

Effects of Food Resources on Spacing Behavior of River Otters: Does Forage Abundance Control Home-Range Size?

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ABSTRACT

We use three analytical techniques to examine home-range dynamics of river otters in Prince William Sound, Alaska, USA, from February 1997 to January 1998, and discuss problems with analysis of linear home ranges. River otters inhabiting marine environments where fish were abundant had smaller home ranges than animals living in freshwater systems with fewer prey, whereas otters using multiple salmon runs had larger home ranges than otters in other habitats.

INTRODUCTION

River otters (*Lutra canadensis*) in Prince William Sound, Alaska, USA, occur at densities of 28-80 animals/100 km of shoreline (Testa et al. 1994), with home ranges that encompass about 20-40 km of shoreline (Bowyer et al. 1995). These otters forage intensively in intertidal and subtidal zones where they prey principally on marine fish (Larsen 1984, Bowyer et al. 1994, Ben-David et al. 1996, 1998). River otters living in this marine environment form large social groups (≤ 18 individuals; Rock

et al. 1994, Testa et al. 1994), but little is known about their spatial relationships or social structure.

We tested the hypothesis that home-range dynamics and other spatial relationships of otters would be related to availability and distribution of their primary prey (fish). We present telemetry analyses using three techniques for calculating home-range area because no single method is suitable for all purposes—the technique most appropriate to use depends upon the hypotheses being tested (Harris et al. 1990) and data collected. Estimates of kernel density define a utilization distribution by assessing the probability that an animal will occur at particular points in space. Kernel estimators are nonparametric and can estimate densities of any shape (Seaman and Powell 1996) by supplying a third dimension representing the amount of time an animal spent in any given area (Seaman et al. 1999); thus these methods are useful for examining the internal structure within home ranges, particularly core areas of use that may be important for foraging or den sites. Kernel estimates, however, are sensitive to autocorrelation (Harris et al. 1990) and changes in smoothing parameters (Worton 1995), and may result in over estimation of the area used (Seaman and Powell 1996). Furthermore, kernel estimates were developed for analysis of spatial data occurring in two dimensions and are problematic for analysis of animals with primarily unidimensional patterns of movement such as river otters, which use a narrow aquatic-terrestrial ecotone (Sauer et al. 1999). Minimum convex polygons (MCP) do not have underlying assumptions of distribution, are not affected by autocorrelation (Harris et al. 1990), and are the oldest and most common method for estimating home ranges (White and Garrott 1990, Seaman et al. 1999). The MCP technique uses the outer points in the spatial distribution to define the boundaries of the home range and may contain large areas that are never used, especially for animals that move in unidimensional space.

For purposes of comparison with other studies of river otters (Green et al. 1984, Reid 1994), we present area calculations for MCP, and Adaptive Kernel (ADK) estimates. We also use Geographical Information System (GIS) ArcInfo, (Redlands, California) to calculate kilometers of shoreline within each of these area estimates using a method described by Sauer et al. (1999).

METHODS

Capture, Tagging, and Tracking

We live-captured river otters using both Hancock and leg-hold traps (Blundell et al. 1999) in spring and early summer 1996-1997. Traps were

placed in blind sets (i.e., no bait or lure) on trails at latrine sites and monitored by means of trap transmitters (Telonics, Mesa, Arizona, USA) that signaled when a trap had been sprung. River otters were anesthetized with Telazol (9mg/kg; A. H. Robins, Richmond, Virginia, USA) administered by hand injection for otters captured in Hancock traps and with Telinject darts and a blowgun for otters captured in leg-hold traps. We surgically implanted river otters with telemetry transmitters (Model IMP/400/L, Telonics, Mesa, Arizona) inserted into the peritoneal cavity through an incision made on the right side, posterior to the last rib. Each muscle layer was closed separately with simple-interrupted sutures, and the skin was closed with a continuous subcuticular suture line. As a final precaution, the skin incision was sealed with surgical glue. We implanted 17 otters (12 males, 5 females) in 1996 in the Jackpot Bay area and 8 river otters (5 males, 3 females) in 1997 in this area. Twelve otters (8 males, 4 females) were implanted with radio transmitters in Herring Bay in 1997. All radio tracking in 1996 was conducted from a boat, resulting in only partial home-range information for otters using freshwater systems. For this reason, we only report data collected using aerial tracking. Otters were radio tracked from a small fixed-wing aircraft from February 1997 to January 1998 ($n = 29$ occasions). Once a telemetered otter was located, Geographic Positioning System (GPS) coordinates were recorded by flying the plane directly over the location and recording latitude and longitude. Additionally, point locations for each otter were plotted on United States Geological Survey (USGS) maps (1:63360 scale) to provide a secondary source of location information in the event of an error in recording GPS locations. When otters were observed engaging in foraging activity, their location, distance from shore, and group size was recorded. All methods used in this research were approved by an Institutional Animal Care and Use Committee at the University of Alaska Fairbanks.

