Managing for Beaver on the Bighorn National Forest

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Wyoming Game and Fish Department
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Abstract: The Wyoming Game and Fish Department conducted six beaver cache surveys on the Bighorn National Forest of Wyoming between 1986 and 2002. A seventh beaver cache survey was conducted in 2003 with funding provided by the Bighorn National Forest. Beaver populations on the Forest have declined in recent years. Drainages that contain beaver generally have lower populations, while many previously occupied habitats are no longer populated. We failed to detect evidence of beaver activity in ten sixth-order watersheds, which were occupied historically.

The long-term decline of beaver numbers may be much more acute. Forest rangers documented a growing population from 1914 through 1941 in response to beaver restoration efforts. By the 1940s the beaver population was estimated at 1,200. If these data are correct, populations have experienced dramatic declines since then.

The Department and Forest recognize the value of beaver to the ecosystem. For instance, the agencies are proposing that beaver serve as a Management Indicator Species (MIS) in the revised Forest Plan. An MIS serves as a barometer for species viability.

The Forest contains approximately 10,537 acres of potential beaver habitat based on our model. Of those, 1,126 acres are known to be occupied and another 1,633 have historic evidence of beaver. Many habitats identified by the model are unsuitable, however, due to patch size and the lack of connectivity. Others are deficient of quality food and dam building materials or adequate flows to maintain water levels. Nevertheless, it's clear that beaver could occupy substantially more area on the Forest.

In response to declining populations and the absence of this keystone species in some drainages, the agencies are collaborating with the Rocky Mountain Elk Foundation, Wyoming Governor's Big Game License Coalition and Bow Hunters of Wyoming to transplant beaver to previously occupied habitats. We prioritized release sites by considering model outputs such as patch size and connectivity. We also considered historic activity, watershed activity and suitable habitat conditions. Based on our analysis, we recommend that beaver be transplanted to at least fourteen sites. More should be considered once these are occupied.

INTRODUCTION

The beaver (*Castor canadensis*) will likely be classified as a Management Indicator Species within the Bighorn National Forest (Forest) Plan which is currently being revised. The status of beaver may be indicative of a larger functional group of species. To some the beaver is considered a nuisance because they cause flooding, detain irrigation flows, or remove desired woody plants. Despite these concerns, the benefit of beaver in riparian systems far outweighs potential problems that might arise.

Beaver improve many aspects of riparian habitats for wildlife. More than 80 percent of wildlife in Wyoming relies on riparian zones (McKinstry et al., 2002). Ponds created by beaver improve water quality, increase riparian area and store water for dry months (Olson and Hubert, 1994). In some cases, bird densities in active beaver habitats have been shown to be three times that of adjacent riparian habitats (Collins, 1993). Forage production is improved around beaver ponds, which increases grazing capabilities for wild and domestic ungulates. Beaver also create excellent habitat for trout. Studies have shown that trout size and biomass are greater in streams with beaver ponds (Olson and Hubert, 1994).

This paper summarizes recent and historic population trends, analyzes available and suitable habitats and recommends future management direction for the species.

STUDY AREA

The 1,107,671-acre Forest is approximately 80 miles long and 30 miles wide. Elevations range from approximately 4,000 to 13,175 feet. Annual precipitation varies from eight inches on the west side of the range to 15 inches on the east and 24 inches at higher elevations. Vegetation is typical of the central Rocky Mountain region, with low-elevation juniper (Juniperus osteosperma), mid-elevation ponderosa pine (Pinus ponderosa) and Douglas-fir (Pseudotsuga menziesii), and high elevation lodgepole pine (Pinus contorta) and spruce-fir (Picea engelmannii and Abies lasiocarpa). Aspen (Populus tremuloides) stands are infrequent. Numerous large natural openings and gentle slopes at high elevation characterize the Forest. Big sagebrush (Artemisia tridentata) and Idaho fescue (Festuca idahoensis) dominate forest openings. Land uses include livestock grazing, logging and a variety of recreational activities. Despain (1973) provides a detailed description of vegetation, soils, geology and climate of the Forest.

