*WETLANDS*, Vol. 16, No. 2, June 1996, pp. 127–133


# BEAVER PONDS CREATE WETLAND HABITAT FOR BIRDS IN MOUNTAINS OF SOUTHEASTERN WYOMING

Duffy J. Brown, Wayne A. Hubert, and Stanley H. Anderson
*Wyoming Cooperative Fish and Wildlife Research Unit*
*University of Wyoming*
*Box 3155, University Station*
*Laramie, WY 82071*

*Abstract:* We studied the use of beaver ponds and associated wetlands by ducks and waterbirds on the Laramie Range, Albany County, Wyoming, during 1994. Our goal was to identify physical habitat features of beaver ponds associated with use by migrating, breeding, and postbreeding ducks and other birds associated with aquatic habitats. Species richness of birds observed at beaver ponds was positively correlated with water surface area, area of shallow water, length of woody shoreline, and shoreline development (the ratio of shoreline length to the circumference of a circle of the same area as the water surface of the pond). Duck use (green-winged teal, mallard, and ring-necked duck) was positively correlated with water surface area, area of shallow water, and length of woody shoreline, but negatively correlated with the ratio of the area of submergent vegetation to water surface area. Use by riparian birds (red-winged blackbird and Brewer's blackbird) was positively correlated with water surface area, area of shallow water, area of emergent cover, and length of woody shoreline.

*Key Words:* beaver, waterfowl, ducks, riparian, Wyoming

## INTRODUCTION

Wetlands in the Rocky Mountains can provide habitat for migrating and breeding waterfowl (Peterson and Low 1977, Ringelman 1992). Among wetlands used by waterfowl in the Rocky Mountains are those formed by beaver (*Castor canadensis* Kuhl) when they build ponds (Medin and Clary 1990).

Ponds built by beaver provide wetlands with several features important to ducks and waterbirds (birds other than waterfowl associated with water). For example, beaver ponds increase the surface area of water, extend the riparian zone, and enhance the structural diversity of stream systems (Naiman et al. 1984). Organic matter and nutrients in beaver ponds enhance aquatic plant and invertebrate production (Wilde et al. 1950, Rutherford 1964, Naiman 1988). Removal of deciduous trees by beaver increases the density and height of wetland grasses, forbs, and shrubs around ponds and enhances duck nesting cover. Shallow-water foraging areas along the edge of beaver ponds warm quickly in spring and provide sites where plant seeds and invertebrates can be obtained by ducks and waterbirds.

Beaver create or enhance habitat for duck breeding and brood rearing (Frary 1954, Stanton 1965, Renouf 1972, Nummi 1992) and for resting during migration (Peterson and Low 1977, Hair et al. 1978). Duck use has been observed to be greatest among ponds actively used by beaver (Neff 1957, Nevers 1968, Collins 1972, Renouf 1972, Brown 1994).

There is limited information on beaver ponds and associated wetlands as habitat for birds, especially in montane systems. The purpose of this study was to determine the extent to which montane beaver ponds and associated wetlands are used by ducks and waterbirds and to define relations between bird use and wetland habitat features in mountains of southeastern Wyoming.

Brown (1994) found that duck and waterbird use is predominantly associated with beaver ponds having water surface areas greater than 1000 $m^2$. As a result, our objectives were to (1) describe duck and waterbird use among beaver ponds with water surface areas greater than 1,000 $m^2$, (2) describe the physical habitat features associated with these ponds, (3) and determine if relations exist between bird use and habitat features.

## STUDY AREA

The study area was in southeastern Wyoming on the Laramie Range in the Medicine Bow National Forest. The upper 5 km of three adjacent watersheds—Middle Lodgepole, North Branch of Middle Lodgepole, and North Lodgepole creeks—were the focus of this study because they contained high densities of beaver ponds (Brown 1994).

Elevation of the beaver ponds ranged from 2300 to 2550 m above mean sea level. Uplands were dominated by rolling hills, forested on north facing slopes. Ponderosa pine (*Pinus ponderosa* Engelm.), Douglas fir (*Pseudotsuga menziesii* Franco), lodgepole pine (*Pinus contorta* Engelm.), limber pine (*Pinus flexilis* James), Engleman spruce (*Picea engelmannii* Engelm.), and aspen (*Populus tremuloides* Michx.) occurred in forested areas. South facing slopes and ridgetops were dominated by a variety of grasses and sagebrush (*Artemisia* spp.). Stream valleys and riparian zones contained willows (*Salix* spp.), sedges (*Carex* spp.), and grasses.