Prey Availability

We conducted scuba-diving transects in July of 1996 and 1997 in both study areas to assess fish abundance at otter latrine sites ($n = 15$ sites/year) and at random sites ($n = 15$ sites/year). Fish were counted along two 30-m transects/site and categorized into eight family groups and three size classes (<8 cm, 8-15 cm, >15 cm). We also assessed six random and six latrine sites in the freshwater system.

Analysis

We used CALHOME (Kie et al. 1996) to estimate home ranges (ADK and MCP) and GIS-ArcInfo to calculate shoreline distances within these polygons (Sauer et al. 1999). We arbitrarily selected 50% ADK contours to examine core areas of use.

RESULTS

We obtained sufficient locations ($n = 657$ locations; $n = 25$ locations per otter) to assess home-range size for 29 river otters (20 males, 9 females) from February 1997 to January 1998. River otters inhabiting our study areas used three general habitat-prey associations: marine, fresh water, and areas with salmon runs. Prey abundance in the marine system did not differ between study areas, so we combined data from both areas to test for differences in sizes of home range between otters using different habitat-prey associations, and differences in home-range size between genders.

River otters inhabiting marine environments, where fish were abundant, had smaller home ranges than otters living in freshwater systems with fewer prey, whereas otters using multiple runs of salmon, which were geographically dispersed, had larger home ranges than otters in either marine or freshwater habitats (Table 1). Shoreline within the freshwater habitat is underrepresented because locations in secondary and tertiary tributaries did not result in creek shoreline being measured near these locations.

Table 1. Differences in home ranges for river otters inhabiting different habitats in Prince William Sound, Alaska, USA, (February 1997 – January 1998), pooling data from both sexes and both study areas (P-values from one-way ANOVA).

HOME RANGE ANALYSIS	HOME-RANGE ESTIMATES									P-value
	MARINE			FRESH WATER			SALMON RUNS			
	n	SD		n	SD		n	SD		
Adaptive Kernel (ADK) 50% Ha	21	571	764	4	666	284	4	3648	566	0.000
Adaptive Kernel (ADK) 95% Ha	21	4255	5994	4	5327	4547	4	21185	2508	0.000
Min. Convex Polygon 95% Ha	21	3083	6548	4	3400	3080	4	9227	1728	0.175
Km Shoreline within 50% ADK	21	7	6	4	4	3	4	15	17.8	0.018
Km Shoreline within 95% ADK	21	40	49	4	25	10	4	97	12	0.046

Males had significantly larger home ranges for both 95% estimates and core areas (50%) than did females in both marine and freshwater environments (Table 2), but the proportion of the 95% area contained within the core area tended to be greater for females than for males (Table 3).

Table 2. Difference in size of home ranges for female and male otters in Prince William Sound, Alaska, USA, (February 1997 – January 1998), pooling data from all habitats and both study areas (P-values from one-way ANOVA).

HOME-RANGE ANALYSIS	HOME-RANGE ESTIMATES						P-value
	FEMALES			MALES			
	n	SD		n	SD		
Adaptive Kernel (ADK) 50% Ha	9	232	200	20	1357	1396	0.024
Adaptive Kernel (ADK) 95% Ha	9	1207	637	20	9227	8490	0.009
Minimum Convex Polygon 95% Ha	9	674	389	20	5459	6805	0.046
Km Shoreline within 50% ADK	9	4	4	20	10	6	0.016
Km Shoreline within 95% ADK	9	15	7	20	60	51	0.015

Table 3. Proportion (50% ADK/ 95% ADK) of the shoreline distance in the entire home range (95% Adaptive Kernel; ADK) represented in the core area of use (50% ADK) for otters in our study areas in Prince William Sound, Alaska, USA, (February 1997 – January 1998).

SEX	MARINE		FRESH WATER
	Herring Bay	Jackpot Bay	Jackpot Bay
Females	20.6%	39.9%	24.3%
Males	12.8%	24.1%	17.7%

River otters in Prince William Sound exhibited intersexual overlap of home ranges but intrasexual patterns differed between the genders. Female otters had low spatial overlap and most appeared to have exclusive core areas of use, whereas male otters showed a substantial overlap in home-range areas including overlap of male-group home ranges with those of other male groups and with solitary males (50% Adaptive Kernel; Figure 1).

Each method of home-range analysis showed similar trends although MCP estimates were more conservative in both area and shoreline estimates (Table 1 and Table 2) than ADK estimates. Standard methodologies for calculating home-range areas may not be appropriate for use in river otters because otters use narrow strips of habitat associated with the aquatic-terrestrial ecotone (Figure 2).

