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DISTRIBUTION OF VERTEBRATES OF THE BIGHORN CANYON NATIONAL RECREATION AREA

Stanley H. Anderson\textsuperscript{1}, Wayne A. Hubert\textsuperscript{1}, Craig Patterson\textsuperscript{2}, Alan J. Redder\textsuperscript{3}, and David Duvall\textsuperscript{3}

\textbf{Abstract.}—During a survey of the vertebrates in the Bighorn Canyon National Recreation Area, 46 mammal, 210 bird, 9 reptile, 5 amphibian, and 28 fish species were found. Habitat structure and moisture were two environmental variables associated with species numbers across this 1,820-ha area. Eight distinct habitats were evaluated. In coniferous forests, 27\% of the birds and 54\% of the mammals were observed. Sagebrush/grasslands and upland shrublands were very arid and had relatively few vertebrates. Five introduced game birds occurred in sagebrush habitat. Riparian and wetland habitats had the largest number of unique vertebrates, 38 and 77 respectively. The establishment of Bighorn Lake in 1968 influenced the fisheries in streams and rivers as 10 introduced fish species are now there.

The Bighorn Canyon National Recreation Area (BCNRA) in north central Wyoming and south central Montana provides an array of habitats. Climate and rain shadows have a major impact, resulting in arid, high prairie being the dominant habitat. However, varied habitat types provide homes for many species of fish and wildlife. While moisture has a major influence on habitat and thus fish and wildlife, people have also impacted heavily on the region. Direct forms of habitat alteration through grazing, brush removal, and fire suppression have changed species composition. Perhaps more dramatic changes have resulted from introduction of exotic species.

The objectives of our study were: (1) to determine patterns of vertebrate species richness within BCNRA, (2) to determine habitat features influencing species distribution and species richness patterns, and (3) to examine the influence of people on vertebrate distribution and species richness.

\textbf{Study Area}

The BCNRA lies between the Bighorn Mountains to the east and the Pryor Mountains to the west. Elevation ranges from 1,120 m above sea level near Fort Smith, Montana, to 2,355 m in the Pryor Mountains, Wyoming. The BCNRA is approximately 12 km northeast of Lovell, Wyoming, and 40 km southeast of Billings, Montana. Habitat types are highly diverse in the area that extends 90 km from north to south. The north and south ends are wide, flat valleys, while the central portion is a rolling plain cut by the 335-m-deep Bighorn Canyon.

There is wide seasonal and geographic variation in temperature and precipitation. Annual temperatures range from \(-26\) C to over \(38\) C \((X = 10\) C). A precipitation gradient exists between Lovell, a desert with only 18 cm of precipitation/year, and Fort Smith, a grassland with over 50 cm of precipitation/year (National Park Service 1981).

In the south, plant communities consist primarily of saltbush (\textit{Atriplex} spp.) and greasewood (\textit{Sarcobatus} spp.) in drier sites, while along the Bighorn River, Shoshone River, and the Bighorn Lake, plains cottonwood (\textit{Populus deltoides}) is found. Further north, communities of Utah juniper (\textit{Juniperus osteosperma}), sagebrush (\textit{Artemisia} spp.), mountain mahogany (\textit{Cercocarpus ledifolius}), and grasslands dominate the uplands. Several small creeks flow eastward from the Pryor Mountains, and in these riparian areas narrowleaf cottonwood (\textit{Populus angustifolia}), skunkbush (\textit{Rhus trilobata}), and other woody vegetation are found. A Douglas-fir (\textit{Pseudotsuga menziesii}) forest covers most of the upper portions of the Pryor Mountains, with limber pine (\textit{Pinus flexilis}) occurring on

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the lower benches. North of the Pryor Mountains near Dry Creek, stands of ponderosa pine \textit{(Pinus ponderosa)} and Douglas-fir occur on most north-facing slopes; mountain mahogany is common on the south-facing slopes. The riparian zones in this area consist mainly of boxelder \textit{(Acer negundo)}, chokecherry \textit{(Prunus virginiana)}, water birch \textit{(Betula occidentalis)}, and other species of shrubs and trees. Small stands of ponderosa pine are found near Fort Smith, and grasslands in the vicinity are indicative of a mixed prairie.

