River Otter, *Lontra canadensis*, Food Habits in the Missouri Ozarks

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The reintroduction of River Otters (*Lontra canadensis*) between 1982 and 1992 resulted in widespread occurrence of the species throughout the Missouri Ozarks. This study examined otter diets from the vicinity of two Ozark streams in relation to seasonal and spatial trends. Otter scats (N = 4750) were collected and analyzed from the Osage Fork River and Big Piney River during the summer and winter seasons of 2001 and 2002. During the winter (January-March), fish occurred in 86% of the samples. During the summer (June–August), occurrence of fish dropped to approximately 15% for both rivers. Seven families of fish were identified in the diets, with Centrarchidae being most common regardless of river or season. Within the Centrarchidae, the genus *Lepomis* (mostly Longear Sunfish, *Lepomis megalotis*) was most common, with *Micropterus* (mostly Smallmouth Bass, *Micropterus dolomieu)* and Rock Bass (*Ambloplites rupestris*) also well represented. The mean age of *Ambloplites* consumed ($\bar{x}$ = 3.3 years) was consistently older than that of either *Micropterus* ($\bar{x}$ =2.54 years) or *Lepomis* ($\bar{x}$ =2.78 years). Crayfish were recovered from a mean of 85.2% of scats in the winter and 99% in the summer. Smaller fish and crayfish were more common from the upper reaches of the streams while larger fish were prevalent in the lower reaches.

Key Words: River Otter, *Lontra canadensis*, *Lutra canadensis*, diet, food habits, predator, crayfish, fish, Centrarchidae.

River Otters, *Lontra canadensis*, were reintroduced in Missouri during a 10-year program initiated in 1982. River otters in North America are known to consume primarily fish and crayfish, although there is great regional variation (Lagler and Ostenson 1942; Greer 1955; Ryder 1955; Hamilton 1961; Knudsen and Hale 1968; Sheldon and Toll 1964; Grenfell 1974; Toweill 1974; Lauhachinda 1978; Gilbert and Nancekivell 1982; Anderson and Woolf 1987; Tumilson and Karnes 1987; Reid et al. 1994).

In addition to regional variation, several aspects of otter diets important to understanding their ecological role have not been examined. For example, studies have not examined spatial variations in the otter diet, specifically the variation in diet from the headwaters downstream. Fish communities are known to vary longitudinally in stream systems; this gradient is expected to influence otter diets. Also, no study has identified depredated fishes beyond the taxonomic level of family. This limitation is particularly important for Ozark streams, because the family Centrarchidae contains several popular sport fish including: black bass (*Micropterus* spp.), Rock Bass (*Ambloplites rupestris*), crappie (*Pomoxis* spp.) and several other sunfish species (*Lepomis* spp.). Without accurate techniques to identify Centrarchidae beyond the family level, it is impossible to determine whether a scale from a depredated fish is from a black bass or a sunfish.

The goal of this study was to obtain a better understanding of otter food habits in the Missouri Ozarks. The objectives were to:

(1) compare seasonal differences in otter diets on two Ozark streams during the winter and summer seasons;

(2) describe spatial variation in otter diets on these two streams;

(3) quantify the fish component of the diet at the family level;

(4) describe the specific Centrarchidae genera in otter diets, including age distributions; and

(5) quantify the crayfish component of otter diets.

Study Area

We studied otter diets in two Ozark streams, Osage Fork River and Big Piney River. Both streams are in the Gasconade River watershed, which lies on the northern side of the Ozark drainage divide (Nigh and Schroeder 2002) entirely within the state of Missouri, USA. This region is characterized by deeply dissected sandstone, limestone, and dolomite hills. There is moderate to high relief near the rivers. The upland areas are primarily oak-hickory woodlands with some pine-oak woodland, and cleared agricultural land. The

streams of the region are influenced by numerous springs that contribute to a significant base flow. The rivers typically have low turbidity and well defined riffle-pool complexes.

Osage Fork River originates in Webster County and flows through Wright and Laclede counties before its confluence with the Gasconade River in Pulaski County. The reaches we sampled were all contained in Laclede County and included a reach from State Highway J to State Highway 5, State Highway 5 to State Highway B, and State Highway B to the Missouri Department of Conservation's (MDC) Drynob Access near State Highway 32 (Figure 1). In addition, we examined diets on three significant tributaries to Osage Fork River located in Laclede County, including; Mill Creek, North Cobb Creek, and Cobb Creek (Figure 1).

Big Piney River originates in Texas County and flows through Phelps and Pulaski counties before its confluence with the Gasconade River in Pulaski County. We examined otter diets on three reaches of the Big Piney, including U.S. Highway 63 to MDC's Dog's Bluff Access, U.S. Forest Service Slabtown Access to MDC's Ross Access, and U.S. Forest Service East Gate Access to U.S. Forest Service Road #1730 (Figure 1). In addition, we examined diets on three major tributaries in Texas County, including Indian Creek, Hog Creek, and West Piney Creek (Figure 1).