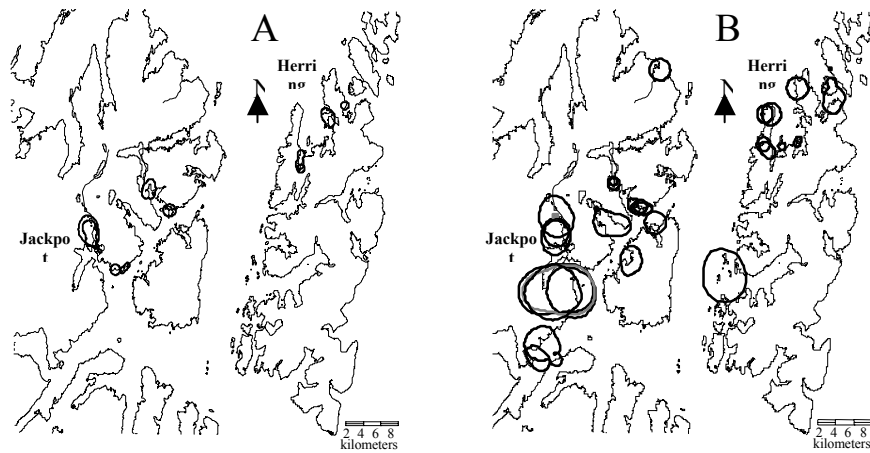


Figure 1. Core areas of use (50% Adaptive Kernel) for female (A) and male (B) river otters in Prince William Sound, Alaska, USA (February 1997 - January 1998). In most instances core areas for females did not overlap. Males (both solitary and males in groups) had substantial overlap in core areas.

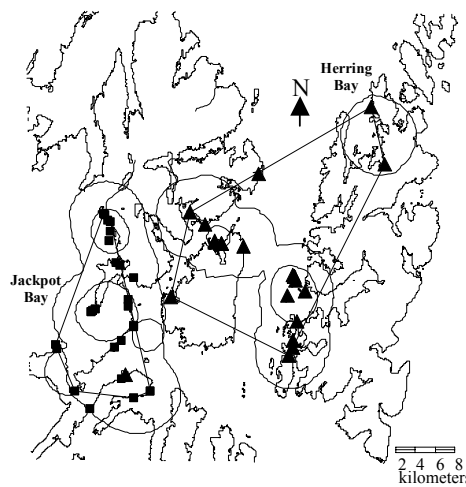


Figure 2. Adaptive Kernel contours (95% and 50%) and minimum convex polygons (95%) for two otters in Prince William Sound, Alaska, USA (February 1997 - January 1998), showing different patterns of movement. Symbols are the telemetry locations for each otter.

DISCUSSION

We suggest that the social structure of river otters (males primarily in groups, females mostly solitary) is resource related and has a strong influence on spatial relationships, home-range size, and diet. Spatial organization in solitary Carnivora is believed to be resource related (Sandell 1989), with distribution of females determined by food availability, and male distribution, at least during mating season, dependent upon female dispersion. Female river otters tended to have larger core areas relative to total home-range area (Table 3), suggesting that a larger proportion of their home ranges may be important for foraging. Our sample size for females, however, is small and we may not have a complete representation of space use for this gender.

The sexual dimorphism in our system is not pronounced. Males range from 10-13% larger than females in length:weight ratios, yet their home ranges in all habitats ranged from two to ten times larger than those of females (Table 2). We suggest that larger home ranges for males is more likely related to females as a resource, because males use areas much larger than would be needed to support their metabolic needs (McNab 1963, Sandell 1989). Moreover, a smaller proportion of their total area is contained in the core for males compared with females, the area presumably of greatest importance to individuals. Additionally, we suggest that male otters traveling in groups may be foraging cooperatively. Indeed, the otters using numerous salmon runs were a group of males that traveled together once the salmon started to spawn. These males traveled greater distances than males using other resources, but salmon runs provided rich sources of prey, likely compensating for the distance traveled.

Seaman and Powell (1996) concluded that Adaptive Kernel estimates resulted in overestimation of area, and this may be occurring in our results here (Figure 2). Nonetheless, the comparison of relative size of home ranges between genders and different habitat-prey associations that we present herein still provide valid assessments, and information on spatial relationships is largely independent of analysis technique.

We hypothesize that the distribution of prey, rather than simply abundance of forage, has a substantial effect on spacing behavior of otters. We will further explore this and similar hypotheses by testing for seasonal shifts in home ranges using additional radio telemetry locations and we will investigate seasonal variation in abundance of marine fish at otter latrines and random locations. We also will use microsatellite DNA to examine the effect of genetic-relatedness on spatial relationships of river otters, and perhaps gain some insight into which males (social or solitary) gain reproductive opportunities.

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