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AVAILABILITY OF SUITABLE HABITAT FOR NORTHERN RIVER OTTERS IN SOUTH DAKOTA

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ABSTRACT—Currently, the northern river otter (*Lontra canadensis*) is listed as a threatened species in South Dakota. We determined whether adequate habitat was available for reintroducing river otters in South Dakota. The 17 rivers/creeks included in the analysis were selected according to stream size, water gradient, and water permanence. A vegetation transect was conducted and a water sample was collected at each study site, ranging from one to four per river. Rivers/creeks were rated (1 = least suitable to 5 = most suitable) according to habitat requirements of river otters in the following categories: stream characteristics, watershed features, water quality, prey availability, and other factors. Based on the habitat survey and rating criteria, rivers/creeks with high ratings have sufficient riparian habitat (vegetation bordering water), water quality, and prey availability for river otters. The five highest-rated rivers were the Bad, Big Sioux, James, North Fork of the Whetstone, and Little White.

Key Words: *Lontra canadensis*, northern river otter, prey availability, reintroduction, riparian habitat, river/creek, South Dakota, water quality

Introduction

Historically, northern river otters (*Lontra canadensis*) occupied all major waterways of the United States and Canada (Halbrook 1978; Hall

1981; Jones et al. 1983; Lariviere and Walton 1998). Currently, river otters are abundant in Alaska, most of Canada, the Pacific Northwest, the Great Lakes region, and most states along the Atlantic Coast and Gulf of Mexico (Hall 1981). Two decades ago, river otters were protected in 17 states either as a threatened or endangered species (Melquist and Hornocker 1983). Because of reintroduction efforts by individual wildlife agencies, the number of states that legally protect river otters has been reduced to seven.

Formerly, river otters inhabited riparian areas and permanent bodies of water throughout South Dakota (Choate and Jones 1981; Jones et al. 1985). In the late 1800s, river otters were extirpated from South Dakota's waters due to extensive trapping and loss of habitat (Over and Churchill 1941; Choate and Jones 1981; Jones et al. 1983; Jones et al. 1985). In the last 25 years, there have been only 34 verified sightings of river otters in South Dakota (Kiesow and Dieter 2003). The river otter is protected as a threatened species in South Dakota (Ashton and Dowd 1991). Consequently, there is increased interest in restoring river otters to their native range in South Dakota. Our project was initiated to determine the likelihood of a successful river otter reintroduction program in South Dakota using habitat and water quality data of major rivers/creeks in order to ascertain whether these waterways provide suitable habitat for river otters.

Methods

South Dakota lies in the Northern Great Plains and is dissected by many rivers, streams, and creeks. Natural ecosystems include northern floodplain forest, tallgrass prairie, mixed-grass prairie, shortgrass prairie, and ponderosa pine (*Pinus ponderosa*) woodland (Jones et al. 1985).

We selected specific waterways based on three habitat requirements of river otters: (1) stream orders 3 through 7 (large rivers) according to the Strahler Order stream order system (Murphy and Willis 1996), (2) permanent water flow, and (3) low gradient (slow-moving waters) (Mack 1985; Bradley 1986; Johnson and Madej 1994; Reid et al. 1994). Waterways that were selected included the Big Sioux River, James River, Vermillion River, Missouri River, Little Minnesota River, Jorgensen River, North Fork of the Whetstone River, Moreau River, Grand River, Virgin Creek, Cheyenne River, Bad River, Medicine Creek, White River, Little White River, Rapid Creek, and Belle Fourche River (Fig. 1).

We selected one to four study sites per river/creek based on habitat availability, river/creek accessibility, beaver (*Castor canadensis*) activity,