In 1968 the Yellowtail Dam was completed near Fort Smith, Montana. The dam formed the 113-km-long Bighorn Lake on the Bighorn River within Bighorn Canyon. Some maps incorrectly refer to the Bighorn Lake as the Yellowtail Reservoir. Normal pool elevation is 1,213 m, but much variation occurs (National Park Service 1981). Causes of this variation are complex but include weather, depth of mountain snowpack, flow-rate adjustments made at Boysen and Yellowtail dams, and evaporation rates. Changes in the surface area of the reservoir are minor at the north end because of steep canyon walls, but at the south end the reservoir inundates large, shallow areas along the Bighorn and Shoshone rivers (National Park Service 1981). When the pool level is low, these floodplains are dry, greatly reducing the amount of wetlands present.

Additional aquatic environments consist of the two headwater rivers and several small streams. The Bighorn and Shoshone rivers are relatively warm, silt-laden rivers upstream from Bighorn Lake. Seventeen streams flow into Bighorn Canyon. These are mostly small streams, many ephemeral, that have downcut channels in steep, narrow canyons. A few perennial, coldwater streams capable of supporting salmonids are found in the area.

While the addition of Bighorn Lake is a recent impact to the Bighorn Basin, this land has been impacted by people for more than 10,000 years. Early Indian hunters sought food there. Later Crow Indians settled around the Bighorn Canyon. Explorers and trappers came in the early nineteenth century. Trails were established across the area to reach mines in Montana around the time of the Civil War. Large cattle ranches were established some 15 years following the war. Today land-use practices within and adjacent to the BCNRA include grazing, farming, mining, and recreational activities.

\section*{Methods}

Two seasons of field investigations were conducted on BCNRA. During 1984 data were collected on birds and mammals. In 1985 field data collection emphasized fish, amphibians, and reptiles.

Birds were observed while walking transects. The use of binoculars and a spotting scope helped establish at least two transects of 300–1,000 m in each vegetation type. Birds seen or heard within 15 m of the transect were recorded. Transects were walked at least five times.

Mammals were surveyed by incidental observations of species and tracks. Small mammals were captured by setting 20 museum specials, 5 rat, and 10 pit traps along transects in each habitat. Two snap traps and one pit trap were set at 10-m intervals along transects, although pit and snap traps were not set simultaneously. Bats were captured in two mist nets set near or over wetlands, at heights of 2.5–5.0 m and 1.5–3.0 m. Each net was 20 m long and 2.5 m wide. Voucher specimens were deposited in the vertebrate museum at the University of Wyoming.

Electrofishing was done 20–23 June 1985 in the 12 largest perennial streams in the BCNRA: Black Canyon Creek, Little Bull Elk Creek, Big Bull Elk Creek, Hoodoo Creek, Dryhead Creek, Deadman Creek, Gypsum Creek, Trail Creek (north and south forks), Layout Creek, Porcupine Creek, and Crooked Creek. In most streams, electrofishing began at the mouth of the creek and continued upstream until fish were no longer captured or the BCNRA boundary was reached.

The Bighorn River was sampled using a 5-m-long, 5-mm mesh bag seine. Minnow traps were set in pools and under overhanging boulders in streams and on the bottom and within vegetative cover of emergent wetlands. Additional information on fish distribution was obtained from examining data collected by the Wyoming Game and Fish Department and the Montana Department of Fish, Wildlife, and Parks.

Herpetological searches were concentrated in wetlands and riparian areas in May, June, and early July to coincide with breeding seasons. Searches for snake dens were made in late August and September along south-facing ridges (Duvall et al. 1985) near Sykes Moun-
tait and East Pryor Mountain. Specific habitat types were searched on foot, and straight-line transects were walked.

Three passive capture methods were used. Baited hoop nets were set in the Bighorn River for turtles. Baited minnow traps were set in wetland and riverine habitats for amphibians and small turtles. A combination of plastic mesh drift-fencing and 20-liter pitfall traps was used for snakes and lizards. Lizards were also noosed in areas where thick vegetation prevented hand capture. Road cruising on both paved and unpaved roads was used for sampling snakes (Campbell and Christman 1982).