Materials and Methods

River Otter scats were collected from the Big Piney River and Osage Fork River systems during the winter (January–March) and summer (June-August) seasons of 2001 and 2002. To select sample sites we divided each stream, including major tributaries, into 16 km reaches and randomly chose four of these reaches for each river. Each of these 16 km reaches were then divided into equal 0.4 km segments, of which 10 were selected for sampling for each reach. This yielded 4 km of streamside to sample for each reach of stream, and thus 16 km for each stream. Each reach of stream was visited three times during each season, approximately two weeks apart. With the exception of tributary reaches, all study areas were accessed with a canoe. Within the 0.4 km segments, both banks of the river were searched for otter scats and latrines. All latrines located within the study segments were marked with flagging and assigned a unique identification number. All otter scats were removed on the first visit of the season to assure that all scats recovered from two subsequent visits during the season were deposited between visits. During the next two visits, all otter scats found in the segments were collected and individually stored in plastic bags for later analysis.

Scats were dried in a food dehydrator prior to analysis. Dried scats are much easier to examine because small pieces, such as fish scales, do not adhere together. The scat material was then carefully sorted, and potentially diagnostic materials retained. Diagnostic materials consisted primarily of fish scales, bones, feathers, crayfish cheala, and hair. Presence or absence of these prey items was recorded. The frequency of occurrence (% of scats containing a prey item) was determined. This approach was used to make data comparable to other food habit studies (e.g., Lagler and Ostenson 1942; Wilson 1954; Ryder 1955; Hamilton 1961; Knudsen and Hale 1968; Grenfell 1974; Toweill 1974; Lauhachinda 1978; Gilbert and Nancekivell 1982; Reid et al. 1994). Scat analysis on captive European River Otters (*Lutra lutra*) showed frequency of occurrence to accurately represent diets and the relative importance of prey types (Erlinge 1968). Calculating percent by volume was not considered feasible due to the varying digestibility of food types. For example, crayfish have a relatively high proportion of indigestible material (i.e. chitin) compared to a fish of the same mass and would be over-represented in a scat sample (Pierce 1979).

Fish scales recovered from scats were pressed on acetate plates and the impressions were viewed with a microfiche reader. Scales were aged by annuli counts and identified to the family level using established keys (Lagler 1947; Oats et al. 1993; Daniels 1996). Scales identified as the family Catostomidae (suckers) may have included the carp species of the family Cyprinidae (minnows) because carp scales are indistinguishable from Catostomidae (Lagler 1947; Oats et al. 1993; Daniels 1996). Similarly, the western mosquitofish (*Gambusia affinis*) of the family Poeciliidae (livebearers) are combined with Fundulidae (top-minnows and killfishes). Ictaluridae (catfish) and Cottidae (sculpins), while present in rivers in low densities (Pflieger 1997), both lack scales and cannot be separated. Therefore, we assumed that the presence of fish bones in a scat sample without any scales indicated the presence of one of these two families. These two families are referred to collectively as "scaleless fish". Several measurements were taken from lateral line scales from the family Centrarchidae and used in a linear discriminant analysis model to identify specific centrarchid genera (Roberts et al. 2007).

Results

Otter diets contained fish, crayfish, amphibians, reptiles, mammals and birds. Crayfish and fish were the predominant prey items. A total of 777 samples was collected during the winter seasons and 1137 samples were collected during the summer seasons from the Big Piney River. A total of 1443 samples was collected during the winter seasons and 1393 samples were collected during the summer seasons from the Osage Fork River. Fish were more frequently found in the winter. Fish remains were found in 88% of all winter season Big Piney samples and in 84.3% of all winter season Osage Fork samples (Table 1). During the sum-