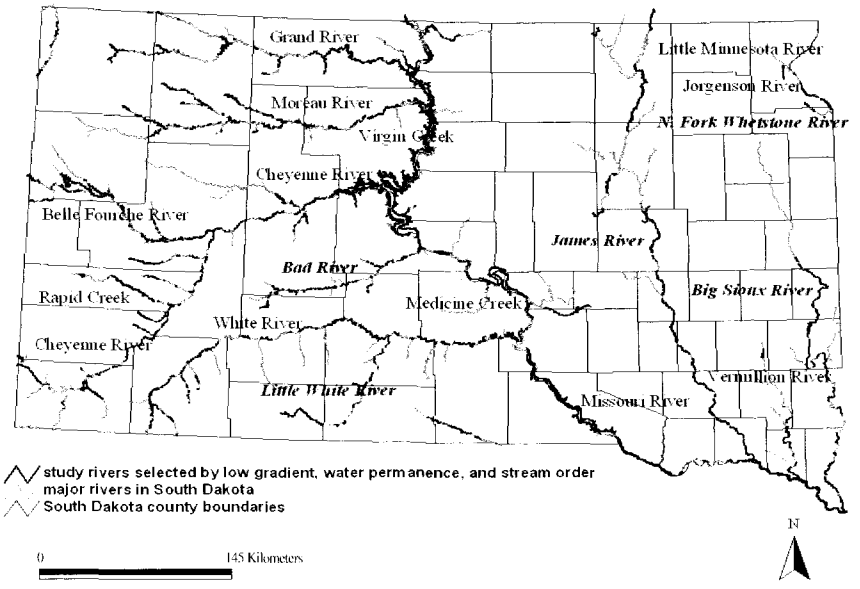

Figure 1. Rivers/creeks selected (as indicated by the blackened sections) in South Dakota as determined by permanent water flow, stream orders 3 through 7, and low gradient. From these, study sites were selected for conducting habitat and water quality surveys during 2001 in order to determine the suitability of the habitat for river otters. The names of the five rivers recommended for release sites of river otter, as determined by overall river ratings, are italicized.

and past river otter sightings, depending on the length of the river/creek. At each study site we surveyed one habitat transect for floral and faunal species, including non-fish prey. Habitat transects were less than 5 m inland from the high water mark on each river/creek, and the centerline (of the transect) measured 50 m long with six 10 m perpendicular lines intersecting it every 10 m. At each study site, one water sample was collected to measure the water quality variables pH, nitrogen (nitrate-nitrogen [mg/l]), phosphorus (orthophosphate [mg/l]), dissolved oxygen (ppm), and alkalinity (methyl-orange [mg/l]). Additional water measurements included temperature (°C) and secchi depth (m) (distance to which light penetrates water).

Other data collected were as follows: presence of tributaries, rivers/creeks, or wetlands associated with each selected river/creek; presence of beavers and river otters; percentage of ground cover (undergrowth vegeta-

tion); percentage of canopy cover; fish census; and Global Positioning System (GPS) location. Percentage ground cover was segmented into several categories (graminoid [grasses, sedges, and rushes], forb, shrub, and other [litter]), but only ground cover of graminoid species per river/creek was considered for evaluating suitability of habitat for river otter use. Fish census data were provided through past work on major river systems throughout South Dakota (Berry et al. 1993; Lott et al. 1993; Schmulbach and Braaten 1993; Dieterman and Berry 1994; Hampton and Berry 1997; Dieterman and Berry 1998; Loomis et al. 1999; Fryda 2001; Milewski 2001). Furthermore, land use and cover maps were used to aid in rating rivers/creeks for the potential use (of these rivers/creeks) by river otters and to identify possible release sites (on rivers/creeks with high ratings) for reintroduction purposes.

After our fieldwork was completed, the average collected values for each river/creek were rated 1 (least suitable for river otters) through 5 (most suitable for river otters) or 1, 3 (median suitability), and 5 based on the range of values in each of the following criteria: (1) stream characteristics, such as varying water depth and suitable bank cover; (2) watershed features, such as presence of beaver populations and suitable wetlands nearby (1 km either direction from the study sites); (3) water quality; (4) prey availability, such as fish populations and other aquatic species; and (5) other factors, such as private or public ownership (Appendix). Some of these criteria were adopted from past feasibility studies, for example, Bich (1988) and Johnson and Madej (1994), but were not used to formulate a model such as Habitat Suitability Index (HSI). Thus, HSI models are not discussed in this paper. For example, turbidity/secchi depth (a stream characteristic) was rated as follows: 1 = shallowest depth, 2 = <20 cm (deep), 3 = 20 to 40 cm, 4 = >40 cm, and 5 = deepest depth. Values of the rates for each criterion are available in the Appendix.

Results and Discussion

Nearly all rivers/creeks have a high percentage of canopy and ground cover (≥55% when combined) in the riparian areas, which is valuable habitat for river otters. Most plant families in the riparian areas were Asteraceae (sunflower), Poaceae (grass), Fabaceae (bean), Salicaceae (willow), Rosaceae (rose), Vitaceae (grape), Aceraceae (maple), Lamiaceae (mint), and Asclepiadaceae (milkweed). Canopy cover of trees and tall shrubs ranges

from 0% to 29%, while ground cover of graminoid vegetation ranges from 11% to 40%.

