

BEAVERS IN THE BOREAL: A LODGE CENSUS OF BESNARD LAKE



FIGURE 1: A juvenile beaver eating the bark of an alder stem on Besnard Lake, July 2021. All photos taken and provided by the authors.

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The North American Beaver (*Castor canadensis*) is a common resident of Canada's boreal forest. Beavers have long been a compelling research subject due to the extensive impacts of their dam building and tree cutting on waterways and near-shore forests, and their creation of wetland habitat for other species. While beavers live in a broad range of habitats, they are best known for damming streams. Lakes, though, are also good beaver habitat.¹ Beavers that live in lakes can build dams to regulate the inflow and outflow of water. They also shape the near-shore forest composition through selective tree cutting² (Figure 1). Despite the fact that it is well known that beavers live in lakes, their occurrence in this habitat is not often studied.

Lakes are common in Saskatchewan's boreal forest and beavers live in most of them. Besnard Lake (Figure 2) is located about 50 km west of La Ronge and has a surface area of 172 km.² It is in the

area of Saskatchewan long known to have high beaver population density.³ Water flows into Besnard Lake primarily via the Mercer River and out of the lake towards the Churchill River via Black Bear Island Creek in the north end of MacDougall Bay. The lake has a complex, 575-km long shoreline that includes approximately 250 islands. The lake is relatively shallow, with an average depth of 7.9 m and a maximum depth of 30 m.⁴ There is a long history of beaver trapping on Besnard Lake and during the height of the fur trade there were several fur trade outposts in the region.⁵ The trap lines are not currently very active (C. Collins, pers. comm.).

The lake is surrounded by low forested hills that rise less than 100 m above the water. The southern two-thirds of Besnard Lake lies in the boreal plain ecozone while the northern third lies in the boreal shield ecozone (Figure 2). Flora of Besnard Lake has been documented.⁶

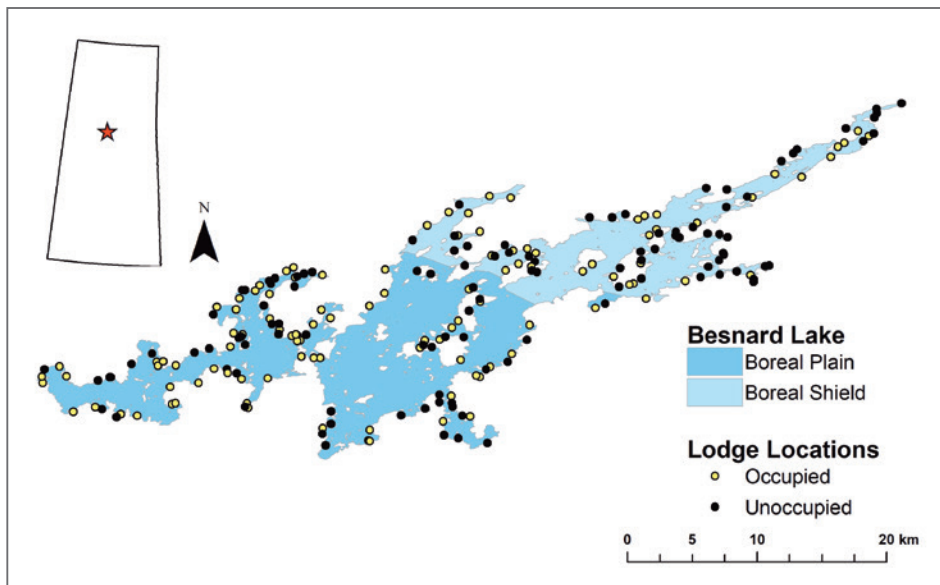


FIGURE 2: Occupied and unoccupied beaver lodge locations on Besnard Lake in 2019. The inset situates the location of Besnard Lake (red star) within Saskatchewan.