The climate is characterized by cool moist summers, dry falls, cold dry winters, and moist springs. Annual precipitation is 35–40 cm with a 60–100 day frost-free period. The national forest is primarily rolling mountain lands that provide a variety of uses, including camping, hiking, fishing, rock climbing, cross-country skiing, biking, and cattle grazing.

## METHODS

### Pond Selection

We aerially photographed the uppermost 5-km reach of each creek in early May 1993 to identify the array of beaver ponds and associated wetlands in each drainage. Photographs were taken from a fixed-wing aircraft approximately 200 m above the ponds. Beaver ponds and associated wetlands with water surface areas greater than 1000 $m^2$ were identified using measurements from photographs. We determined the scale of the photographs from markers placed 40 m apart adjacent to each pond. We digitized the photographs and used a computer program to compute water surface area ($m^2$).

### Bird Surveys

We surveyed birds associated with beaver ponds weekly from 2 May to 8 August 1994 between sunrise and 1100 hours. We began each survey by observing the pond and any associated wetlands from a vantage point for 10 minutes with binoculars. We then walked the perimeter of the pond and associated wetlands to flush and identify birds (Rumble and Flake 1983). We recorded species, number of adult birds, number in broods, and brood age (Gollop and Marshall 1954) for each pond. For ducks, we categorized their stage in the annual cycle as migrating (birds from 1 May to 30 June that did not exhibit territorial or courtship behaviors), breeding (male-female pairs, male-male-female trios, nesting females, or females with broods), or post-breading (non-breeding birds observed 1 July to 8 August that did not meet the criteria for breeding birds) based on the survey date and bird behavior (Hammond 1969). We considered ducklings in class 2C (> 43 days old) as adult birds (Gollop and Marshall 1954).

We classified waterbirds based on foraging behavior and nesting substrate (Harrison 1979, DeGraaf et al. 1985): (1) riparian birds (ground-foraging omnivores that nest in bushes or on the ground), (2) shorebirds (ground- or shore-gleaning insectivores that nest exclusively on the ground), or (3) piscivorous birds (species that feed primarily on fish).

### Habitat Variables

We measured 16 habitat variables from a second set of aerial photographs taken 7 July 1994. We again computed water surface area ($m^2$). We calculated shoreline development as the ratio of shoreline length (m) to the circumference of a circle of the same area ($m^2$) as the surface of the pond (Cole 1994). We measured the area of shallow water ($\leq$ 0.6 m) and the ratio of shallow water to water surface area from photographs and by ground truthing. A staff was used during ground truthing to identify shallow and deep water (Hudson 1983, Rumble and Flake 1983).

The area of submergent vegetation and the ratio of the area of submergent vegetation to water surface area were measured from aerial photographs and by ground truthing. The area of emergent cover and the ratio of the emergent cover to water surface area were measured from aerial photographs and by ground truthing. Emergent cover was defined as live herbaceous plants, live or dead woody plants, and down and dead trees emerging from the water surface. The length (m) and the proportion of shoreline habitat composed of deciduous woody vegetation, herbaceous vegetation, coniferous woody vegetation, or bare ground were measured from aerial photographs as described.

### Data Analysis

We used Pearson's correlation coefficients to test for relations between habitat features (Angresti and Finlay 1986). Simple linear regression and multiple regresion analyses were used to define relations between habitat features and measures of bird use (Zar 1984). Multiple regression models were constructed by initially selecting the habitat variable with the highest correlation to the measure of bird use and adding additional variables that were also correlated with bird use but not correlated with each other. Additional variables were included in multiple regression models only when they significantly accounted for variation in the dependent variable. Magnitude of bird use was defined as the number of species (species richness), the total number of birds observed during all surveys, and mean density of birds (birds/hectare) per survey associated with each pond. All calculations were made using STATISTIX 4.0 (Analytical Software 1991). Significance was determined at P ≤ 0.05 for all tests.

