RESEARCH

Attitudes of Private- and Public-Land Managers in Wyoming, USA, Toward Beaver

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ABSTRACT / A mail survey concerning beaver (*Castor canadensis*) management in Wyoming, USA, was sent to 5265 private-land managers and 124 public-land managers during 1993. The survey was developed in response to increasing interest in beaver management and beaver reintroduction possibilities. Private-land managers responding to the survey supplied information on 62,859 km^2 of land area and 20,037 km of streams. Primary concerns about beaver damage centered on (in decreasing order of importance) blocked irrigation ditches, girdled timber, blocked culverts, and flooded pastures, roads, crops, and timber. Primary benefits that landowners perceive that beaver give them were, in order of importance, elevated water tables, increased riparian vegetation, and increased stock-watering opportunities. Public-land managers also listed these benefits and detriments among their top concerns for beaver. Over 45% of landowners with beaver on their property and all of the public-land managers displayed an interest in a beaver reintroduction program and in more proactive beaver management.

Prior to the arrival of Europeans in North America, the beaver (*Castor canadensis*) population was estimated to be between 60 and 400 million individuals (Naiman and others 1988, after Seton 1929). As eastern beaver populations declined from overharvest, expeditions were often made to the West (1800–1850) solely for the purpose of discovering new trapping areas (Cline 1974). Eventually western regions were also overharvested (Johnson and Chance 1974), and by 1900 beaver were nearly extirpated from North America (Jenkins and Busher 1979). Beaver are resilient, however, and can repopulate an area if suitable habitat is available and the factors suppressing the population are removed or reduced (e.g., trapping). In the late 1960s the population was thought to number between 6 and 12 million in North America (Shaw and Fredine 1971). Beaver population trends in Wyoming are virtually unknown since early population estimates were never made and extensive trapping and transplanting operations along with habitat modifications have occurred since implementation of beaver survey methods.

Beaver are increasingly viewed as an integral part of riparian ecosystem function (Naiman and others 1988), and many public and private groups have made efforts to reestablish them in unoccupied habitat (Apple and others 1985, Hill 1987, Johnson 1984, Maxwell 1994). In Wyoming there is a growing interest in using beaver for riparian improvement, especially in degraded stream habitats. Because of this, the Wyoming Game and Fish Department (WG&FD) wanted to determine the feasibility and public interest of a beaver-reintroduction program. Our objectives were to: (1) survey public and private land managers for attitudes about beaver and beaver management in Wyoming, (2) determine current and future desired trends in beaver populations, and (3) determine the feasibility of developing a beaver reintroduction program for the purposes of wetland creation and riparian enhancement. Similar information has been collected in other parts of the beaver's range (Godbee and Price 1975, Woodward and others 1976, 1985, Payne and Peterson 1986, Wigley and Garner 1987, Enck and others 1992), but we felt that differences would exist, especially with regard to population trends and importance of beaver damage and benefits to landowners.

KEY WORDS: Beaver; Beaver management; *Castor canadensis;* Landowners; Mail surveys; Wildlife values; Wildlife damage

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Methods

To determine attitudes, population trends, and the interest in a beaver reintroduction program, mail surveys were developed that sampled both public- and private-land managers. Information from a broad geographical area is often difficult to obtain, especially if it concerns details about inaccessible areas (i.e., private lands, wilderness). Other researchers have had varied success using mail surveys (Godbee and Price 1975, Woodward and others 1976, 1985, Berg and others 1983, Wigley and Garner 1987, Enck and others 1992),

but it is often viewed as the only method, short of personal interviews, for gathering this type of information.

To answer each of the three objectives, questions were developed that filled information needs about: (1) beaver population status (both current and desired trends in populations), (2) primary damage concerns, (3) primary benefits derived from beaver, (4) landowner tolerance of beaver, and (5) interest in a beaver reintroduction program. Information needs were developed from conversations with biologists and department managers within the WG&FD. Eighteen questions for the private landowners and 12 questions for the public-land managers were developed after an objective-by-question matrix was generated to refine questions and verify that they would answer specific objectives. The survey design followed Enck and others (1992), Wigley and Garner (1987), and Woodward and others (1976). Questions were short, with definitive answers in the case of beaver population numbers and land and stream ownership, or were categorical with check-off or ranking answers.