METHODS

Population data were analyzed for all surveys completed since 1986. The Wyoming Game and Fish Department (Department) inventoried food caches during the falls of 1986, 1987, 1988, 1992, 1993, and 1994 (see Appendix I). These surveys were generally incomplete and only involved the east slope. In 2003 the Forest funded a more complete survey (both east and west slopes) using a helicopter. The population was estimated by multiplying the total number of food caches observed by 4.5. Rutherford (1964) determined that each cache supported an average of 4.5 beaver in willow communities and 5.1 in aspen communities. We used 4.5 since aspen stands are infrequent (Despain 1973) and declining (Bornong, 2002). The resulting population index was further enlarged by 40 percent. Payne (1984) found that 35 to 40 percent of caches are missed during aerial surveys because of obstructed views.

Suitable beaver habitats where identified using a geographic information system (GIS) based model. The initial model was developed by Staley (2004). This preference model used Boolean logic based upon fitting the following criteria:

1) The valley floor gradient must be less than or equal to three percent ($\leq 3\%$).
2) The area must be within 200 meters of aspen or willow.
3) The stream order must be less than or equal to four (≤ 4).

This model incorporated GIS-based data from the Forest Common Vegetation Unit, Valley Floor, and Stream datasets. All parameters had to be met for an area to be considered suitable. Validation occurred by comparing suitable habitat model outputs with known beaver locations from the Department's Wildlife Observation System, and beaver dams and caches identified from aerial surveys. During 2003 flights, beaver dams and caches were recorded using global positioning systems (GPS). This added considerable precision for validating the model.

Our analysis showed that the parameters in Staley's model were too restrictive and failed to delineate all known beaver habitats. Based on this validation, we adjusted model criteria to include the following:

1) The valley floor gradient must be less than or equal to twelve percent ($\leq 12\%$).
2) The area must contain aspen or willow and be within 200 meters of perennial streams or permanent bodies of water.
3) The stream order must be less than or equal to four (≤ 4).
4) Suitable habitat had to be greater than or equal to one (≥ 1) acre in size.

As shown in Table 1, the final model used the same Forest Common Vegetation Unit and Stream datasets. It also incorporated the Forest Waterbody dataset to include suitable aspen and willow habitats found adjacent to ponds and lakes. In addition, the National Elevation Dataset was used to calculate the slope/gradient. Like the original model, suitable habitats had to meet all criteria.

Data Theme	Dataset	Source
Vegetation	bh_cvu	From Bighorn National Forest
Slope/Gradient	Department_slope	From Wyoming Game & Fish
Stream Order	bh_streams	From Bighorn National Forest
Water Distance	bh_streams bh_waterbody	From Bighorn National Forest

Table 1. Data sources used in the final suitable beaver habitat model.

The most significant change to Staley's model involved stream gradient. Studies have shown that 68 percent of beaver colonies occurred in valleys with floor gradient of less than six percent. An additional 28 percent of colonies were found in valleys with a floor gradient of seven to twelve percent. Only four percent were associated with gradients greater than twelve percent (Allen, 1983). Because significant numbers occur in the seven to twelve percent range, we selected twelve percent as the upper acceptable limit.

Polygons less than one acre were removed since all documented beaver habitats exceeded this acreage. This process removed thousands of small isolated polygons that could not feasibly support beaver. Remaining polygons were attributed as to whether they were; 1) occupied by beaver during the 2003 fall survey, 2) historically occupied based on surveys, records or observations, or 3) unoccupied or unknown.

Prior to this effort, historical records were imported to a GIS to facilitate the attributing and validating processes. Figure 1 show an example of our results on the North Tongue River. A map of the entire Forest can be requested from the Department.