## RESULTS

We identified 62 beaver ponds with water surface areas greater than 1000 $m^2$ and randomly chose 29 ponds for study: six on Middle Lodgepole Creek, 11 on North Branch of Middle Lodgepole Creek, and 12 on North Lodgepole Creek. When sampled in July, one pond had dropped to a surface area of 500 $m^2$, but the remaining 28 ponds were all greater than 1000 $m^2$. All 29 ponds were maintained in the dataset for our analysis.

We observed 13 species of birds associated with beaver ponds between 2 May and 8 August 1994 (Table 1). Green-winged teal and mallards were the most abundant ducks. Other common birds included red-winged blackbirds, Brewer's blackbird, common snipe, and spotted sandpipers. Duck use was greatest from early to late May, with little use during the summer (Figure 1). Riparian bird use was greatest from mid-May through late June and declined through July and August. Shorebird use was greatest from early June through late July, with little use during May and August. Piscivorous waterbird use was relatively low, with greatest use during early July through August. Green-winged teal and mallard broods began appearing 10 June, while ring-necked duck broods first appeared 28 June.

Variation in the 16 habitat features was substantial among the 29 ponds (Table 2). Several significant correlations were observed among habitat features. Among the highest correlations were those between water surface area and area of shallow water ($r = 0.93$, $P < 0.0001$), area of emergent cover ($r = 0.82$, $P < 0.0001$), length of woody shoreline ($r = 0.63$, $P = 0.0003$), length of herbaceous shoreline ($r = 0.62$, $P = 0.0004$), and area of submerged vegetation ($r = 0.37$, $P = 0.0467$).

Up to 11 species were observed in association with individual beaver ponds. Species richness was significantly correlated with four habitat features: area of shallow water ($r = 0.54$, $P = 0.0025$), water surface area ($r = 0.49$, $P = 0.0064$), length of herbaceous shoreline ($r = 0.45$, $P = 0.0148$), and shoreline development ($r = 0.40$, $P = 0.0303$). Three habitat features (area of shallow water, water surface area, and length of herbaceous shoreline) were significantly correlated with each other, but shoreline development was not significantly correlated with any of the other three variables. Both the area of shallow water (SHAL) and shoreline development (DEVL) were significant in a multiple regression model accounting for variation ($r^2 = 0.41$, $P = 0.0010$) in species richness:

$$RICH = -1.57 + 0.0015\ SHAL + 1.1800\ DEVL.$$

Due to the strong correlation between area of shallow water and water surface area, a similar model was computed with water surface area (AREA) and shoreline development as the dependent variables ($r^2 = 0.38$, $P = 0.0020$):

$$RICH = -1.43 + 0.0088\ AREA + 1.2479\ DEVL.$$

Species richness was related mostly to area of shallow water or water surface area with additional variation accounted for by shoreline development.

The total numbers of ducks, migrating ducks, breed-

Table 1. Mean number of birds per survey over two time periods on 29 beaver ponds on the Laramie Range, 1949 (N = number of surveys during each season). Standard errors in parentheses.

| Species | 2 May–30 June (N = 9) | 1 July–8 Aug (N = 6) |
|---|---|---|
| DUCKS | | |
| Mallard *Anas platyrhynchos* Linnaeus | 8.56 (2.78) | 3.67 (0.99) |
| Green-winged teal *Anas crecca* Linnaeus | 11.00 (3.19) | 3.33 (0.99) |
| Ring-necked duck *Aythya collaris* Donovan | 2.22 (0.74) | 1.33 (0.42) |
| RIPARIAN BIRDS | | |
| Red-winged blackbird *Agelaius phoeniceus* Linnaeus | 9.44 (1.02) | 3.33 (1.26) |
| Brewer's blackbird *Euphagus cyanocephalus* Wagler | 17.00 (1.85) | 1.17 (0.54) |
| SHOREBIRDS | | |
| Spotted sandpiper *Actitis hypoleucos* Linnaeus | 5.11 (1.27) | 5.50 (1.48) |
| Sora *Porzana carolina* Linnaeus | 0.33 (0.24) | 0.67 (0.33) |
| Virginia rail *Rallus limicola* Vieillot | 0.11 (0.11) | 0.33 (0.21) |
| Common snipe *Gallinago gallinago* Linnaeus | 2.33 (0.62) | 2.67 (1.26) |
| Killdeer *Charadrius vociferus* Linnaeus | 1.00 (0.37) | 0.67 (0.49) |
| Wilson's phalarope *Phalaropus tricolor* Vieillot | 0.22 (0.22) | 0.00 (0.00) |
| PISCIVOROUS BIRDS | | |
| Great blue heron *Ardea herodias* Linnaeus | 0.11 (0.11) | 0.83 (0.17) |
| Belted kingfisher *Ceryle alcyon* Linnaeus | 0.00 (0.00) | 1.17 (0.31) |