Suitable habitat for river otters consists of waterways with adequate riparian vegetation, including canopy and ground cover (Mowbray et al. 1976), so rivers with a high percentage of canopy and ground cover receive high ratings (according to this rating system). The riparian vegetation along the rivers/creeks in South Dakota consists primarily of graminoid and tree species. The percentage of cover, particularly graminoid cover, along most rivers/creeks should provide sufficient cover for river otter use because of a high percentage of canopy and ground cover. Presence of adequate ground cover, especially graminoid species, is more important than forest canopy cover due to the habits of river otters (Waller 1992). However, Waller (1992) stated that the presence of tree canopy is important in winter. Ninety-three percent of the sites occupied by river otters in northwestern Montana had tree canopy, primarily consisting of birch and cottonwood trees (Waller 1992). Consequently, rivers/creeks with a high percentage of canopy and ground (graminoid) cover provide good habitat as protective cover and as potential den-sites or resting areas for river otters.

River otters use riparian areas with low to moderate bank slopes that contain bank dens and other habitat created by beavers (Malville 1990; Waller 1992). The banks of rivers/creeks in South Dakota range from gently to steeply sloped, but most rivers/creeks are moderately sloped and possess bank dens created by other animals, primarily coyote (*Canis latrans*) and beaver. Beaver activity is found in nearly every major waterway in South Dakota (Smith 2001). Therefore, ample den-sites should be available for river otters, particularly for rearing young. In addition, beavers produce lodges and cut down trees, creating in-stream structures. River otters typically select areas with waterway obstructions for resting and feeding areas (Dronkert-Egnew 1991). Thus, rivers/creeks with moderate slopes and high beaver activity receive high ratings.

Ratings for water quality (based on the measured variables) are relatively similar between rivers/creeks, but some parameters show differences. The four most important water quality parameters for evaluating habitat for river otters are water clarity (or secchi depth), alkalinity, nitrogen, and phosphorus. Rivers/creeks with low ratings for water quality are very alkaline, have high levels of phosphorus (orthophosphates) and nitrogen (nitrates), and often experience more disturbances from land-use practices (e.g., agriculture and urbanization) within their watersheds. Secchi depth

ranges from 0.01 to 0.9 m. Alkalinity ranges from 140 to 740 mg/l, phosphorus ranges from 0.7 to 6.3 mg/l, and nitrogen ranges from 0.01 to 0.26 mg/l. Other water quality parameters (e.g., pH and temperature) show little variability among rivers/creeks, thus they are not factors in evaluating habitat for river otters.

Turbid water conditions are a concern for river otters seeking prey in waterways. Turbidity, measured as secchi depth, reduces the depth to which light can penetrate, limiting primary production (Kohler and Hubert 1999) and affecting the ability of river otters to see underwater. As a result, turbidity affects the hunting efficiency of river otters but does not preclude their use of habitat (Beck 1993). Therefore, river otters should be able to hunt effectively in most rivers/creeks of South Dakota. Even so, rivers with turbid water (or low secchi depths) receive low ratings.

Alkalinity, a measure of the ability of water to resist changes in pH, has a direct effect on freshwater rivers (Stewart et al. 1999). Rivers/creeks in the south central and north central portions of the state have high alkalinity attributable to soils in those areas, and these rivers/creeks are considered "buffered" systems due to their ability to resist changes in pH (Stewart et al. 1999). This buffering system helps maintain a uniform internal environment, thereby sustaining aquatic life. In addition, alkalinity may protect fishes in waterways with high concentrations of dissolved metals (Stewart et al. 1999). Nonetheless, rivers/creeks with high alkalinity receive low ratings. Fish populations appear healthy, according to the diversity of the fisheries (e.g., 9 to 33 fish species per river), and should provide sufficient food to support river otters in alkaline rivers/creeks.

Nitrogen and phosphorus levels vary per river but remain below deleterious levels. If nitrogen in the form of nitrate becomes too high in river systems, aquatic life may suffer because of the unnatural addition of pollutants (nitrate) (Kohler and Hubert 1999). With high phosphorus levels in the form of orthophosphate, some consequences may be the frequent occurrence of algal blooms, a decrease in water transparency, and an increase in submergent and emergent vegetation (in littoral zones) (Kohler and Hubert 1999). Excessive macrophyte abundance can adversely affect predator-prey relationships by providing too much cover for prey or by reducing prey survival (Kohler and Hubert 1999); thus, rivers/creeks with high nitrogen and phosphorus levels receive low ratings.