**RESULTS**

The BCNRRA study sites consisted of 1,820.8 ha of terrestrial and aquatic habitat plus Bighorn Lake. Eight distinct habitats were evaluated (Table 1). Sagebrush/grassland areas consisting of 698.8 ha (38.8% of the terrestrial habitat) were the most arid and often had rock outcrops. Upland shrub communities of juniper and mountain mahogany were also arid and consisted of 728.2 ha (40%). Mixed conifer forests were on 108.8 ha or 6%. Douglas-fir, rocky mountain juniper, ponderosa, and limber pine were the dominant tree species in these relatively dry forests. Riparian habitat included creek woodland and floodplain forests with narrowleaf cottonwood, Russian olive, box elder, elm (*Ulmus pumila*), Saskatoon serviceberry (*Amerianchier alnifolia*), chokecherry, hawthorne (*Crataegus sp.*), wild rose (*Rosa sp.*), and mountain maple (*Acer glabrum*). Riparian areas made up 263.2 ha (14.4%) of the terrestrial habitat.

Wetlands were found on 21.8 ha (1.2%). Some wetland areas were mudflats. In the summer, emergent wetlands were created as water inundated the vegetation, which consisted of sedges (*Cyperus spp.*, *Juncus spp.*), rushes (*Scirpus spp.*), and cattail (*Typha latifolia*).

Streams flowing into Bighorn Lake within BCNRRA range from ephemeral watercourses to perennial, coldwater streams. Several are impacted by upstream uses such as water diversion and cattle grazing. The two headwater rivers, Bighorn and Shoshone, are relatively warmwater, turbid streams.

Water quality and discharge of these rivers are both strongly influenced by upstream water development and agricultural practices. Within BCNRRA these two streams support a variety of warmwater fishes.

Bighorn Lake has impounded the Bighorn River within BCNRRA. The reservoir is generally confined by the wall of Bighorn Canyon. It is deep with very little littoral area. At the headwaters there are expanses of shallow mud flats periodically exposed when the reservoir is drawn down. The reservoir supports a coldwater fishery with a variety of sport, forage, and rough fishes. Water quality changes over the length of the reservoir with eutrophic conditions near the headwaters and relatively oligotrophic conditions near the dam.

**Species/Habitat Association**

During the two-year project, 28 fish, 5 amphibians, 9 reptiles, 210 birds, and 46 mammals were found in BCNRRA (Appendix). The number of vertebrate species found in each of the eight classes of habitat is listed in Table 2.

**SAGEBRUSH AND GRASSLANDS.**—Of the 98 species found here, 15 were unique in this habitat (Table 2). Say’s phoebe and grasshopper sparrows were observed in the sagebrush flats near Crooked Creek. Brewer’s sparrows were common in the sagebrush habitat on the dryhead range.

The only specimen of a northern grasshopper mouse was collected in the sagebrush flats near Crooked Creek. Ord’s kangaroo rats were common there. One rare Merriam’s shrew was captured in the sagebrush on the dryhead range, and tracks of black bears were found.
### Table 2. Numbers of vertebrate species found in eight habitat types of BCNRA. Numbers in parentheses indicate number of species found only in that habitat. Habitats are shown in order from xeric to mesic.

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<thead>
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<th>Taxa</th>
<th>Sagebrush grassland</th>
<th>Upland shrub</th>
<th>Conifer forest</th>
<th>Riparian</th>
<th>Wetland</th>
<th>Streams</th>
<th>Headwater rivers</th>
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<td>Species totals</td>
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<td>88(10)</td>
<td>156(38)</td>
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<td>1.2</td>
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*From Table 1

This was the habitat of the spadefoot toad, although it is not common in BCNRA. Horned and sagebrush lizards were found in these habitats. Bullsnakes, yellow-bellied racers, and milksnakes were observed in sagebrush habitat.

**Upland shrub.**—Few bird species nested in upland shrub habitats, and relative abundance of species appeared to be low. Mixed species flocks of birds were commonly seen moving through upland shrub habitats in the late summer and fall. Pocket mice were captured in a sagebrush-juniper area. An Ord’s kangaroo rat was trapped in sandy soil in juniper and mountain mahogany. No amphibians were found in these dry habitats. The eastern short-horned and northern sagebrush lizard were observed here, as were the bullsnake, racer, and prairie rattlesnake.