Dominant trees include jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), white birch (*Betula papyrifera*) and beaver's preferred food, trembling aspen (*Populus tremuloides*). In the boreal plains ecozone there are also expansive peat bogs along the shoreline of lakes; those bogs that are treed have tamarack (*Larix laricina*) and black spruce. However, smaller wetlands consisting primarily of fens occur along the water's edge of the boreal shield ecozone. The shrubs in the fens mainly consist of alder (*Alnus incana*) and willow (*Salix* spp.). Beavers commonly cut down both of these shrubs for food and material to disrupt the flow of water and build their lodges. Besnard lakes' location along the boreal plain/shield boundary, and its shoreline complexity, make it an interesting place to ask questions of beaver habitat choices.

In 2019, we conducted a census of beaver lodges on Besnard Lake. We estimated the number of beaver colonies (families) via counting the number of occupied beaver lodges between late June and the end of August. For the lodge census, we used the systematic survey

methods developed for the ongoing monitoring of Bald Eagles (*Haliaeetus leucocephalus*) which subdivided the lake into 50 sections⁷, each consisting of approximately 11.5 km of shoreline (mainland and island). We surveyed each of these sections by boat. Since there are hundreds of reefs on Besnard Lake, shorelines were surveyed from a distance (10-40 m) at a boat speed of 2-15 km/h. When observing the shoreline, one observer used binoculars and another observer did not. When a lodge was spotted, the boat was navigated to within 2 m of the lodge and its coordinates obtained with a hand-held GPS.

Food caches are an effective indicator of occupancy by beaver colonies in regions where winter ice forms.⁸ We recorded whether lodges were occupied primarily based on the presence of a cache (Figure 3), which is a pile of branches of woody species constructed during autumn to supply food through the winter in northern latitudes. But we also considered collections of recently cut stems at a lodge as evidence of beaver occupation. We did not evaluate the reproductive status of beaver pairs occupying lodges. Since one beaver colony (family group) may use one

or multiple lodges⁹, lodge sites were considered to be separate territories if they were at least 0.5 km apart.¹⁰ We also recorded location (mainland, island) and shoreline habitat (upland, wetland) for each lodge. If the shore vegetation was burned in the 2015 fire (the Egg Lake fire), we recorded that. With permission from Ducks Unlimited Canada, available habitat (upland, wetland) was determined in ArcGIS using imagery from the Canada Wetland Inventory (see <https://www.ducks.ca/initiatives/canadian-wetland-inventory/>) for a 50-m zone from the shore inland. This zone width seemed most appropriate to characterize near-shore habitats as beavers rarely travel farther than this from water to cut trees.¹¹ To determine whether beavers occupy a particular shoreline habitat in proportion to its availability, we carried out a chi-squared goodness of fit statistical test.

We found 225 beaver lodges on Besnard Lake (Figure 2). Lodges often occurred in small bays that had water deep enough to make it unlikely that it would freeze to the bottom in winter.¹² Some of the lodges were surrounded by water but many were built onto the shoreline. Shoals were present at many bay entrances, providing lodges a degree of protection from wave action.¹³ Only in five instances were there multiple lodges (not more than two) built in close proximity (within 0.3 km of one another). Beaver colonies are known to use newer and older lodges co-located in a lake bay.¹ Although we looked carefully, we did not observe any beaver burrows on the lake, which Bashinskiy¹⁴ reports as the main type of habitation structure on lakes rather than lodges throughout the northern hemisphere. Beavers likely build lodges rather than dig burrows on Besnard Lake due to the rocky shores and thin soils.