Private Landowner Survey

Using a WG&FD landowner database, we identified 5265 landowners in Wyoming to whom we mailed the initial survey. After two months, identical follow-up surveys were mailed to nonrespondents along with a short letter encouraging them to respond (Enck and others 1992). Both surveys were mailed with postage-paid return envelopes. One year after the last survey was mailed we attempted to contact by telephone 100 randomly sampled nonrespondents. When contact was made we used another survey to gather information on land ownership, stream ownership, beaver presence or absence, beaver population trends, and frequency of beaver damage. These contacts were used to test the null hypotheses that nonrespondents did not differ from respondents with respect to land and stream ownership and presence of beaver. No effort was made to weight the responses of landowners with acreage of land or length of stream that was under their control. For our purposes we felt that each landowner's opinion should be equal. Theoretically, game and fish agencies deal with individuals and should not weigh decisions based on a particular landowner's preference.

Public-Land Manager Survey

One hundred twenty-four public-land managers/wildlife biologists (usually wildlife biologists at the district level) were identified from records provided by the US Forest Service (USFS), Bureau of Land Management (BLM), Wyoming Association of Conservation Districts (WACD), and WG&FD. Undoubtedly, there were more managers knowledgeable about beaver than those identified, and to compensate for this deficiency we encouraged all public managers to network and gather information from other biologists in their area.

Public-land managers were mailed surveys with questions similar to those sent to private landowners, but the surveys also included questions about information needs concerning beaver management and the desire for a statewide beaver management meeting. We also included a mapping exercise with the survey. The maps consisted of 1:100,000 scale topographical maps that covered the respective manager's jurisdiction. On these maps we asked them to identify four types of watercourses: (1) areas that currently have populations of beaver, (2) areas where beaver have been extirpated, (3) areas where riparian improvement is being actively pursued using beaver management, and (4) riparian areas that could be improved with the introduction of beaver. Information from maps was used to answer questions about trends in beaver populations and to identify areas where beaver could be used for riparian habitat improvement.

Some land areas reported on by private landowners may have also been accounted for by public-land mangers, since we treated lands leased (including public leases) and owned by private landowners as the same. For our purposes we felt that this was acceptable since: (1) we wanted to get information from both public and private land managers, (2) we treated the results separately, (3) both private- and public-land managers were reporting on their respective areas as a whole and were not asked specifics about individual streams, and (4) the only questions where double counting would present a problem were those associated with beaver population estimates and we used only the estimates that were supplied by the private landowners.

Articles concerning the surveys were carried by local newspapers, radio stations, WG&FD publications, and newsletters sent out by the Wyoming Stock Growers Association (WSGA), Wyoming Wool Growers Association (WWGA), and Wyoming Wildlife Federation. Additionally, for surveys mailed to public-land managers we requested that supervisors of the potential respondents encourage, if not require, employees to fill out the survey.

Statistical Analyses

All statistical analyses were performed using SPSS (1990) and SigmaStat (Jandel Scientific 1994) statistical software. Two-tailed *t* tests were used to determine the differences between respondents and nonrespondents with respect to land acreage and stream length. We used

Table 1. Perceptions (percentages of total) of actual and desired beaver population status in Wyoming[a]

Category	Landowners	Public managers	Non-respondents
Past and current population trends			
Increasing	37	25	20
Decreasing	20	20	30
Remain stable	43	55	50
Desired future population trends			
Increase	11	63	—[b]
Decrease	52	37	—[b]
Stable	39	—[b]	—[b]

[a]Columns may not sum to 100% due to rounding error.

[b]Question not asked of this group.

z tests to compare the proportional differences between land and stream ownership and beaver presence/absence of respondents and nonrespondents. Tests were considered significant at $P \leq 0.05$.

Results

Survey Returns

Of the 5265 landowners (we defined public-land leaseholders as landowners), 2900 returned surveys, for a return rate of 55%. We removed 521/2900 surveys because they were not landowners or leaseholders in Wyoming, did not provide acreage or stream length data, or owned/leased less than 4 ha. Of 124 public-land manager surveys mailed, 72 (58%) were completed and returned.

Beaver Population

Private-landowner respondents supplied information for 62,859 km^2 of land area (25% of Wyoming) and 20,037 km of streams and rivers. One thousand ten landowners (42,179 km^2 land area, 8559 km streams/rivers) reported that they had seen beaver on their property and estimated that they had 9312 beaver ponds, 5444 colonies, and 24,109 beaver. This translates to an estimated 2.82 beaver/km of stream for streams with beaver or 1.2 beaver/km of stream for the entire reporting area. (We do not provide variance estimates since these figures are derived from exact population numbers estimated from landowners.)

The majority of both landowners and public-land managers felt that beaver populations in Wyoming were stable or increasing (Table 1). Of those public-land managers that reported beaver populations to be decreasing in their area, over 60% listed some form of diminished habitat quality as the cause (Table 2).