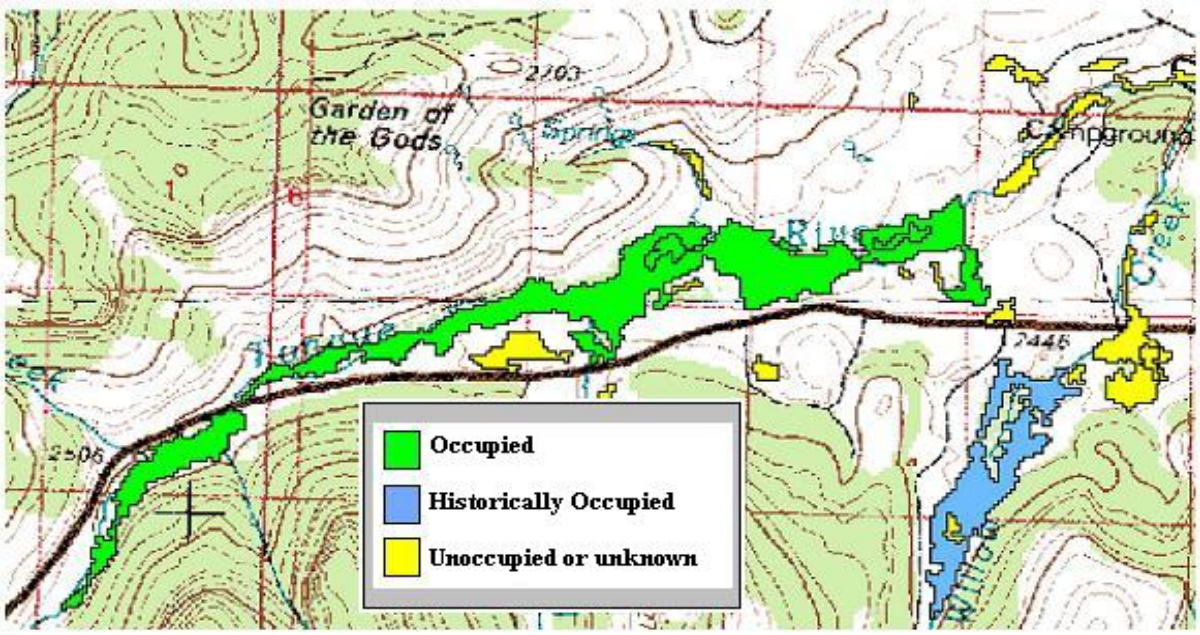

Figure 1. Map showing the results of the habitat suitability model after delineated polygons were attributed on the North Tongue River near Burgess Junction.

Suitable habitats were sorted by size (based on polygon area) in order to prioritize areas for beaver reintroduction efforts. We felt larger areas of suitable willow and aspen resources gave transplanted beaver the best chance for survival. We also considered patch connectivity in the prioritization. Priority sites were visited to collect information relative to the health and availability of willow and aspen resources and possible ecological benefits. Photographs of vegetation and their GPS locations were taken at each site.

RESULTS

As shown in Figure 2, historical documents indicate that in 1940 the Forest beaver population had grown to approximately 1,200 (Warder, 2004). This recovery was due to a transplant effort aimed at improving the furbearer industry (Blair, 1987). In 1994 the estimated population index was 340. By 2003, the beaver population index was down to 200 animals. Recent population indexes were extrapolated to correct years when a substandard number of drainages were not surveyed (see Appendix I).

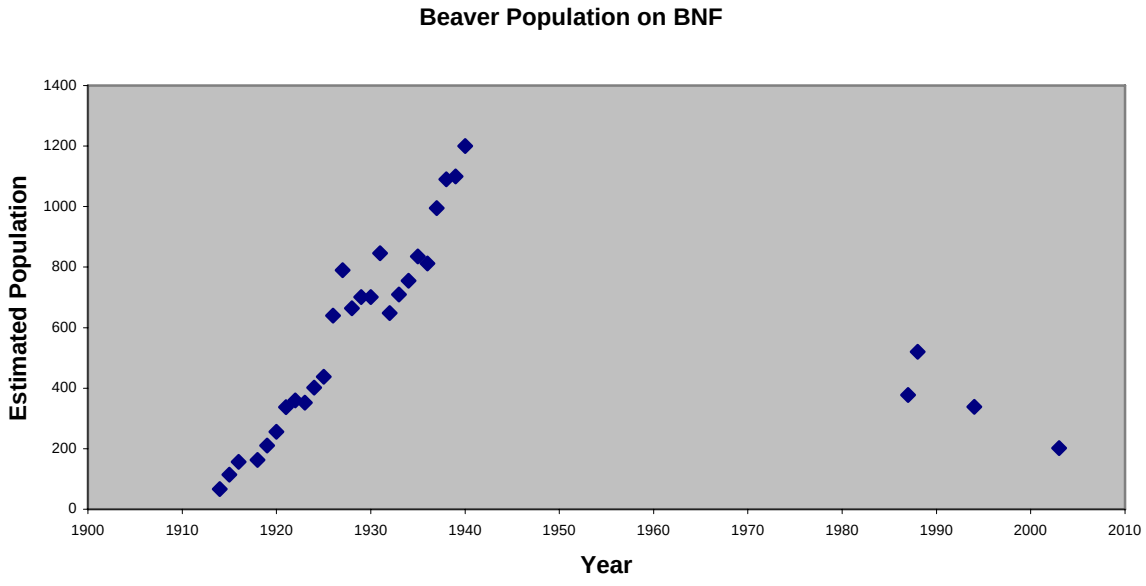

Figure 2. Graph depicting the USFS ranger data from 1914-1940 and Department beaver index data from 1986-2003.

