The Canadian Field-Naturalist

Volume 122, Number 4 October–December 2008

The Density of Beaver, *Castor canadensis,* Activities along Camrose Creek, Alberta, within Differing Habitats and Management Intensity Levels

BETHANY M. LOATES[1] AND GLEN T. HVENEGAARD[1,2]

[1]University of Alberta, Augustana Campus, 4901-46 Avenue, Camrose, Alberta T4V 2R3 Canada
[2]corresponding author

Loates, Bethany M., and Glen T. Hvenegaard. 2008. The density of Beaver, *Castor canadensis,* activities along Camrose Creek, Alberta, within differing habitats and management intensity levels. Canadian Field-Naturalist 122(4): 299-302.

Beaver (*Castor canadensis*) occupy a variety of habitats in North America, but prefer Aspen (*Populus tremuloides*) and willow (*Salix* spp.) for food and construction materials. Beaver landforms, such as dams, can cause many problems for landowners, resulting in varied management efforts, such as dam dismantling and Beaver removal. The goal of this study was to compare the density of Beaver activity along Camrose Creek, Alberta, among a variety of habitats and management intensities. Along this 35 km creek there were an average of 0.46 food caches/km, 0.57 lodges/km, and 3.06 dams/km (of which 1.66/km were altered by people and 1.40/km were unaltered). There were more caches, lodges, and unaltered dams in Trembling Aspen forests compared to other habitats. Areas with some management had more food caches and either altered or unaltered dams than areas with no management.

Key Words: Beaver, *Castor canadensis*, density, habitat, management, Alberta.

Beavers (*Castor canadensis*) are found in streams, ponds, and lake edges throughout most of Canada and the United States south of the tree line (Jenkins and Busher 1979; Muller-Schwarze and Sun 2003). Beavers eat leaves, twigs, and bark of most species of deciduous trees and shrubs, with a preference for Trembling Aspen (*Populus tremuloides*) and willow (*Salix* spp.) that grow near water, along with many herbaceous plants (Jenkins and Busher 1979). Beavers typically colonize areas where foraging can take place within 100 m of the water (Jenkins 1980; Skinner 1984).

Beavers construct dams, lodges, food caches, trails, and canals for protection and foraging. Dams are interwoven structures built from rocks, logs, grass, and mud to impound water along streams (Muller-Schwarze and Sun 2003). The resulting ponds provide year-round habitat and allow Beavers to easily transport logs and branches in the summer. Lodges, the principal shelter for a Beaver colony, are occupied for several years (Dieter and McCabe 1989), providing protection from the cold, heat, and predators (Muller-Schwarze and Sun 2003). Each Beaver colony has an average of 4-8 Beavers and 1-3 lodges (Jenkins and Busher 1979). Normally, each colony has one food cache (Broschart et al. 1989), a pile of submerged branches stored in the fall for consumption during the winter (Swenson et al. 1983). Trails are well-worn paths created by walking and dragging tree limbs. Canals are deeper-cut trails or dredged channels filled with water (Butler and Malanson 1994).

Beaver activities are both beneficial and problematic for landowners (Hammerson 1994). Beaver activities help increase aquatic structural diversity, stabilize the water table, and open forest canopies. However, Beaver activities can also flood neighboring land, damage preferred plants, and create public safety concerns (Schulte and Muller-Schwarze 1999). As a result, many Beaver populations around human settlements are managed. In some cases, Beaver numbers are maintained at a level deemed acceptable, and in other cases all Beavers are kept out of specific areas (Schulte and Muller-Schwarze 1999). Typical controls include harvesting, sterilizing, or relocating Beavers, removing dams, introducing natural predators, protecting individual trees, managing water levels, and using Beaver repellants (Schulte and Muller-Schwarze 1999). Not all controls are feasible due to costs or logistics, and success in controlling Beaver numbers by these methods varies considerably (Hammerson 1994).

Along Camrose Creek in east-central Alberta, Beaver management typically occurs from April to September. Dams are removed with manual labour, back hoe tractors, or dynamite. Sporadically, Beaver repellants such as flow-through pipes are used with little success.

Harvesting is conducted through controlled shooting or lethal trapping by landowners or municipal officials. Occasionally, Beavers are live-trapped and relocated.

There is little local information about Beaver density, habitat preferences, and management effectiveness. Thus, the goal of this study was to determine the density of Beaver activities along Camrose Creek, and to compare density among a variety of habitats and management intensities. We predicted that Beaver colony density would be higher within aspen forests than in other habitats such as urban areas, farmland, and badlands. We also predicted that Beaver density would be lower in areas with more intensive management than in areas with less intensive management.