Table 2. Reasons why beaver populations have declined in Wyoming as reported by 72 public land-managers

Reason for decline	Ranking	Total (%)
Habitat degradation	1	23
Overuse of habitat by beaver	2	20
Habitat succession	3	19
Over trapping	4	18
Dewatering of streams	5	17
Disease	6	4

Nonrespondents

Of 100 nonrespondents surveyed, we were unable to contact 56 due to phone numbers being unlisted or the landowners had moved (34), and after three attempts we no longer attempted contact (22). Three landowners were unwilling to answer our questions and 21 were not landowners or leaseholders or did not have surface water on their property. The percentage of nonrespondents with beaver habitat (49%) was not significantly different from the respondents (51%, $z = 1.20$, $P = 0.23$). Of the nonrespondents that had beaver habitat, only 11 (25% of nonrespondents contacted) had seen beaver on their property within the last five years, and this was significantly less than respondents that had seen beaver (42%, $z = 2.17$, $P = 0.030$). The average landownership for nonrespondents was 5842 ha and was not significantly different from respondents (2568 ha, $P = 0.063$, $df = 2451$). Likewise the average stream length for nonrespondents (2.9 km) was not significantly different from respondents (5.1 km, $P = 0.595$, $df = 2357$).

Beaver Damage and Benefits

The majority of landowners with beaver reported damage problems (89%). Damage complaints focused on blocked irrigation structures and road culverts and girdled timber (Table 3). Only 11% of private landowners with beaver on their property reported that they did not have any damage from beaver. Of the landowners reporting beaver on their property, 50% actively trapped beaver and 39% did not remove any beaver. Another 10% did not remove beaver but wanted to have them removed. Seven percent of landowners paid to have beaver removed from their property and another 10% were willing to pay someone to trap beaver.

There was little difference in the ranking of beaver damage problems between landowners and public-land managers except for blocked culverts and flooded roads (Table 3). Public-land managers reported more problems with these two categories.

The benefits most important to landowners included

Table 3. Comparison of rankings for this study and three others that examined relative importance of beaver damage and benefits[a]

	Study				
	This study				
	Landowners[b]	Public Managers[c]	Arkansas[d]	South Carolina[e]	North Carolina[f]
Beaver damage					
No damage	(11)	—[g]			
Water control structures[h]	1 (25)	2 (22)	8	—[g]	—[g]
Girdled timber	2 (25)	4 (14)	1	1	1
Blocked culverts	3 (22)	1 (25)	5	3	3
Flooded pasture[i]	4 (10)	5 (11)	3	4	7
Flooded roads	5 (6)	3 (14)	7	6	5
Flooded crops[j]	6 (6)	6 (9)	2	5	4
Flooded timber	7 (6)	7 (3)	4	2	2
Damaged dams[k]	—[g]	—[g]	6	7	6
Beaver benefits					
No benefits	— (51)	—[g]	—[g]	—[g]	—[g]
Elevated water tables	1 (19)	2 (18)	6	6	5
Riparian vegetation	2 (16)	1 (20)	—[g]	—[g]	—[g]
Increased stock watering	3 (15)	6 (8)	1	5	6
Fishing opportunities	4 (13)	4 (12)	3	3	3
Aesthetic qualities	5 (12)	5 (12)	2	1	2
Improved water quality	6 (11)	3 (17)	—[g]	—[g]	—[g]
Hunting	7 (9)	7 (6)	5	2	1
Recreational trapping	8 (4)	8 (5)	4	4	4
Trapping for money	9 (2)	9 (3)	7	7	7
Meat for food	—[g]	—[g]	8	8	8

[a]Percentages (%) for each response are given for this study. Percentages do not sum to 100 due to rounding error.

[b]A sample of 1010 Wyoming landowners with beaver on their property taken from a sample of 2900 mail survey respondents.

[c]Responses are from a sample of 72 Wyoming public-land managers.

[d]Wigley and Garner (1987).

[e]Woodward et al. (1976).

[f]Woodward et al. (1985).

[g]Question not asked in survey.

[h]Includes any type of irrigation structures (i.e., irrigation ditches and headgates).

[i]Includes both irrigated and nonirrigated hay.

[j]Includes crops such as wheat, corn, and barley.