Note: The 1941 data estimated the beaver population at 4500 beaver. Since it deviated so far from other years, we removed it from the chart.

The accuracy of population estimates from 1914 to 1940 is not known. These data and a description of their origin can be found in Appendix II. It's probable that larger beaver populations existed. More recent research-based population index calculations should be more reliable, although not validated for accuracy on the Forest. Whether the population estimates are accurate or not, it appears a steady downward trend has occurred. As shown in Figure 3, the population indexes for 22 watersheds consistently surveyed since 1986 has been cut in half. As displayed in Appendix I, drainages that contain beaver have lower populations than previous years and many historically occupied habitats are without beaver.

According to our model, the Forest contains approximately 10,537 acres of potential beaver habitat. Of those 1,126 acres are known to be occupied and another 1,633 have historic evidence of beaver. Many habitats identified by the model are unsuitable, however, due to patch size and the lack of conductivity. Others lack quality food and dam building materials or sufficient flows to maintain water levels. Nevertheless, it's clear that beaver could occupy substantially more acres on the Forest.

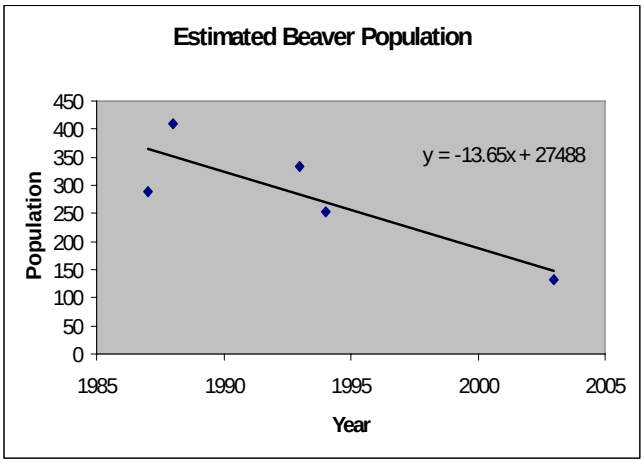

Figure 3. Shows the population trends for 22 drainages consistently surveyed from 1986 to 2003.

Table 2 shows the results of the prioritization process used to identify habitats for reintroduction efforts. Drainages were prioritized and graded. The vegetation type and height of willow and aspen resources were also determined.

Drainage	Priority Number	Site Grade	Vegetation Type	Willow Height
Owens Cr.	1	A	Willow	>6ft
Marcum Cr.	2	B	Willow	<6ft
Prospect Cr.	3	B	Willow	>6ft
Keno Cr. (needs further review)	4	A	Willow/Aspen	>6ft
Heese Cr.	5	B	Willow	>6ft
Bald Mt. Cr.	6	B	Willow	>6ft
Caribou Cr.	7	B	Willow	>6ft
Little Sourdough Cr.	8	B	Willow	>6ft
MF CrazyWoman Cr.	9	B	Willow	>6ft
Upper Muddy Cr.	10	A	Willow/Aspen	>6ft
North Tongue	11	A	Willow	>6ft
Bruce Cr.	12	B-	Willow	>6ft
Half Ounce Cr.	13	C	Willow	<6ft
Compartment Cr.	14	C	Willow	<6ft

Table 2. The drainage, priority, site grade, vegetation type and height of potential release sites on the Forest.

DISCUSSION

Many different issues could be responsible for the reduction of beaver on Forest lands. Disease may have or may be affecting beaver populations. Tularemia can decimate beaver population (Adrian et. al., 1982). Psuedotuberculosis can also affect beaver, although to a lesser extent than tularemia. Staphylococcosis is documented to affect beaver populations. It results in high mortality of rabbits and is believed to have the same affect on beaver (Adrian et. al., 1982). Other diseases are possible too.

Increased road densities in riparian habitats are affecting beaver populations. Beaver have been removed from suitable habitats because they dammed culverts or bridges. The legal trapping of beaver, on the other hand, has been regulated and controlled by the Department, thus is unlikely to have influenced long-term population trends.

Heavy browsing of willow and aspen by livestock and wildlife has been documented on the Forest (Bornong, 2002). The resulting degradation of riparian habitats and lack of rejuvenation in willow and aspen stands may be the greatest contributor to declining beaver populations.