Methods

Camrose Creek, 35 km in length, is located within the Aspen parkland ecoregion of Alberta, 90 km southeast of Edmonton (Figure 1). The creek starts at the Lyseng reservoir outflow (53°06'15"N, 112°52'45"W), meanders south through privately owned farmland, passes through the city of Camrose, cuts through a narrow valley, and empties into the Battle River (52°56'45"N, 112°52'30"W). We walked the entire creek in October and November, 2005. Inventory methods generally followed those of the British Columbia Ministry of Environment, Lands, and Parks (1998). With the help of aerial photographs and 1:20 000 scale topographic maps, we noted the location of all food caches, lodges, and dams. Dams were subdivided into unaltered dams (no evident sign of human management) or altered dams (dams that had signs of mud, logs, and branches removed within the past two years). For analysis, the creek was divided into 1 km-long segments.

Using visual observations of the dominant habitat within 60 m on both sides of the creek, we categorized each creek segment as: (1) farmland for cereal crops and grazing; (2) urban areas, with paved paths or buildings; (3) Trembling Aspen forest; and (4) badlands with short grasses, shrubs, and heavily eroded creek banks.

To determine the intensity of human management of Beavers in the past two years, we conducted telephone interviews with farmers, municipal officials, and wildlife managers who owned land or had management responsibilities along the creek. Based on their responses, we classified the intensity of Beaver management for each creek segment into one of four categories: (1) high – Beaver removal and dam dismantling; (2) medium – Beaver removal only; (3) low – dam dismantling only; and (4) none – no management. We also classified the intensity of Beaver management into two categories, some Beaver removal and/or dam dismantling versus no management.

Using SPSS 11.0, we examined potential differences in Beaver density among varying habitats (four categories) and management intensities (four categories and two categories) by using one-way analyses of variance and t-tests. We conducted post-hoc multiple comparisons with Tukey's honestly significant difference (HSD) test. We set significance levels at $P < 0.05$.

Results

Along Camrose Creek, we recorded 16 food caches (average of 0.46/km), all of which were in the lower 23 km (resulting in an average of 0.70/km for that stretch). We also recorded 20 lodges (0.57/km), 49 unaltered dams (1.40/km), and 58 altered dams (1.66/km). Of the 35 1 km-long creek segments, we classified 13 km as farmland habitat, 11 km as aspen forest, 6 km as urban areas, and 5 km as badlands (Table 1). The creek surveyed began within farmland, passed through city and aspen habitats, and flowed through badland habitat toward the confluence with the river. The number of food caches, lodges, and unaltered dams was significantly different among habitats. Aspen forest habitat contained more food caches than the badland or farmland habitats (Tukey's HSD < 0.05). Farmland had fewer lodges than badland or aspen forest habitats (Tukey's HSD < 0.05). Aspen forest habitats had more unaltered dams than farmland habitats (Tukey's HSD < 0.05). The number of altered dams did not differ by habitat.

The level of management intensity changed frequently along the creek. We classified 12 km as high management intensity, 3 km as medium, 7 km as low, and 13 km with none (Table 2). Using four categories of management intensity, there was no significant difference between management intensity and the number of food caches, lodges, unaltered dams, and altered dams. Using only two management intensity levels (some or none), areas with some management had significantly more food caches, unaltered dams, and altered dams than areas with no management (Table 3).

Discussion

Based on the assumptions that one food cache indicated one Beaver colony and that the average colony held 4-8 Beavers (Jenkins and Busher 1979), we concluded that the total population of Beavers along Camrose Creek in 2005 was between 64 and 128. Further refinement of population estimates would require additional indices, such as visual animal counts, track density, and cache size (Easter-Pilcher 1990; Osmundson and Buskirk 1993).

The average density of Beaver colonies along the entire length of Camrose Creek was 0.46/km (and 0.70/km for the lower 23 km). Summarizing several studies, Jenkins and Busher (1979) reported that the density of Beaver colonies ranged between 0.40/km and 0.80/km. In boreal Minnesota, density ranged between 0.13/km in 1940 and 2.23/km in 1981 (Broschart et al. 1989). In California, density was 0.72/km in the Truckee River and 0.20/km along its tributaries (Beier and Barrett 1989). Similar densities were found in interior Alaska (0.63/km; Boyce 1981), northwest Wyoming (0.90/km; Collins 1976), and central Massachusetts (0.83/km; Howard and Larson 1985).

The average density of dams (both altered and unaltered) in Camrose Creek was 3.06/km. The comparable densities in Quebec (North shore of the Gulf of St. Lawrence; Naiman et al. 1986) and northern Minnesota (Naiman et al. 1988) were 10.60/km and 2.50/km, respectively. There is little comparative information on the density of lodges, trails, or canals.