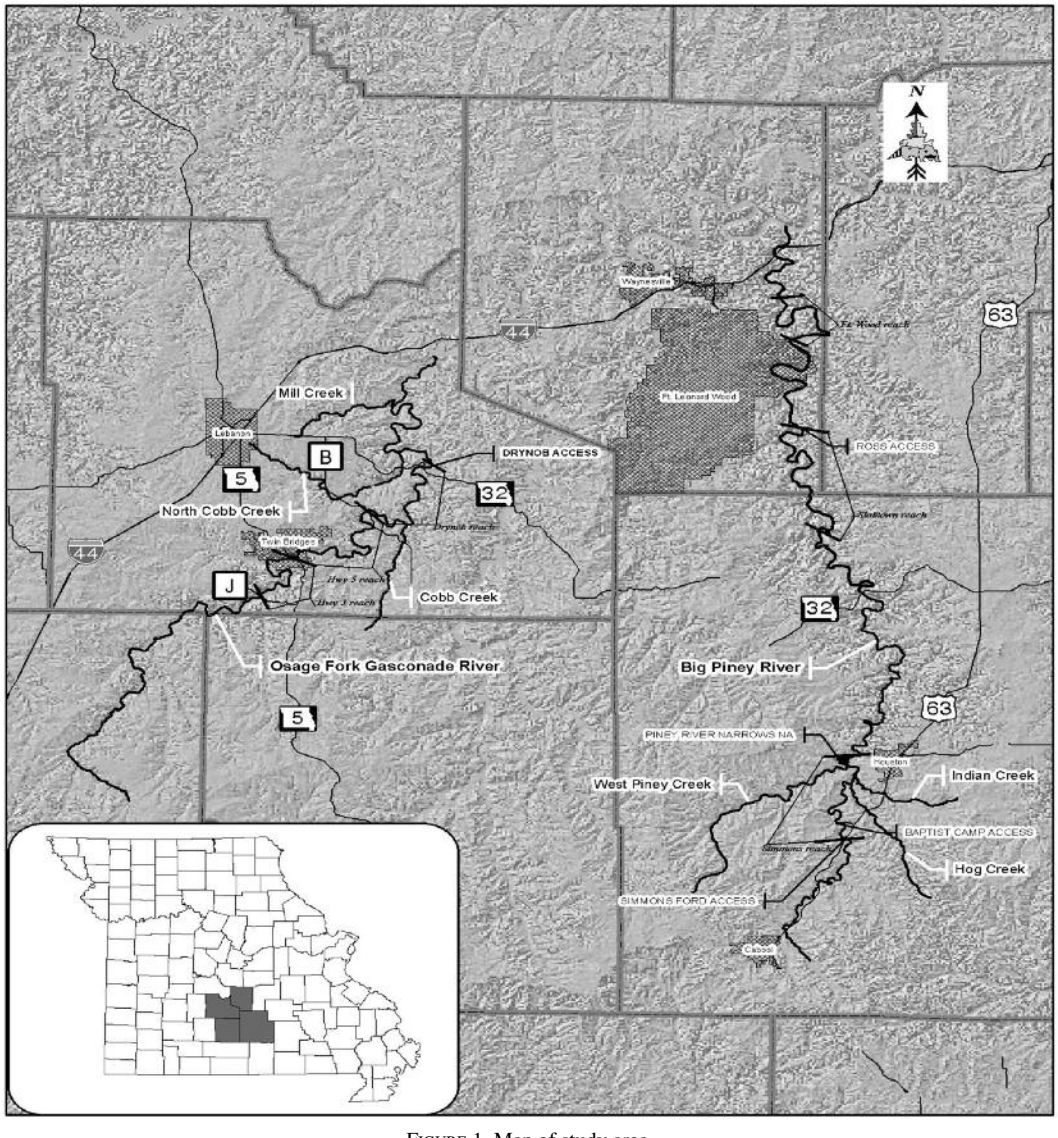

FIGURE 1. Map of study area.

mer seasons, frequency of occurrence of fish remains dropped to 14.6% for Big Piney River and 14.2% for Osage Fork River (Table 2).

On the Big Piney River, frequency of occurrence of fish remains during the winter seasons varied between reaches from 84.7% to 94.34% and showed no distinct spatial variation between upstream and downstream reaches (Table 1). Frequency of occurrence of fish remains in winter samples from the Osage Fork varied between reaches from 81.26% to 93.96% and decreased from the upstream to downstream reaches (Table 1). During the summer seasons, frequency of occurrence of fish remains varied between reaches from 12.7% to 21.74% on the Big Piney River and from 11.22% to 18.25% on the Osage Fork River, with no distinct longitudinal patterns (Table 2).

Of the several fish families identified from scales (Tables 3 and 4), Centrarchidae occurred more frequently than all other families combined during both seasons on both rivers. There was, however, no discernable spatial pattern between reaches (Tables 3 and 4). Centrarchidae did occur in slightly higher frequencies in samples from the Big Piney River during both seasons. Within the family Centrarchidae, the genus *Lepomis* occurred more frequently than *Micropterus* or *Ambloplities* in both rivers regardless of season

TABLE 1. Frequency of occurrence of prey items from otter scat during winter seasons on Big Piney River (B.P.) and Osage Fork River (O.S.).