**Conifer forest.**—Conifer forests had a variety of birds and mammals. Eleven species were found only in this habitat. In the more open forests of ponderosa and limber pine, Cooper’s hawks and some flycatchers were observed. Associated with the understory vegetation were both green-tailed and rufous-sided towhees. Tiger salamanders were occasionally found on the forest floor.

Vagrants shrews and montane voles were captured in the ponderosa pine and Douglas-fir forests, where tracks of mule deer and elk also were frequently found.

**Riparian.**—Shrub and creek woodlands as well as floodplain cottonwood constituted riparian habitats of the BCNRA. These areas had a large number of species, considering their relatively small total area (14.4%). The riparian habitats had a comparatively high number of species (38) found only in that habitat. Many of the unique vertebrates there were birds. Eastern kingbirds, lazuli buntings, rufous-sided towhees, and lark sparrows nested there, while Brewer’s blackbirds and green-tailed towhees were observed once during spring migration. Many birds observed there were also found in plains cottonwood forests.

Few species of mammals were trapped in these habitats, although one of two specimens of western harvest mice and the only western jumping mouse were captured in the mature stand of cottonwoods. A long-tailed weasel was seen, and white-tailed deer were common. Tiger salamanders, chorus frogs, and leopard frogs were found in creek woodlands and floodplain forests. These areas provided moisture necessary to sustain the amphibians. Creek woodlands had a number of the reptile species including the bullsnake, milksnake, gartersnake, and prairie rattlesnake.

**Wetlands.**—Most nesting bird species were associated with palustrine wetlands that had either emergent vegetation or mud shores. Dabbling ducks were observed using wetlands as brood habitat. Both pried-billed grebes and American coots nested in emergent wetlands. Emergent vegetation was commonly used by yellow-headed and red-winged blackbirds, marsh wrens, and common yellowthroats. MacGillivray’s warblers and song sparrows were common in the shrub willow near shore. Because of the many aquatic and water birds found in wetlands, these areas had the highest (77) number of unique species.

Mammals trapped in the wetlands were
mostly deer mice, although a western harvest mouse was collected in a stand of cattails. Mink were observed in an emergent wetland south of the causeway. Chorus and leopard frogs, woodhouse’s toad, and tiger salamanders were found in wetlands with several snakes and painted turtles.

STREAMS.—Five species of fish were captured by electrofishing in streams (Appendix). Fish were found in only 6 of 12 perennial streams: Black Canyon Creek, Big Bull Elk Creek, Dry Head Creek, Deadman Creek, Gypsum Creek, and Porcupine Creek. Only the four largest streams contained salmonids. Most fish were captured in riffles or in pools beneath overhanging boulders.

HEADWATER RIVERS.—The fish species known to occur in the headwater rivers were quite varied and included at least 19 species. Many species were ephemeral residents of rivers, using them during the spawning seasons. A variety of nongame fishes resided in the headwater rivers during much of the year. They included the lake chub, sturgeon chub, flathead chub, longnose dace, river carp-sucker, longnose sucker, white sucker, shorthead redhorse, and stonecat. The headwater rivers had low sport fishing value within BCNRA.

RESERVOIR.—The reservoir in both Montana and Wyoming supported a substantial sport fishery. Sport fish introductions into the reservoir have lead to at least 10 additional fish species. While centrarchids have been introduced, they were not a dominant family because of the limited littoral areas, relatively cold water, and fluctuations in water levels. The reservoir had the greatest diversity of fish species (25) as a result of the diversity of habitat features encountered over its length. Six fish were found only in the reservoir. Twenty-seven species occurred in the reservoir or rivers entering the reservoir as observed by the Wyoming Game and Fish Department and the Montana Department of Fish, Wildlife and Parks, which routinely surveyed these waters (Appendix).

Shifts in Species Richness

Each habitat type provided features that attracted species. Both habitat structure and moisture, which are examined in the discussion, influenced species richness. The drier habitats had fewer species than the terrestrial moist habitats (Table 2). Structure, however, influenced the total species count. Conifer forests, for example, had more birds than did the sagebrush/grassland and upland shrub habitats. No amphibians or reptiles were found in forest communities. Birds were in much higher numbers in riparian and wetland habitats. Thus, the changes in total species numbers were seen more in birds than in any of the other vertebrate groups.