A comparison of occupied sites



FIGURE 3: Caching of food (woody materials) in a pile close to the entrance of the lodge, as shown here, supplies a beaver family with much of its food during the winter when the lake is frozen; 11 October 2020.

is the most biologically useful measure of beaver density. Lodge occupancy was 50% and occupied lodge density was 0.19 colonies/km of shoreline. Lodge occupancy was lower than that recorded for a lake about half the size of Besnard in Texas (95% occupancy)¹⁵, but there are only a few reports of lodge occupancy for lakes in the scientific literature. A high ratio of unoccupied to occupied lodges can reflect overharvesting, overpopulation or other environmental constraints.¹⁶ Fluctuating lake levels might make some lodges habitable in drier or wetter years.¹⁴ In lakes where water levels fluctuate greatly year to year a high incidence of two or more lodges within 0.5 km of one another, usually at different heights relative to the high water mark, would be expected; however, we observed few instances of two or more lodges within 0.5 km of each other. It is also unlikely that

the low lodge occupancy reflects overharvesting. Although there are two trap lines passing through the lake, neither have been very active for many years. More likely, the occupancy rate reflects the fact that beavers will move from lodge to lodge every few years¹⁷ when the forest regrowth is sufficient to again support their tree cutting.²

Within 50 m of shore, there was 13.5 km² (55%) of upland habitat, 5.5 km² (22%) of wetland habitat and 5.6 km² (23%) of open water (small lakes). Wetland habitat was used in a higher proportion to its abundance and upland habitat was used in a lower proportion to its abundance ($\chi^2 = 14.0$, $p = 0.0002$). Higher occurrence of beavers in wetlands than uplands has also been reported in northern British Columbia, and was attributed to wetlands having more high-value forage species.¹⁸

In particular, wetlands often have a high abundance of willows (*Salix* sp.), which can sustain longer term consumption by beaver owing to their quick regenerative capacity.^{19,20} But beaver can also subsist on sedges (*Scirpus*, *Typha*, etc.)²¹ and other emergent aquatic plants²², which are common in boreal wetlands. Also important in influencing beaver habitat choices is how close the high-value forage is to shore. Beavers forage close to shore to minimize the time and energy expenditure involved with cutting a tree, sectioning it into manageable pieces, and dragging the pieces to water.^{23,24} Foraging close to shore also reduces predation risk.²⁵ The uplands thus might have been used in a lower proportion to their abundance as the Ducks Unlimited Canada data indicate 73% of the upland forests within 50 m of the shore were conifer-dominated, which are tree species typically avoided

by beavers.² One other thing we noticed was that at many of the wetland sites, beavers had excavated an extensive network of forage trails through them to access trees (especially aspen) in the uplands (Figure 4). Interconnection of lake habitats by beaver canals has been noted elsewhere, for example, at Miquelon Lake Provincial Park east of Edmonton.²⁶ Why wetland habitat at Besnard Lake is being selected by beavers at a higher proportion to its availability is unclear — is it selected to reduce predation risk or to access a wide range of high-value forage species?

The materials with which beaver lodges were constructed varied across the lake, mostly by habitat type (Figure 5). In wetland habitat (especially bogs and treeless fens),

fewer sticks were used and lodges were built primarily from excavated peat soil. In upland habitat, beavers primarily used logs and branches. Regardless of their location, most lodges were tall, likely so that breathing holes would be above snow (Figure 6). The area receives on average 154 cm of snow each winter (Environment and Climate Change Canada climate ID station no. 4064150, La Ronge). Many lodges had a roughly circular base and conical side view but some were lodge complexes consisting of two or more conical shapes, suggesting they had been built onto by multiple generations of beavers. Successive beaver colonies occupying a single site will repair old lodges or expand them instead of building new ones.²⁷ We observed only one instance of

a new lodge being built on the lake during our census.