Taxa	B.P.-Tributaries (n = 243) % (n)	B.P.-Simmons (n = 213) % (n)	B.P.-Slabtown (n = 268) % (n)	B.P.-Ft. Wood (n = 53) % (n)	B.P. Totals (n = 777) % (n)
Fish	88.5 (215)	90.1 (192)	84.7 (227)	94.3 (50)	88.0 (684)
Crayfish	81.5 (198)	60.6 (129)	82.8 (222)	54.7 (29)	74.4 (578)
Amphibian	10.3 (25)	11.3 (24)	9.7 (26)	9.4 (5)	10.3 (680)
Bird	0.4 (1)	0.00 (0)	0.0 (0)	0.0 (0)	0.1 (1)
Mammal	0.00 (0)	0.00 (0)	0.4 (1)	0.0 (0)	0.1 (1)
Reptile	0.4 (1)	0.00 (0)	0.0 (0)	0.0 (0)	0.1 (1)
Taxa	O.F-Tributaries (n = 149) % (n)	O.F.-Highway J (n = 420) % (n)	O.F.-Highway 5 (n = 255) % (n)	O.F.-Drynob (n = 619) % (n)	O.F. Totals (n = 1443) % (n)
Fish	94.0 (140)	85.7 (360)	83.9 (214)	81.3 (503)	84.3 (1217)
Crayfish	94.0 (140)	83.1 (349)	93.7 (239)	96.1 (595)	91.7 (1323)
Amphibian	27.5 (41)	17.1 (72)	8.6 (22)	9.5 (59)	13.4 (194)
Bird	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Mammal	0.0 (0)	0.0 (0)	0.8 (2)	0.0 (0)	0.1 (2)
Reptile	0.0 (0)	0.0 (0)	0.0 (0)	0.2 (1)	0.1 (1)

TABLE 2. Frequency of occurrence of prey items from otter scat during summer seasons on Big Piney River (B.P.) and Osage Fork River (O.S.).

Taxa	B.P.-Tributaries (n = 427) % (n)	B.P.-Simmons (n = 317) % (n)	B.P.-Slabtown (n = 370) % (n)	B.P.-Ft. Wood (n = 23) % (n)	B.P. Totals (n = 1137) % (n)
Fish	13.8 (59)	17.4 (55)	12.7 (47)	21.7 (5)	14.6 (166)
Crayfish	99.5 (425)	98.7 (313)	99.2 (367)	100.0 (23)	99.2 (1128)
Amphibian	13.6 (58)	13.9 (44)	9.7 (36)	21.7 (5)	12.6 (143)
Bird	0.0 (0)	0.3 (1)	0.5 (2)	0.0 (0)	0.3 (3)
Mammal	2.3 (10)	0.6 (2)	0.3 (1)	0.0 (0)	1.1 (13)
Reptile	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Taxa	O.F-Tributaries (n = 490) % (n)	O.F.-Highway J (n = 367) % (n)	O.F.-Highway 5 (n = 126) % (n)	O.F.-Drynob (n = 410) % (n)	O.F. Totals (n = 1393) % (n)
Fish	15.7 (77)	14.2 (52)	18.3 (23)	11.2 (46)	14.2 (198)
Crayfish	100.0 (490)	99.7 (366)	100.0 (126)	99.8 (409)	99.9 (1391)
Amphibian	21.2 (104)	11.7 (43)	15.9 (20)	7.6 (31)	14.2 (198)
Bird	0.2 (1)	1.9 (7)	0.0 (0)	0.2 (1)	0.7 (9)
Mammal	1.6 (8)	1.6 (6)	4.8 (6)	0.7 (3)	1.7 (23)
Reptile	0.4 (2)	0.0 (0)	0.0 (0)	0.2 (1)	0.2 (3)

(Tables 5 and 6). *Micropterus* and *Ambloplites* occurred in similar frequencies on both rivers. No distinct spatial pattern was observed for any genus.

The mean age of *Ambloplites* was consistently older than either *Lepomis* or *Micropterus* (Table 7). Of the latter two genera, *Micropterus* consistently had the youngest mean age. During the winter, scales from older centrarchids were more common in scats collected from the downstream reaches of the river (Figure 2). During the summer, the small sample size of centrarchids precluded any comparison (Figure 3).

During the winter seasons, both the family Percidae and Fundulidae occurred most frequently in the scats from tributary reaches of both rivers. However, during the summer seasons, no patterns were observed. While Catostomidae occurred in only 2.4% of all the summer samples, their frequency of occurrence increased during the winter seasons to 7.21% and 4.09% of all Big Piney and Osage Fork samples, respectively. The Sciaenidae, Clupeidae, and Ictaluridae and Cottidae always occurred at frequencies less than 5%, regardless of season or river.

Crayfish remains were recovered in 74.4% of all winter season Big Piney samples and 91.7% of all winter season Osage Fork samples (Table 1). The frequency of occurrence of crayfish during the summer seasons increased to 99.21% and 99.9% for all samples from the Big Piney River and Osage Fork