Introduced Species

As people have come to BCNRA, vertebrate species have been introduced into the region. No introduced amphibians, reptiles, or mammals were found, although wild horses were in the region at one time. Introduced birds were primarily game birds: ring-necked pheasant, chukar, grey partridge, and turkey. These species were in sagebrush grassland, with the turkey also using forest and riparian habitats. Starlings were common in wetlands, and house sparrows were common around buildings and bridges.

Of the 25 species of fish known to occur in BCNRA, 10 have been introduced by fishery managers for the purpose of enhancing sport fish diversity. Several species have been stocked in the reservoir since its construction: rainbow trout, brown trout, lake trout, largemouth bass, green sunfish, black crappie, white crappie, and yellow perch. Additional species introduced in the nineteenth century include the brook trout and common carp.

Discussion

The results of our study on BCNRA indicated the importance of two habitat features, moisture and structure. Moisture seemed to have an even more pronounced influence on vertebrate species in the arid region. Combining the riparian and wetland terrestrial habitat, we accounted for only 15.6% of the area. These areas, however, had the more diverse population of vertebrates of the BCNRA. Many of the migratory birds were observed there. Shorebirds and waterbirds, as well as colonial nesting birds, were only in marsh habitat. Creek woodlands, which accounted for only 0.5% of the area, had 30% of the nesting birds. The moist habitat contained 11 of the 46 species of mammals and 9 of the 19 reptiles and amphibians.
Others have shown the importance of moist habitats for vertebrate species. In southern Wyoming, Krueger and Anderson (1985) found that birds utilized shrub willow communities in higher proportion than other habitats. They showed the importance of the combined riparian habitats in the midst of a conifer forest and sagebrush community. Each riparian habitat did not have the full complement of all birds. Rather, each small riparian community acted as a component island with its species composition. In the eastern deciduous forest, atmospheric moisture influenced the composite of the breeding bird community (Petit et al. 1985).

Rain, moisture, and/or humidity influenced distribution and reproduction in amphibians and reptiles (Duvall et al. 1982). Some species of frogs must have moist skin in order to breathe.

Tied to the distribution pattern were energy flow and food. Moist areas were likely to have a higher productivity, therefore more food. The concentration of vertebrates in moist habitats meant that they added to the total distribution patterns attracting predators.

Habitat structure has been associated with the presence and diversity of birds and mammals (Shugart et al. 1974). Structure at BCNRA was seen in the coniferous forest from both vertical and horizontal perspectives. Overall, 23.8% of the species of birds observed, 30.1% of the nesting birds, and 24.2% of mammals observed and trapped were in coniferous forests. These habitat types accounted for only 6% of the terrestrial habitats in the study area. Thus, structure of conifer forests appeared to provide habitat for many vertebrates.

Unique aquatic habitats important to fish were the perennial streams that supported salmonids, wetland areas associated with the headwater areas, and gravel-cobble riffles in the headwater rivers. The coldwater streams may support, or could potentially support, native stream fishes such as cutthroat trout. The wetlands associated with headwater streams are probably important spawning and rearing areas for several species, such as the plains kililfish, yellow perch, and the centrarchids. The riffle areas are probably spawning sites for over half of the fish species found in the BCNRA. Maintenance of these habitat features will be critical to maintaining current fish species diversity.

The unique islands of aquatic habitat and the forest structure associated with BCNRA provide the diversity of habitat that allows many species to survive there. Influence of people can be seen through the introduction of new species, primarily for sport hunting and fishing, and alteration of habitats that affect native species, primarily through water development and agriculture practices.

Acknowledgments

We appreciate the assistance of many individuals on the project. We thank K. Diem for his interest and his help in obtaining funding. Special thanks to J. T. Peters for his help with the field work and logistical support, and his hospitality. W. Benniebies and R. Lake provided logistical support. Those who aided in the field work included L. Clark, J. Jones, M. Earnhardt, L. Kinter, J. T. Patterson, and T. Peterson. L. Clark, P. Gordon, B. Harrison, G. Jones, R. Kent, R. Lake, R. Myers, L. Pechacek, J. T. Peters, L. Stahl, and S. Yekel provided useful suggestions and observations about species within the BCNRA. D. Walker and G. Menkens confirmed identifications of small mammals, and M. Bogan identified several bats. Finally, M. Brandt and L. Sweanor prepared many of the small mammals and bats for the museum. The project was funded by the University of Wyoming—National Park Service Research Center.