MANAGEMENT IMPLICATIONS

Beaver on the Forest can facilitate riparian habitat restoration and function. McKinstry and Anderson (2002) found that beaver could be used to create wetlands and improve riparian habitat.

The Department has periodically contracted trappers to live trap beavers from private lands where they are causing damage. These "problem" beaver are then transported to suitable but unoccupied habitats. McKinstry and Anderson (2002) determined that 17 beaver on average needed to be relocated to an area within six months to establish a reproducing pair. This is due to mortality (30 percent) and emigration (51 percent), which total 81 percent. They suggested beaver be released in groups to increase the likelihood of colonization. Transplants in the fall were more successful because beaver were instinctively preoccupied with building dams and storing winter food.

We recommend that the agencies follow McKinstry and Anderson's guidelines and transplant beaver to sites found in Table 2. The best time for transplanting is during cool weather between May and September. Repopulating historic habitats and monitoring populations will be essential for maintaining good beaver populations on the Forest. Aerial surveys should be conducted at least every five years.

It's further recommended that biologists aerial survey most, if not all, suitable habitats identified by the predictive model. A GPS should be used to acquire the coordinates of active and historic caches and dams. The population index should be calculated in the same way as described in this report to maintain consistency.

SUMMARY

Beaver are important to the wildlife and ecological health of the Forest. It's clear that beaver populations are well below historical and desired levels and need management action to increase their numbers. Management should also take steps to improve willow and aspen resources. Persistent transplanting of beaver to unoccupied suitable habitats will take advantage of their ability to restore depleted riparian habitats. At a minimum, managers should restore beaver populations to levels found in the 1980s, while working towards historic levels.

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Appendix I

Drainage	Caches Observed																
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Prospect Cr.	2	1	1					4	1									0
Compartment Cr.	1	1	3					2	2									0
Owen Cr.	4	2	6					5	2									0
Sheely Cr.	0	0	0					0	0									
Marcum Cr.	4	2	3					0	0									0
S. Tongue	1	1	2					0	0									2
Prune Cr./Sybley Cr.	1	0	0					0	0									
N. Tongue	9	10	13					13	9									5
Big Willow	3	6	6					2	1									0
French Cr.		2	3			0			0									1
N. Fork Clear Cr.		0	0			3			4									2
M. Fork Clear Cr.		0	0			1			0									0
S. Fork Clear Cr.		0	0			0			0									
Sourdough Cr.		2	7			9			5									2
L. Sourdough Cr.		0	0			1			2									0
Pole Cr.		5	6			3			6									1
Caribou Cr.		3	3			3			0									0
Goodman Cr.		2	2			0			1									0
N.F. Crazy Woman Cr.		3	6			4			2									3
M.F. Crazy Woman Cr.		2	ns			ns			2									0
Muddy Cr.		3	2			1			1									1
Poison Cr.		1	1			0			2									4
Hesse Cr.		2	1			2			2									0
Doyle Cr.		ns	1			ns			1									3
Webb Cr.																		2
Taylor Cr.																		1
EF Big Goose Cr																		2
Grommund Cr.																		1
Soldier Park																		2
Total Cache Seen	**25**	**48**	**66**				**27**	**26**	**43**									**32**
Estimated missed cache	**10**	**19.2**	**26.4**				**10.8**	**10.4**	**17.2**									**12.8**
Total Cache	**35**	**67.2**	**92.4**				**37.8**	**36.4**	**60.2**									**44.8**

Note: (ns) means there were no surveys conducted that year in the drainage.

Appendix II

In 1899 the Wyoming state legislature closed the season on beaver trapping for a period of approximately 20 years, because of depleted beaver populations. In 1914 USFS rangers began keeping population logs on beaver populations. That year the population was estimated at 67 animals. Around 1930, the Wyoming Game and Fish Department began live trapping beaver and releasing them into suitable habitats on state and federal lands. The combination of the reintroduction efforts and trapping closures helped establish a healthy population by 1940.

Year	Beaver Population
1914	67
1915	114
1916	157
1918	163
1919	210
1920	256
1921	337
1922	359
1923	352
1924	402
1925	438
1926	640
1927	790
1928	664
1929	701
1930	701
1931	846
1932	648
1933	710
1934	755
1935	835
1936	812
1937	995
1938	1090
1939	1100
1940	1200
1941	4500