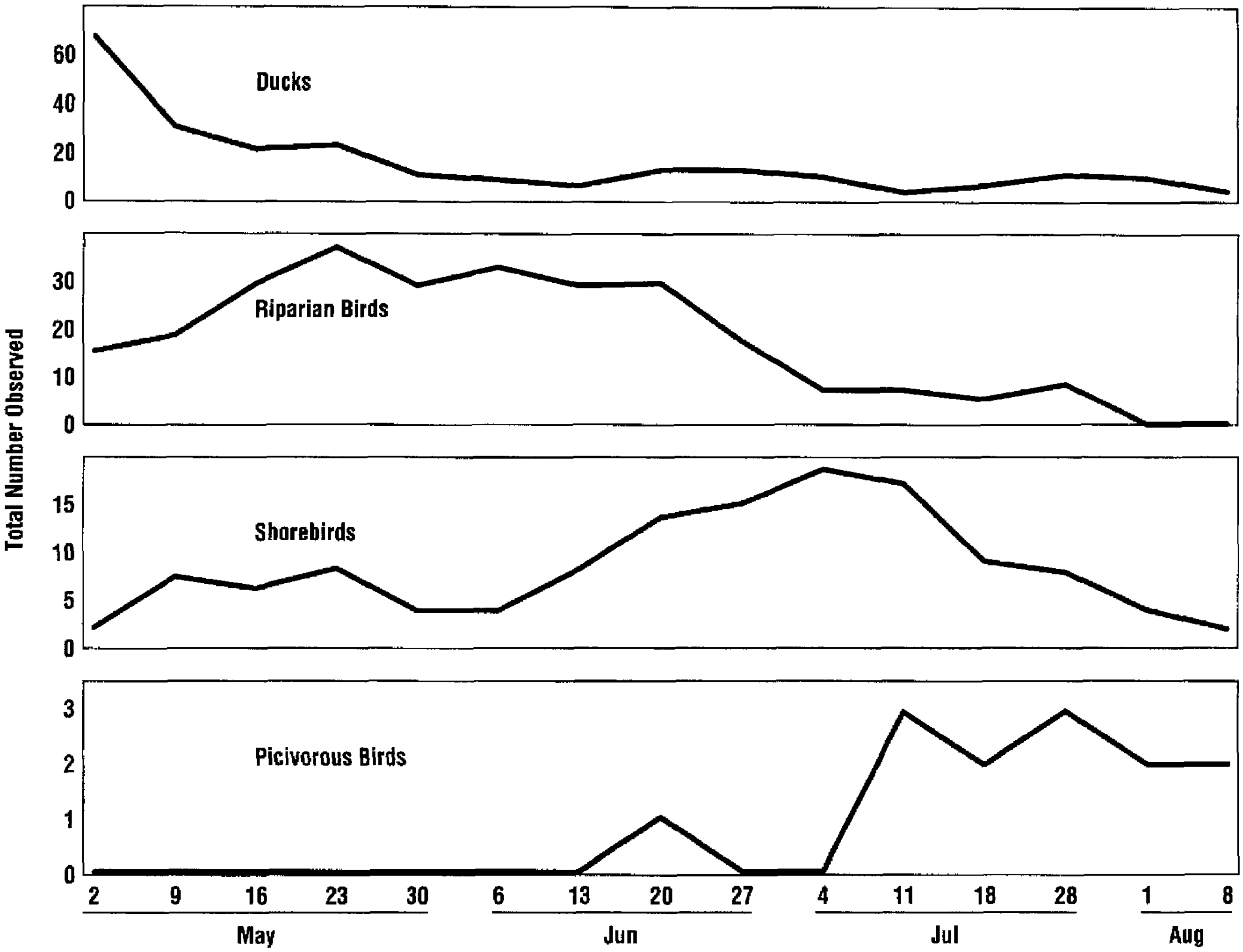


Figure 1. Total numbers of ducks, riparian birds, shorebirds, and piscivorous birds observed on the 29 beaver ponds on the Laramie Range, WY on each survey date, 2 May–8 August 1994.