The one measurement of dissolved oxygen taken at each sample site indicated that no rivers/creeks were below 5 ppm. Typically, oxygen concentrations need to be greater than 2 ppm to support low-oxygen-tolerant

fishes (Kohler and Hubert 1999). Even though dissolved oxygen is highly variable throughout the year, numerous fish species were present in all rivers/creeks, indicating that dissolved oxygen may be sufficient to sustain diverse fish populations.

River otters utilize waterways that are not highly polluted (Griess 1987). Rivers/creeks in South Dakota appear to have adequate water quality, though it tends to fluctuate by waterway, section, season, and year. However, water quality is more important to prey species than to river otters; thus, the presence of prey alone indicates that water quality is sufficient to support river otters. Rivers/creeks in the northeast and extreme west portion of South Dakota have the highest ratings in water quality (e.g., North Fork of the Whetstone River and Belle Fourche River), while rivers/creeks in the southwest have the lowest ratings in water quality (e.g., White River and Rapid Creek).

Fishes, particularly medium to large fishes, are important prey for river otters. Therefore, fish species at least 20 cm long are included as possible prey for river otters (Eddy and Underwill 1982; Neumann and Willis 1994). The number of fish families (per river) ranges from 5 to 14, while the number of fish species ranges from 9 to 33. Common fish families include Catostomidae (sucker), Cyprinidae (minnow), Ictaluridae (bullhead), Percidae (perch), Centrarchidae (sunfish), and Esocidae (pike). Fish species present in most rivers include *Ameriurus* spp. (bullhead), *Ictalurus* spp. (catfish), *Micropterus* spp. (bass), *Poxomis* spp. (crappie), *Cyprinus carpio* (common carp), *Carpiodes carpio* (river carpsucker), *Lepomis macrochirus* (bluegill), *Perca flavescens* (yellow perch), *Esox lucius* (northern pike), and *Catostomus commersoni* (white sucker).

Other aquatic species such as crayfish, mussels, and frogs supplement river otters' diet during the summer. Other prey taxa range from 0 to 4 per site. Common family representatives of other prey include Ranidae (true frogs) and Anodontidae (mussels).

A limiting factor for the survival of river otters is prey base. River otters select areas where prey is available. All rivers/creeks that were sampled in South Dakota have a sufficient number of prey species for river otters, but biomass measurements are not available. Rivers/creeks with a high diversity of fish and non-fish prey receive high ratings, and rivers/creeks with the most diverse prey base are the James River, Vermillion River, and Big Sioux River.

Overall ratings of the studied rivers/creeks (or simply the overall river ratings) are established primarily based on riparian habitat, water quality,

TABLE 1
OVERALL RIVER RATINGS AND INDIVIDUAL CATEGORY RATINGS OF SELECTED RIVERS/CREEKS IN SOUTH DAKOTA

River/Creek	Overall rating*	Stream characteristics	Watershed features	Water quality	Prey availability	Other factors
Bad	75	32	14	11	8	10
Big Sioux	74	35	15	8	7	9
Missouri	73	28	16	10	5	14
James	72	32	16	8	8	8
North Fork Whetstone	72	28	19	11	4	10
Little White	69	28	18	10	4	9
Vermillion	68	29	14	10	9	6
Cheyenne	68	31	14	10	4	9
Jorgenson	68	26	19	10	6	7
Belle Fourche	67	30	12	12	6	7
Moreau	67	26	15	11	7	8
Grand	65	29	13	11	7	5
Medicine	64	25	11	10	9	9
Virgin	63	20	16	11	7	9
Little Minnesota	62	24	15	10	6	7
Rapid	61	26	13	7	4	11
White	60	31	11	6	3	9

Note: Rating scale is 1 (lowest suitability for river otters) to 5 (highest suitability for river otters).
*Maximum rating = 105

and prey availability, as these variables seem to influence habitat selection by river otters. The ratings specify which rivers/creeks in South Dakota are most suitable for river otters (or rather, the five best waterways for river otters based on the available habitat). The overall river ratings range from 60 to 75 points, with the maximum possible rating being 105 points (Table 1). The five highest overall river ratings indicate the most suitable rivers/creeks (of those selected and studied) for river otters based on their habitat requirements, and these rivers/creeks are the Bad River, Big Sioux River, James River, North Fork of the Whetstone River, and Little White River (Fig. 1).