The July 2015 wildfire burned large tracts of forest in the northeast and extreme western parts of the lake. The fire effectively cleared the ground of standing vegetation and litter along much of its path. In our census, we observed 24 lodges along the shoreline burned in the wildfire, five (20%) of which were occupied by beavers. In September 2020 we re-surveyed the burned shoreline and observed 12 occupied lodges using the same methods described earlier. Seven of these lodges were classified abandoned in 2019 and then were re-occupied by beavers in 2020 but the other five lodges were new. In September 2021 we observed 13 occupied lodges along shoreline burned in

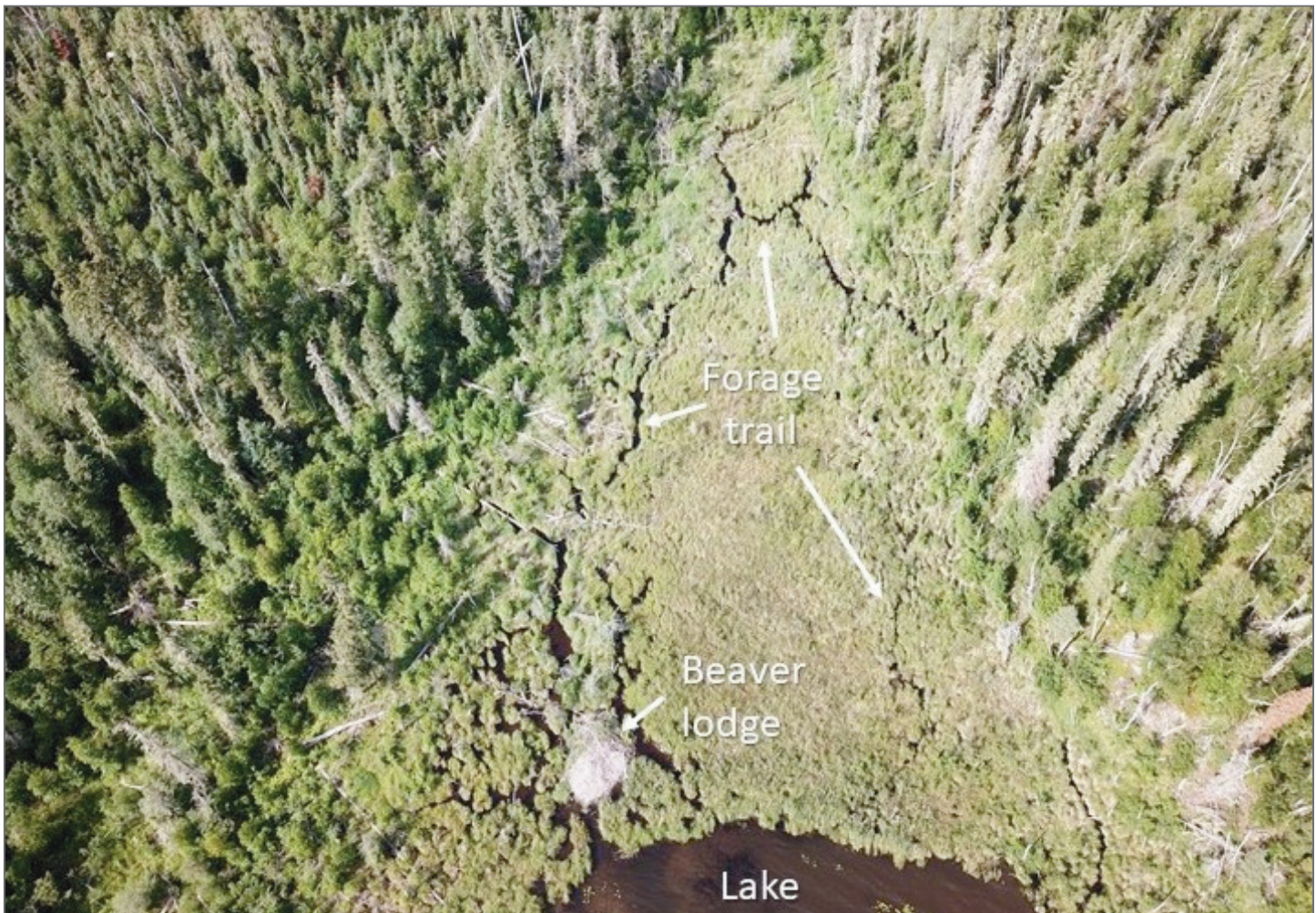


FIGURE 4: Drone (DJI Mavic) acquired image showing a beaver lodge and a network of forage trails leading from the lake, through the small wetland (peatland) to the upland, 4 July 2021.