Table 2. Median, minimum, and maximum values for 16 habitat features measured among the 29 beaver ponds on the Laramie Range, 1994.

| Variable | Median | Minimum | Maximum |
|---|---|---|---|
| Water surface area ($m^2$) | 1400 | 500 | 6000 |
| Area shallow water ($m^2$) | 1186 | 410 | 3790 |
| Area emergent vegetation ($m^2$) | 312 | 65 | 1400 |
| Area submergent vegetation ($m^2$) | 219 | 0 | 1570 |
| Ratio area emergent vegetation/water surface area | 0.20 | 0.06 | 0.48 |
| Ratio area submergent vegetation/water surface area | 0.16 | 0.00 | 0.80 |
| Ratio area shallow water/water surface area | 0.77 | 0.45 | 1.00 |
| Length bare shoreline (m) | 0 | 0 | 45 |
| Length conifer shoreline (m) | 0 | 0 | 50 |
| Length herbaceous shoreline (m) | 123 | 35 | 320 |
| Length woody shoreline (m) | 84 | 10 | 270 |
| Proportion woody shoreline | 0.39 | 0.00 | 0.80 |
| Proportion herbaceous shoreline | 0.60 | 0.00 | 0.85 |
| Proportion bare shoreline | 0.00 | 0.00 | 0.30 |
| Proportion conifer shoreline | 0.00 | 0.00 | 0.20 |
| Shoreline development | 3.31 | 2.40 | 5.30 |

Table 3. Significant ($P \leq 0.05$) correlations between bird use (total number of birds) and five habitat variables: water surface area (AREA), area of shallow water (SHAL), length of woody shoreline (LWDY), area of emergent vegetation (AEMG) and ratio of the area of submergent vegetation to water surface area (RSUB).

| | Habitat Variable | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | | SHAL | | LWDY | | AEMG | | RSUB | |
| Bird group | r | P | r | P | r | P | r | P | r | P |
| Total ducks | 0.41 | 0.027 | 0.40 | 0.032 | 0.39 | 0.034 | | | −0.38 | 0.040 |
| Migrating ducks | 0.39 | 0.037 | 0.37 | 0.046 | | | 0.42 | 0.022 | | |
| Breeding ducks | 0.38 | 0.040 | 0.39 | 0.036 | 0.39 | 0.043 | | | −0.38 | 0.044 |
| Riparian birds | 0.73 | <0.001 | 0.71 | <0.001 | 0.64 | <0.001 | 0.52 | <0.001 | | |

ing ducks, and riparian birds were positively correlated with water surface area, area of shallow water, length of woody shoreline, or area of emergent cover (Table 3). Total numbers of ducks and breeding ducks were negatively correlated with the ratio of the area of submerged vegetation to water surface area. However, water surface area (AREA), area of shallow water (SHAL), length of woody shoreline (LWDY), and area of emergent cover (AEMG) were all significantly correlated with each other. The ratio of the area of submerged vegetation to water surface area (RSUB) was not significantly correlated to the other four habitat features, but when included in multiple-regression models, it did not significantly account for variation in total numbers of ducks or breeding ducks beyond that accounted for by the other habitat features individually.

Because water surface area (AREA) and area of shallow water (SHAL) individually accounted for variation in total numbers of ducks (TDUK), migrating ducks (MDUK), breeding ducks (BDUK), and riparian birds (TRIP), simple-linear regression models are presented for these relations: TDUK = 2.76 + 0.0236 AREA, $r^2 = 0.17$, $P = 0.0268$; TDUK = 2.30 + 0.0036 SHAL, $r^2 = 0.16$, $P = 0.0316$; MDUK = −0.03 + 0.0036 AREA, $r^2 = 0.15$, $P = 0.0373$; MDUK = −0.08 + 0.0005 SHAL, $r^2 = 0.14$, $P = 0.0459$; BDUK = 2.87 + 0.0184 AREA, $r^2 = 0.15$, $P = 0.0397$; BDUK = 2.34 + 0.0013 SHAL, $r^2 = 0.15$, $P = 0.0360$; TRIP = −4.30 + 0.0686 AREA, $r^2 = 0.53$, $P < 0.0001$; TRIP = −5.56 + 0.0104 SHAL, $r^2 = 0.50$, $P < 0.0001$. No significant correlations were observed between any of the 16 habitat features and the total numbers of postbreeding ducks, shorebirds, or piscivorous birds. Additionally, no significant correlations were found between the habitat varibles and density (number/ha) for any group of birds.