Each of these five rivers appears to have sufficient percentages of canopy and graminoid cover primarily comprised of Poaceae and Asteraceae.

In general, human impact to these rivers is moderate, and stream banks of these rivers are moderately sloped. Water quality varies among rivers, although three out of the five rivers deemed suitable for river otters have water quality that is above average in relation to other rivers/creeks in South Dakota. In all (studied) rivers, the prey base, in terms of suitable prey species and fish length, seems to be adequate to support river otters. All the selected rivers provide additional water sources, such as wetlands and (river) tributaries, for river otters to use. The rivers with the highest overall rating have the greatest chance of sustaining northern river otters and promoting future population growth, though these rivers could be the best of a selection of unsuitable rivers/creeks rather than the best of a selection of suitable rivers/creeks.

Conclusions

The results of our study indicate that it is feasible to reintroduce river otters in South Dakota. Natural expansion of previously reintroduced river otters may occur in extreme eastern South Dakota, but it is difficult to predict whether river otters would naturally expand into western South Dakota, as the waterways in eastern South Dakota flow north and south rather than east and west. Therefore, we recommend river otter reintroduction on five different rivers in South Dakota, although river otters would probably survive in additional waterways of the state (Fig. 1), that is, if additional rivers/creeks provide adequate habitat.

Specific reintroduction procedures will be identified if a river otter restoration program is designated in South Dakota (Berg 1982; Mack 1985; Griess 1987; Johnson and Madej 1994; Serfass et al. 1996). Such procedures include public involvement (Hamilton et al. 2000), proper pre-release care (Serfass, Peper, et al. 1993), and post-release monitoring (Serfass, Brooks, et al. 1993).

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APPENDIX

RATING CRITERIA USED TO EVALUATE MAJOR RIVERS/CREEKS IN SOUTH DAKOTA FOR HABITAT USE BY RIVER OTTERS IN 2001

Stream characteristics
Varying water depths (deep, shallow, variable)
Slow velocity—low gradient (fast–high, moderate–medium, slow–low)
Turbidity/Secchi depth (shallowest, <20 cm, 20–40 cm, >40 cm, deepest)
Presence of stream meanders (6–7 [stream order], 3, 4–5)
Suitable bank cover (≤39% [graminoid and canopy cover], 40%–43%, 44%–48%, 49%–54%, ≥55%)
Presence of bank and instream structures (0, 1–2, >2)
Permanence of water supply (high [potential to dry out or freeze solid], moderate, low)
Species diversity (<20 [species], 20–29, 30–39, 40–49, >49)

Watershed features
Presence of wetlands (0, 1–2, >2)
Presence of beaver (0% [of sites], 1%–25%, 26%–50%, 51%–75%, 76%–100%)
Intensity of beaver trapping (high, moderate, low)
Human impact (high, moderate, low)
Presence of suitable tributaries (0, 1–14, >15)

Water quality
Nitrogen/nitrate-nitrogen (highest, >0.15 mg/l, 0.15–0.1 mg/l, <0.1mg/l, lowest)
Phosphorus/orthophosphate (highest, >4 mg/l, 4–2 mg/l, <2 mg/l, lowest)
Alkalinity/methyl-orange (highest, >350 mg/l, 350–200 mg/l, <200 mg/l, lowest)

Prey availability
Diversity of fish populations (least [number of fish species], <10, 10–20, >20, greatest)
Other aquatic prey (0 [other prey detected per site], 1–2, >2)

Other factors
Public ownership (lowest % [of adjacent public lands], <20%, 20%–50%, >50%, highest
Private land ownership (highest % [of adjacent private lands], ≥90%, 89%–65%, ≤64%, lowest)
Stream accessibility (low [number of potential access points], medium, high)

Note: Rates of 1 (least suitable) through 5 (most suitable) or 1, 3 (median suitability), and 5 were given to each characteristic based on parenthetical criteria. For example, rates for the criterion "presence of beaver" would be as follows: 1 = 0% (of sites), 2 = 1%–25%, 3 = 26%–50%, 4 = 51%–75%, and 5 = 76%–100%.

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