As expected, the density of Beaver activity was higher in aspen forest habitats than in other habitat types. Aspen trees are the preferred source of food and construction material for Beavers (Jenkins and Busher 1979). Nevertheless, Beavers found in the city and badland habitats obviously found enough food and construction material to survive (i.e., willow, alder [*Alnus* spp.], and White Birch [*Betula papyrifera]*). Because the farmland stretches of the creek contained no colonies, it is likely that the dams present were not active. The low number of altered dams in the city may reflect the presence of a lake in the city (making it difficult for Beavers to construct dams) or the reluctance of officials to manage dams within the city limits.

In creek segments with some Beaver management, there were more caches, unaltered dams, and altered dams than in areas with no management. These results (except for the latter) were contrary to our predictions, and might reflect the landowners' efforts to concentrate Beaver control activities in areas with high Beaver densities to keep those densities at levels acceptable to landowners. Moreover, little or no management is needed where there is little Beaver activity. Thus, this study could not determine if management intensity has an effect on the density of Beaver populations.

There are several limitations to this study. First, the 1 km-long segments of the creek that were used for units of analysis may have masked finer-scale changes in habitat and management efforts. Second, designating management intensity levels had potential problems. Even though we interviewed all landowners and managers along the creek as to which Beaver management techniques they employed, we did not determine the frequency or success of those techniques. Moreover, we found some inconsistent results (e.g., altered dams within segments reported to have had no dams dismantled).

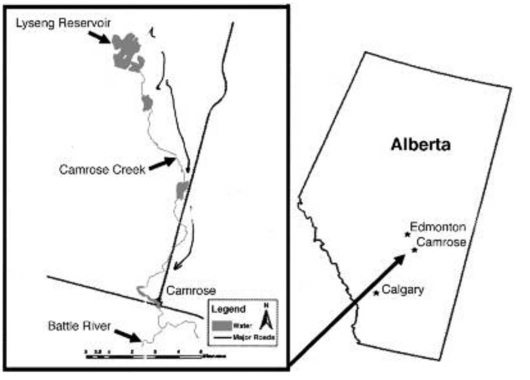

FIGURE 1. Location of Camrose Creek in east-central Alberta, where Beaver density, habitat, and management intensity were measured in 2005.

Further research should focus on Beaver activity densities using finer-scale analyses of habitat suitability and management intensity. A study over several years would provide valuable data to help understand changes in Beaver populations, habitat preferences, and management effectiveness. Other research could examine the effectiveness of alternative forms of management (Hammerson 1994), foraging strategies within habitats (Basey et al. 1988; Fryxell 1992), and the critical thresholds for distance to food resources for successful Beaver colonies (Fryxell and Doucet 1991).

Acknowledgments

We thank J. Loates and B. Kiem (nee Scholten) for field assistance, C. Clarkson and local landowners for management information, the University of Alberta's Augustana Campus for logistic support, and the Centre d'Écologie Fonctionnelle et Evolutive (of France's Centre National de la Recherche Scientifique) for library support. We are grateful to G. Hood and two anonymous reviewers for their helpful comments on earlier drafts of this paper.

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TABLE 1. Differences in Beaver activity density (per km) among four habitat types.

Habitat Type	Caches	Lodges	Unaltered dams	Altered dams
Farmland	0.00^{a}	0.00^{a}	0.38^{a}	1.92
Badland	0.40^{a}	0.80^{b}	1.50^{ab}	2.80
City	0.50^{ab}	0.50^{ab}	1.50^{ab}	0.33
Aspen forest	1.00^{b}	1.18^{b}	2.64^{b}	1.55
F (df = 3)	13.160	8.980	6.309	1.076
P	<0.001	<0.001	0.002	0.373

[a,b]Where superscripts are different there is a statistical significance between habitats at $P < 0.05$, using Tukey's HSD test.

TABLE 2. Differences in Beaver activity density (per km) among four management intensity levels.

Management Intensity	Caches	Lodges	Unaltered dams	Altered dams
None	0.20	0.33	0.67	0.67
Low	0.80	1.00	1.60	2.00
Medium	0.33	0.33	1.33	0.67
High	0.67	0.75	2.25	3.00
F (df = 3)	2.606	1.476	2.760	2.712
P	0.069	0.240	0.059	0.062

TABLE 3. Differences in Beaver activity density (per km) between two management intensity levels.

Management Intensity	Caches	Lodges	Unaltered dams	Altered dams
None	0.20	0.33	0.67	0.67
Some	0.65	0.75	1.95	2.40
t (df = 33)	2.530	1.695	2.651	2.226
P	0.016	0.099	0.012	0.030

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Received 11 August 2008
Accepted 2 March 2009