## DISCUSSION

Green-winged teal, mallards, red-winged blackbirds, Brewer's blackbird, common snipe, and spotted sandpipers were the most abundant bird species associated with beaver ponds on the Laramie Range of southeastern Wyoming. These species are commonly associated with beaver ponds in the central Rocky Mountains (Frary 1954, Casagranda 1955, Peterson and Low 1977, Medin and Clary 1990). Breeding ducks comprised a higher proportion of total ducks during 1994 (77%) than was observed during another study of beaver ponds (43%) on the Laramie Range during 1993 (Brown 1994). This may be attributed to selection of ponds greater than 1000 $m^2$ in 1994 but inclusion of ponds that were 55–3540 $m^2$ in 1993.

It seems that montane beaver ponds in southeastern Wyoming are important as nesting habitat for ducks. Svingen (1991) found similar results on stock ponds in north-central Wyoming. Density of breeding ducks (pairs/hectare) on beaver ponds on the Laramie Range was low compared to other wetlands in the north-central United States where densities ranged from 1.3 to 7.7 pairs per surface hectare (Smith 1953, Stoudt 1969, Lokemoen 1973, Ruwaldt et al. 1979, Svingen 1991).

Of the habitat features that were measured, water surface seemed to be the dominant feature affecting use by ducks. Water surface area was correlated with other habitat features that were also related to abundance of ducks and riparian birds, such as the area of shallow water and length of shoreline with herbaceous vegetation. Other studies of ducks associated with beaver ponds and stock ponds indicate that water surface area is an important habitat feature (Casagranda 1955, Renouf 1972, Lokemoen 1973, Flake et al. 1977, Rumble and Flake 1983). Hudson (1983) suggested that larger ponds offer more security to duck broods. Generally, the greater the visual or spatial isolation that a wetland provides, the greater number of duck pairs it can support (Evans and Black 1956, Swanson 1959, Hudson 1983).

No significant relations were observed between bird density and habitat features. This indicates that the magnitude of bird use was largely influenced by water surface area. However, species richness was related to both water surface area and shoreline development, indicating that increased habitat heterogeneity and the amount of riparian habitat affect the variety of birds that may use a pond (Rafe et al. 1985, Friley 1988).

Greater use of beaver ponds by riparian birds was associated with increasing water surface area, area of shallow water, length of shoreline with woody cover, and area of emergent cover. Larger ponds probably provided riparian birds with greater ability to space themselves among individual territories. Also, red-winged blackbirds and Brewer's blackbird use deciduous riparian plants for reproduction and feeding (Medin and Clary 1990). Consequently, shoreline habitat became an additional habitat feature important to riparian birds associated with beaver ponds on the Laramie Range.

Measurements of water surface areas from aerial photographs accounted for variation in the number of ducks and riparian birds associated with beaver ponds on the Laramie Range in southeastern Wyoming. Additionally, water surface area and shoreline development accounted for variation in the number of bird species associated with beaver ponds. Rough estimates of amount and quality of habitat provided by beaver ponds in the Laramie Range and the numbers and diversity of ducks and riparian birds that use beaver ponds in particular drainages can be obtained from aerial photographs using the regression models presented in this paper. It is likely that a similar approach could be used in other areas of the Rocky Mountains.

## ACKNOWLEDGMENTS

This study was funded by the Wyoming Cooperative Fish and Wildlife Research Unit and the University of Wyoming. The Unit is jointly supported by the University of Wyoming, Wyoming Game and Fish Department, National Biological Service, and Wildlife Management Institute. We thank T. Marwitz and M. McKinstry for their assistance.

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Manuscript recieved 17 May 1995; revision received 14 December 1995; accepted 18 January 1966.