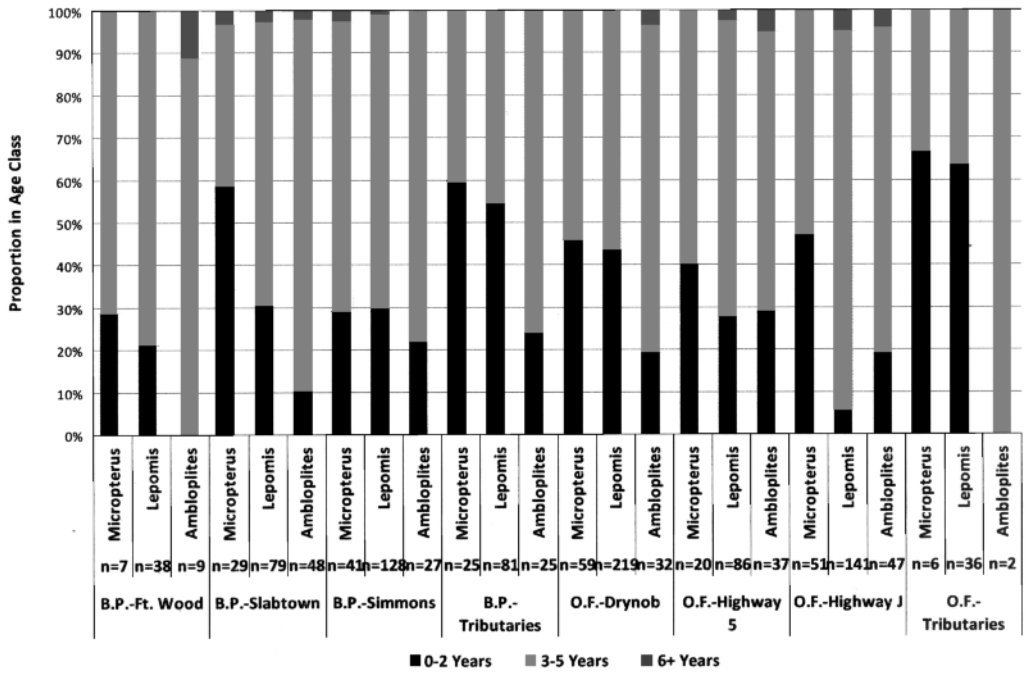

FIGURE 2. Age distributions of Centrarchidae genera in otter scats collected from the Big Piney River (B.P.) and Osage Fork River (O.S) reaches during the winter seasons.

TABLE 3. Frequency of occurrence of families of fish recovered from the scats of otters during the winter seasons on Big Piney River (B.P.) and Osage Fork River (O.S.).

Family	B.P.-Tributaries $n = 243$ % (n)	B.P.-Simmons $n = 213$ % (n)	B.P.-Slabtown $n = 268$ % (n)	B.P.-Ft. Wood $n = 53$ % (n)	B.P. Totals $n = 777$ % (n)
Centrarchidae	68.3 (166)	81.7 (174)	65.7 (176)	84.9 (45)	72.2 (561)
Percidae	27.2 (66)	14.6 (31)	12.3 (33)	5.7 (3)	17.1 (133)
Cyprinidae	16.9 (41)	30.1 (64)	28.7 (77)	28.3 (15)	25.4 (197)
Fundulidae	21.0 (51)	7.5 (16)	7.1 (19)	1.9 (1)	11.2 (87)
Catostomidae	2.1 (5)	10.8 (23)	9.7 (26)	3.8 (2)	7.2 (56)
Sciaendiae	0.0 (0)	0.5 (1)	1.5 (4)	0.0 (0)	0.6 (5)
Clupeidae	0.0 (0)	0.0 (0)	0.0 (0)	3.8 (2)	0.3 (2)
Scaleless	1.2 (3)	0.9 (2)	1.1 (3)	0.0 (0)	1.0 (8)
Unknown	1.65 (4)	1.4 (3)	0.0 (0)	1.9 (1)	1.0 (8)
	O.F.-Tributaries $n = 149$ % (n)	O.F.-Highway J $n = 420$ % (n)	O.F.-Highway 5 $n = 255$ % (n)	O.F. Drynob $n = 619$ % (n)	O.F. Totals $n = 1443$ % (n)
Centrarchidae	52.4 (78)	67.9 (285)	62.0 (158)	65.1 (403)	64.0 (924)
Percidae	65.1 (97)	19.1 (80)	29.8 (76)	34.7 (215)	32.4 (468)
Cyprinidae	12.8 (19)	17.1 (72)	9.4 (24)	9.2 (57)	11.9 (172)
Fundulidae	38.3 (57	11.7 (49)	5.5 (14)	4.7 (29)	10.3 (149)
Catostomidae	4.7 (7)	5.4 (23)	4.3 (11)	2.9 (18)	4.1 (59)
Sciaendiae	0.0 (0)	0.2 (1)	2.4 (6)	2.6 (16)	1.6 (23)
Clupeidae	0.0 (0)	0.5 (2)	0.0 (0)	0.2 (1)	0.2 (3)
Scaleless	0.0 (0)	4.1 (17)	3.9 (10)	1.9 (12)	2.7 (39)
Unknown	4.0 (6)	3.3 (14)	1.6 (4)	1.8 (11)	2.4 (35)

TABLE 4. Frequency of occurrence of families of fish recovered from the scats of otters during the summer seasons on Big Piney River (B.P) and Osage Fork River (O.S.).