Literature Cited

APPENDIX

Habitat association of vertebrates in the BCNRA (* indicates introduced species, ** indicates that species is likely to occur in indicated habitat but not documented within survey).

<table>
<thead>
<tr>
<th>Species</th>
<th>Habitat association (code from Table 1)</th>
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<td>Channel Catfish, Ictalurus punctatus</td>
<td>7,8</td>
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<tr>
<td>Stonecat, Noturus flarus</td>
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<td>Burbot, Lota lota</td>
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<tr>
<td>Plains Killifish, Fundulus zebrinus</td>
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<tr>
<td>Largemouth Bass*, Micropterus salmoides</td>
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<tr>
<td>Black Crappie*, Pomoxis nigromaculatus</td>
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<td>Walleye*, Stizostedion vitreum citrinum</td>
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<td>Red-sided Gartersnake**, Thamnophis sirtalis</td>
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<td>Wandering Gartersnake, Thamnophis elegans</td>
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<td>Prairie Rattlesnake, Crotalus viridis</td>
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**FLY** (scientific names according to Baxter and Simon [1970])

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<td>Rainbow Trout**, Salmo gairdneri</td>
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<td>Brook Trout**, Salvelinus fontinalis</td>
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<td>Lake Trout**, Salvelinus manningii</td>
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<td>Lake Chub, Conclusis phrribenus</td>
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<td>Common Carp*, Cyprinus caprio</td>
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<td>Sturgeon Chub, Hybopsis giehla</td>
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<td>Flathead Chub, Hybopsis gracilis</td>
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<td>Fathead Minnow, Pimephales promelas</td>
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<td>Longnose Dace, Rhinichthys cataractae</td>
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<td>River Carpsucker, Carepoides carpio</td>
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<td>White Sucker, Catostomus commersoni</td>
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<td>Mountain Sucker, Catostomus platyrhynchus</td>
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Eurasian Wigeon, Anas penelope 5
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Cinnamon Teal, Anas cyanoptera 5
Green-winged Teal, Anas crecca 5
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Redhead, Aythya americana 5
Canvasback, Aythya valisineria 5
Bufflehead, Bucephala albeola 5
Oldsquaw, Clangula hyemalis 5
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<td>Lark Sparrow, <em>Chondestes grammacus</em></td>
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<td>Song Sparrow, <em>Melospiza melodia</em></td>
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<td>McCown's Longspur**, <em>Calcarius meccowii</em></td>
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<td>Chestnut-collared Longspur**, <em>Calcarius ornatus</em></td>
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<td>Lapland Longspur**, <em>Calcarius lapponicus</em></td>
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<td>Snow Bunting, <em>Plectrophenax nivalis</em></td>
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<td>Porcupine, <em>Erithizon dorsatum</em></td>
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<td>Red Fox, <em>Vulpes vulpes</em></td>
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<td>Swift Fox**, <em>Vulpes velox</em></td>
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<td>Raccoon, <em>Procyon lotor</em></td>
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<td>Pine Martin**, <em>Martes americana</em></td>
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<td>Ermine**, <em>Mustela erminea</em></td>
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<td>Long-tailed Weasel, <em>Mustela frenata</em></td>
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<td>Mink, <em>Mustela vison</em></td>
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<td>Badger, <em>Taxidea taxus</em></td>
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<td>Spotted Skunk, <em>Spilogale putorius</em></td>
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<td>Striped Skunk, <em>Mephitis mephitis</em></td>
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<td>River Otter**, <em>Lutra canadensis</em></td>
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<td>Mountain Lion, <em>Felis concolor</em></td>
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<td>Lynx**, <em>Felis lynx</em></td>
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<td>Bobcat, <em>Felis rufus</em></td>
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<td>Elk, <em>Cervus elaphus</em></td>
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<td>White-tailed Deer, <em>Odocoileus virginianus</em></td>
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<td>Pronghorn, <em>Antilocapra americana</em></td>
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<td>Bighorn Sheep, <em>Ovis canadensis</em></td>
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