FIGURE 5: Examples of the diversity of construction and composition of beaver lodges on Besnard Lake.

2015 (Figure 7); nine were classified abandoned in 2019. Wildfires renew early successional species like aspen, which is an important beaver food resource.² Aspen are quick growing trees; aspen forest stands can reach 10% canopy cover and 5 m average tree height within 5–10 y post fire²⁸, but it can take upwards of 20–30 y after a wildfire to renew beaver food resources sufficiently to increase beaver density.^{29,30} However, fire disturbance can also support production of aquatic plants, the availability of which is associated with the persistence and density of beaver occupancy in lakes.³¹ We will continue to monitor the number of occupied lodges along the burned shoreline to evaluate recovery post-fire.

It might be expected that lodge density would be lower on islands than the mainland at Besnard Lake, as islands burn less often and thus have mostly coniferous forests. However, this was not the case. While we did observe more occupied beaver lodges on the mainland (83) than on islands (17), the shorelines were used in proportion to their



FIGURE 6: Snow covered, occupied beaver lodge with close-up of breathing hole on top (inset) at Besnard Lake, March 2021. This is the same lodge shown in Figure 3.



FIGURE 7: An occupied beaver lodge built in 2021 along the shoreline burned in 2015. Note the growth of aspen and alder along the shoreline.

abundance ($\chi^2 = 2.9$, $p = 0.089$). The reason for this is not clear. Perhaps it is because on islands, beavers are less vulnerable to predators like wolves, bears, wolverines and cougars³²⁻³⁵ or perhaps it is because many of the islands are large and have small bays. Further research is recommended to provide insights on this observed pattern.

Occupied lodge density was higher in the part of the lake lying in the boreal plain (0.21/km of shoreline) than in the boreal shield (0.17/km). Beavers, however, used the shoreline of the lake in the boreal plain (61%) and in the boreal shield (39%) in proportion to their availability ($\chi^2 = 1.05$, $p = 0.31$). This was somewhat surprising as there was 2.4 times more wetland habitat available within 50 m of the lake in the boreal plain than the boreal shield. Further, Symington³ reported that beaver fur production in the Canadian shield was low owing to dominance of coniferous species. The lack of difference in lodge density on Besnard Lake between the two

boreal ecozones may be an artifact of the spatial resolution at which the boundary was identified. The boundary for the ecoregions was retrieved from Agriculture and Agri-Food Canada's Terrestrial Ecoregions of Canada open-access dataset; this dataset contains GIS shapefiles for the entire country. In examining the regional physiography on higher resolution aerial photographs and in site visits, it is likely that the boreal plain-shield boundary is farther south than in the federal dataset which might influence the use of the shoreline statistics.

In summary, we observed 225 beaver lodges on Besnard Lake in 2019 and no beaver burrows. Half of the lodges were occupied, with a density of 0.19 beaver colonies/km of shoreline. Lodges varied in composition, depending on the habitat. In wetlands lacking trees, lodges were built primarily from excavated peat whereas in uplands and treed wetlands, lodges were built primarily from logs and branches. We found that wetland habitat

was used in a higher proportion to its abundance and upland habitat was used in a lower proportion to its abundance, consistent with observations of beaver habitation in other lakes in Canada. Foraging trails were common in wetlands, terminating at uplands. Although occupied lodge density was higher in the part of the lake lying in the boreal plain than in the boreal shield, beavers surprisingly used both shorelines in proportion to their availability despite there being more wetland habitat available within the boreal plain than the boreal shield. The wildfire in 2015 burned at least two dozen beaver lodges; however, a more than two-fold increase in the number of occupied lodges observed between 2019 and 2020 is encouraging evidence of beavers' quick recovery.

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