Family	B.P.-Tributaries $n = 427$ % (n)	B.P.-Simmons $n = 317$ % (n)	B.P.-Slabtown $n = 370$ % (n)	B.P.-Ft. Wood $n = 23$ % (n)	B.P. Totals $n = 1137$ % (n)
Centrarchidae	8.0 (34)	12.3 (39)	7.6 (28)	21.7 (5)	9.3 (106)
Percidae	0.2 (1)	1.3 (4)	1.1 (4)	0.0 (0)	0.8 (9)
Cyprinidae	0.9 (4)	1.9 (6)	0.0 (0)	0.0 (0)	0.9 (10)
Fundulidae	1.2 (5)	0.0 (0)	0.5 (2)	4.4 (1)	0.7 (8)
Catostomidae	0.0 (0)	0.0 (0)	0.5 (2)	0.0 (0)	0.2 (2)
Sciaendiae	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Clupeidae	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Scaleless	2.3 (10)	3.2 (10)	1.6 (6)	0.0 (0)	2.3 (26)
Unknown	2.1 (9)	0.3 (1)	1.6 (6)	0.0 (0)	1.4 (16)
	O.F.-Tributaries $n = 490$ % (n)	O.F.-Highway J $n = 367$ % (n)	O.F.-Highway 5 $n = 126$ % (n)	O.F. Drynob $n = 410$ % (n)	O.F. Totals $n = 1393$ % (n)
Centrarchidae	8.2 (40)	9.0 (33)	10.3 (13)	3.9 (16)	7.3 (102)
Percidae	4.3 (21)	1.6 (6)	0.8 (1)	1.5 (6)	2.4 (34)
Cyprinidae	0.8 (4)	0.5 (2)	1.6 (2)	0.7 (3)	0.8 (11)
Fundulidae	0.2 (1)	0.5 (2)	4.0 (5)	0.7 (3)	0.8 (11)
Catostomidae	0.8 (4)	0.0 (0)	0.0 (0)	0.0 (0)	0.3 (4)
Sciaendiae	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Clupeidae	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Scaleless	2.5 (12)	2.5 (9)	2.4 (3)	4.2 (17)	2.9 (41)
Unknown	1.8 (9)	1.4 (5)	1.6 (2)	0.5 (2)	1.3 (18)

TABLE 5. Frequency of occurrence of Centrarchidae genera in otter scats collected during the winter seasons on Big Piney River (BP) and Osage Fork River (O.S.).

Genus	B.P.-Tributaries $n = 243$ % (n)	B.P.-Simmons $n = 213$ % (n)	B.P.-Slabtown $n = 268$ % (n)	B.P.-Ft. Wood $n = 53$ % (n)	B.P.-Totals $n = 777$ % (n)
Micropterus	9.5 (23)	17.8 (38)	10.1 (27)	13.2 (7)	12.2 (95)
Lepomis	28.8 (70)	48.4 (103)	25.8 (69)	56.6 (30)	35.0 (272)
Ambloplites	10.3 (25)	11.3 (24)	16.4 (44)	17.0 (9)	13.1 (102)
Indiscernible	46.5 (113)	44.6 (95)	40.7 (109)	47.2 (25)	44.0 (342)
	O.F.-Tributaries $n = 149$ % (n)	O.F.-Highway J $n = 420$ % (n)	O.F.-Highway 5 $n = 255$ % (n)	O.F.-Drynob $n = 619$ % (n)	O.F.-Totals $n = 1443$ % (n)
Micropterus	4.0 (6)	11.4 (48)	7.5 (19)	9.2 (57)	9.0 (130)
Lepomis	19.5 (29)	39.5 (166)	27.1 (69)	29.7 (184)	31.1 (448)
Ambloplites	1.3 (2)	11.0 (46)	13.7 (35)	4.9 (30)	7.8 (113)
Indiscernible	38.3 (57)	44.5 (187)	37.7 (96)	46.2 (286)	43.4 (626)

River respectively (Table 2). No distinct spatial pattern was observed between reaches for either river.

Mammals and birds both occurred at low frequencies (< 5%) and occurred most commonly during the summer seasons (Tables 1 and 2). Both occurred most frequently in the upstream reaches of the rivers. All mammals encountered were Muskrats (*Ondatra zibethicus*) with the exception of one Beaver (*Castor canadensis*) that occurred on a tributary reach of the Big Piney River during the winter season. The birds encountered were few in number and not identified.

Amphibians were frequently encountered in both seasons; however, amphibians were slightly more common during the summer season (Tables 1 and 2). With the exception of the Fort Leonard Wood reach of the Big Piney River during the summer seasons, amphibians were more common in the upstream reaches of the river. Reptiles were rarely encountered and occurred in < 0.5% of samples. The reptiles encountered consisted of four snakes and one turtle.

TABLE 6. Frequency of occurrence of Centrarchidae genera in otter scats collected during the summer seasons on Big Piney River (B.P.) and Osage Fork River (O.S.).

