholids (gunnels) and stichaeids (pricklebacks) were combined into one group during scat analyses because of the difficulty in distinguishing between these two families. Likewise, the pleuronectids and bothids (flatfishes) were combined (Table 1).

Occurrence of cottids and scorpaenids in otter scats changed seasonally. Cottids were the most important group during all seasons. A chi-square analysis indicated a significant change in the seasonal use of this group as a result of the changes observed for the *Hemilepidotus* spp. (Table 2). No significant seasonal changes were noted for the hexagrammids. Scorpaenids showed significant changes from winter to spring, when use of cottids by otters decreased and use of scorpaenids increased. Inversely, as cottids increased from spring through the fall, scorpaenids decreased (Table 2). Red Irish lords spawn during

March and April in shallow water (Hart 1973). Some scorpaenids also move into shallow water during spring (Gunderson 1972). It would seem that as a function of their increased abundance, the occurrence of Irish lords in otter scats would increase during the spring. There are three explanations as to why this did not occur: otters preferred scorpaenids over Irish lords, otters were able to capture more scorpaenids than Irish lords, or scorpaenids were more abundant than Irish lords.

The frequency of occurrence of fish, crabs, and birds changed seasonally. The importance of fish throughout all seasons was reflected by their occurrence in 100% of the winter scats, 95% of the spring and summer scats, and 98% of the fall scats. There was a possible compensatory relationship between fish and crab in the diet of otters; as the occurrence of fish decreased crab occurrence increased, and conversely, as fish increased crab decreased. Seasonal changes in the occurrence of crab and fish in otter scats were not significant ($\chi^2 = 3.1$, 3 df, $0.25 < P < 0.5$). The increase in occurrence of crabs during spring and summer may have been due to increased availability; several species of crabs move into shallow water in the spring and summer where they breed (Hatler 1976).

In summary, fish was the most important food eaten by otters. Cottids (sculpins) were the most important group of fish during all seasons despite a 43% decrease in the occurrence of this group from winter to spring. The decrease in cottids occurred together with a 47% increase in the occurrence of scorpaenids (rockfish), the second most common group of fish eaten, and probably reflects seasonal changes in the abundance of these two families. Hexagrammids (greenlings) were the third most commonly occurring family of fish and remained relatively constant over all seasons. Remains from salmonids (salmon) were only found in scats collected in the fall and reflect use of spawning salmon during this season.

Crabs were relatively unimportant in otter diets during all seasons. Slight spring and summer increases in the occurrence of crab remains in otter scats probably reflect movement of crabs from deep to shallow water during these seasons, thereby making them more available to otters.

Bird remains were found in only three scats, suggesting that they offer little more than variety to the diet. The occurrence of deer hair in one scat probably reflects opportunistic feeding on a carcass. Miscellaneous invertebrates occurred often in scats but were apparently consumed first by either fish, crabs, or birds that were in turn consumed by otters.

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AN EVALUATION OF TOTAL TRAPLINE CAPTURES AS ESTIMATES OF FURBEARER ABUNDANCE

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The total number of individuals captured on traplines has been used as an index of abundance for furbearer species (Wood and Odum 1964, Jenkins et al. 1979). However, few studies have actually compared trapline indices to estimates of population size. These comparisons are needed before inferences concerning population trends can be made with confidence. At the U.S. Department of Energy's Savannah River Plant (SRP) in South Carolina, the number of captured furbearers has been used as an index of furbearer abundance since 1954 (Wood and Odum 1964, Jenkins et al. 1979). Since 1976, animals have been livetrapped, tagged, and released to provide estimates of population size via mark-recapture techniques (Otis et al. 1978, White et al. 1982). The objective of this study was to determine whether the total numbers of furbearers captured annually actually reflected trends in furbearer population size.

STUDY AREA AND METHODS

The study was conducted on the 806-km² SRP in South Carolina, 24 km south of Aiken. The area, closed to the public in 1952, was characterized by lowland hardwood swamp and coniferous-oak (*Quercus* spp.) uplands. A detailed description of furbearer habitats on the site was provided by Jenkins and Provost (1964).

Ten 3.2-km traplines were established along secondary dirt roads in the fall of each year. Live traps (37.5 × 50 × 105 cm) were placed at 0.32-km intervals and were positioned in the same place along each line each year since 1976. Traps were baited with venison during 1976 and 1977 and with venison and fish, alternately between traps on a line, during 1978 through 1982. Traps were checked each morning and trapped individuals were ear-tagged and released. Surveys were conducted over 7 consecutive rain-free days each year (700 trap-nights).

Population size was estimated, using capture-recapture and removal methods (Program CAPTURE—Otis et al. 1978, White et al. 1982), for those species for which a minimum of 10 individuals were captured annually. A series of models and estimators are available in CAPTURE to estimate population size. The models allow different types of variation in capture probabilities. Capture probability can vary with time (M_t), behavioral response (M_b), and individual animal (M_h). Of the models available with various combinations of

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