Genus	B.P.-Tributaries $n = 427$ % (n)	B.P.-Simmons $n = 317$ % (n)	B.P.-Slabtown $n = 370$ % (n)	B.P.-Ft. Wood $n = 23$ % (n)	B.P.-Totals $n = 1137$ % (n)
Micropterus	0.0 (0)	0.6 (2)	0.0 (0)	0.0 (0)	0.2 (2)
Lepomis	0.7 (3)	3.2 (10)	1.4 (5)	4.4 (1)	1.7 (19)
Ambloplites	0.5 (2)	0.3 (1)	0.3 (1)	0.0 (0)	0.4 (4)
Indiscernible	7.5 (32)	11.0 (35)	6.5 (24)	21.7 (5)	8.4 (96)
	O.F.-Tributaries $n = 490$ % (n)	O.F.-Highway J $n = 367$ % (n)	O.F.-Highway 5 $n = 126$ % (n)	O.F.-Drynob $n = 410$ % (n)	O.F.-Totals $n = 1393$ % (n)
Micropterus	0.0 (0)	0.0 (0)	0.0 (0)	0.2 (1)	0.1 (1)
Lepomis	0.6 (3)	1.4 (5)	0.0 (0)	0.2 (1)	0.7 (9)
Ambloplites	0.0 (0)	0.8 (3)	0.0 (0)	0.0 (0)	0.2 (3)
Indiscernible	7.6 (37)	7.4 (27)	10.3 (13)	3.9 (16)	6.7 (93)

TABLE 7. Mean age of Centrarchidae genera by river and season

	River and Season			
	Big Piney Winter	Osage Fork Winter	Big Piney Summer	Osage Fork Summer
Micropterus	2.6 ($n = 103$)	2.5 ($n = 136$)	2 ($n = 2$)	3 ($n = 1$)
Lepomis	2.9 ($n = 326$)	2.7 ($n = 554$)	2.9 ($n = 20$)	3.2 ($n = 9$)
Ambloplites	3.3 ($n = 109$)	3.3 ($n = 118$)	3.25 ($n = 4$)	3.33 ($n = 3$)

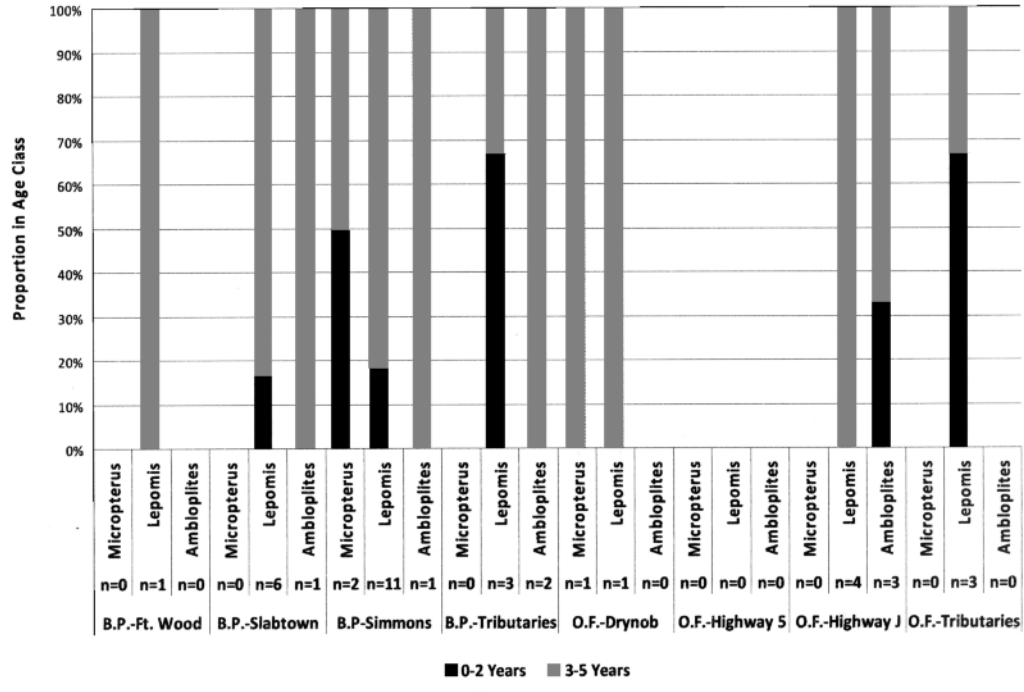

FIGURE 3. Age distributions of Centrarchidae genera in otter scats collected from the Big Piney River (B.P.) and Osage Fork River (O.S) reaches during the summer seasons.

Discussion

During the summer, crayfish compose the majority of the diet, while during the winter the frequency of fish surpassed crayfish on the Big Piney River and was comparable to the frequency of crayfish on the Osage Fork River. This seasonal shift in otter diet has been observed in Illinois (Anderson and Woolf 1987). Crayfish, while not absent, are less active and available during the winter seasons (Muck et al. 2002). The decreased availability of crayfish combined with the tendency of fish to be less active and slower during the winter (Wardle 1980) may be the reason that increased fish predation is observed during the winter season.

The importance of fish in diets of Ozark otters is similar to other studies conducted during winter seasons spanning five decades (Lagler and Ostenson 1942; Wilson 1954; Ryder 1955; Hamilton 1961; Sheldon and Toll 1964; Knudsen and Hale 1968; Grenfell 1974; Toweill 1974; Lauhachinda 1978; Gilbert and Nancekivell 1982; Reid et al. 1994). Surprisingly, there was little spatial variation in prey taxa occurrence for either river. Crayfish were a more common diet item in the upper reaches of the Osage Fork River, but this trend was not observed on the Big Piney River. Larger fish are less common in upper reaches of streams and probably account for the high frequency of crayfish in otter diets from these reaches (Schlosser 1987).

The family Centrarchidae was the most frequently occurring family in the diet during both seasons in both rivers. Estimates of fish communities on Courtois Creek, an Ozark stream assumed to be representative of typical small to medium-sized Ozark streams had approximately 32% more standing crop of Catostomidae than Centrarchidae (Fajen 1975). Despite this, Catostomidae occurred in the diet much less frequently than Centrarchidae. Other studies have concluded that centrarchid fish are preyed on disproportionately because centrarchids occur in areas where otters forage, such as the littoral zone (Greer 1955; Ryder 1955; Sheldon and Toll 1964). Both Smallmouth Bass and Rock Bass avoid open water in favor of cover (rootwads, log complexes, logs) occurring near the shoreline (Probst et al. 1984). The findings of this study also suggest that otters prey disproportionately on certain centrarchid species because of the latter's tendency to inhabit areas where otters forage.

The high relative frequency of *Lepomis* compared to *Micropterus* and *Ambloplites* is likely a function of high relative densities of *Lepomis* species in Ozark streams. In Courtois Creek, there were approximately 887% more *Lepomis* than *Micropterus* and approximately 851% more *Lepomis* than *Ambloplites* (Fajen 1975).

Fish communities vary longitudinally (Schlosser 1987). However, very little spatial variation in diet was observed for most of the fish families, except Fundulidae and Percidae. During the winter seasons both families occurred more commonly in scats from the upper reaches of the stream. Both of these families are composed of small fishes in Ozark streams. Darters (*Etheostoma* spp.) are the common Percidae found in these Ozark streams. Larger streams support a variety of habitat types that, in turn, can support an increased species diversity and species richness (Schlosser 1987). Lower order reaches of rivers have fish communities composed primarily of small fishes. The spatial trends observed for Fundulidae and Percidae in otter diets are probably a function of the longitudinal gradient in fish communities.

The frequencies of crayfish recorded during the summer seasons were higher than in any previous study conducted on river systems (Lagler and Ostenson 1942; Wilson 1954; Ryder 1955; Hamilton 1961; Knudsen and Hale 1968; Grenfell 1974; Toweill 1974; Gilbert and Nancekivell 1982; Reid et al. 1994). The relatively high occurrences of crayfish are likely a result of the fact that the Missouri Ozarks have some of the highest densities of crayfish reported in the United States (DiStefano 1993). Crayfish are consumed during both the winter and summer seasons, although they occur in the otter diet much more frequently during the summer season. The two species of crayfish that inhabit the study area, *Orconectes punctimanus* and *Orconectes luteus*, do not burrow during the winter (Pflieger 1996); a life-history characteristic that results in these two species always being available for otters.

The frequencies of amphibians and reptiles in Ozark diets are similar to those reported in other regions (Lagler and Ostenson 1942; Wilson 1954; Ryder 1955; Hamilton 1961; Knudsen and Hale 1968; Toweill 1974; Lauhachinda 1978; Anderson and Woolf 1987). In the present study, one turtle was identified in a sample collected during the summer. Although otters were observed consuming a large terrapin in Florida (Stophlet 1947), with this one exception, no previous evidence of otter predation on turtles has been reported in otter diets, even in areas where turtles were abundant (Greer 1955; Grenfell 1974; Toweill 1974; Lauhachinda 1978).

Mammals and birds were encountered more frequently during the summer but never occurred at frequencies greater than 5% during either season. These results are similar to several previous studies (Wilson 1954; Greer 1955; Hamilton 1961; Sheldon and Toll 1964; Knudsen and Hale 1968; Grenfell 1974; Toweill 1974; Lauhachinda 1978). Higher frequencies of mammal remains were found in the diets of otters in Alberta, Canada (Gilbert and Nancekivell 1982). The low frequencies of mammal remains in Ozark otter diets suggest that birds and mammals are not an important prey item for River Otters and are probably utilized only opportunistically.

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