[k]Damage to fishing pond dams from burrowing.

elevated water tables, increased riparian vegetation, and increased stock-watering opportunities (Table 3). Forty-nine percent of landowners reported that beaver did not give them any benefit. Almost 11% of landowners with beaver felt that they used them as a tool for riparian management and another 11% wanted to use them for riparian management. Of landowners with potential beaver habitat but no beaver present, 11% wanted to have beaver introduced to their property and 10% of all landowners wanted to see beaver numbers increase (Table 1). Perhaps most important was that 45% of landowners with beaver wanted more information on managing beaver.

Once again there was little difference in the rankings of benefits between landowners and public-land managers with the exception of a higher emphasis on improved water quality and a lower emphasis on stock-watering opportunities by the public managers. All public-land managers requested more information on managing beaver and had areas where beaver could be used to improve riparian habitat.

Discussion

Response to our survey was high compared to responses to similar beaver surveys. Woodward and others (1976) reported a 21% response rate to a beaver mail survey conducted in South Carolina. A return rate of 10% was reported for a postal survey of economic and environmental impacts of beaver in North Carolina (Woodward and others 1985). In Arkansas, Wigley and Garner (1986) had a 52% return rate of a mail question-

naire to landowners. In a mail survey concerning the distribution of mountain lions (*Felis concolor*) in Wyoming, Berg and others (1983) had a 43% response rate. We felt that our high response rate was due to several factors, including publicizing the survey in several publications specific to landowners and enlisting the help of major landowner groups such as the WSGA and WWGA.

Response rates greater than 65% are thought to negate nonresponse bias (Dolsen and Machlis 1991). While our response was not this high, we feel our results accurately reflect true landowner opinion due to our large sample size and lack of differences between respondents and nonrespondents. Our results from comparing our nonrespondents to our respondents indicate that the primary reasons for no response were that the landowner was no longer present at that address, that the landowner never received the questionnaire, or the landowner did not have any streams or beaver on their property so they did not respond.

Our population estimates of 0.64 beaver colonies per kilometer of stream are average to above average for exploited northern beaver populations (see Hill 1982 for a review). From our surveys we estimate that between 42% and 48% of streams in Wyoming have beaver associated with them. Most landowners and public-land managers felt that beaver populations were either stable or increasing. Increasing populations may be due to several factors including decreased trapping demands from depressed fur markets and landowners being more tolerant of beaver and their habitats. Private landowners in particular responded more strongly that beaver were increasing (Table 1) and less that they were stable. This difference may reflect a geographical difference between public and private lands. In Wyoming beaver have been trapped intensively from low-elevation riparian areas during the last 150 years (Johnson and Chance 1974, Hafen 1982). Beaver may have become established in upper watershed refugia (generally under control of public-land managers), where their populations are more stable, and have recently expanded into the lower watersheds that are under private ownership. The depressed fur market could accelerate this movement of beaver by allowing animals that would normally be trapped on public lands to move into areas under private ownership.

While landowners and public-land managers agreed on past and current beaver population trends, they differed with respect to desired population trends (Table 1). The majority of landowners wanted to see beaver numbers decrease or remain stable, while the public-land managers wanted beaver populations to increase. Most private land in Wyoming is located within lower-elevation, low-gradient riparian systems [cottonwood and aspen (*Populus* spp.) and willow (*Salix* spp.)], which is the preferred habitat for beaver (Jenkins and Busher 1979, Hill 1982, Novak 1987) and is also the primary location for irrigated hay meadows and rural development (Knight 1994). Beaver/landowner conflicts are a growing concern in these areas, especially with landowners that manage for increased riparian vegetation (e.g., willows). Conversely, land that is managed by public-land managers in Wyoming is typically at higher elevation, where conflicts with rural development are not a factor (e.g., US Forest Service lands); is not irrigated or water is scarce (e.g., Bureau of Land Management lands); or is managed specifically for wildlife benefits (e.g., Wyoming State Trust and WG&FD lands) where beaver are tolerated. Managers of Wyoming public lands are often trying to improve riparian habitats, and encouraging beaver to establish, whether through imposing limitations on trapping seasons or direct reintroduction efforts, can be a useful tool (Johnson 1984, Apple and others 1985, Hill 1987, Maxwell 1994). Public-land managers may need to adjust programs to accommodate growing concerns by private landowners regarding increasing beaver populations and their potential conflicts with current land management practices.

Damage problems important to landowners centered on blocked irrigation structures and road culverts and on girdled trees. These problems were not ranked as high in southern areas of the beaver's range (Woodward and others 1976, 1985, Wigley and Garner 1987) where more importance is placed on the flooding of crops, pasture, and trees (Table 1) (Bullock and Abner 1985, Woodward and others 1985, Wigley and Garner 1987). In a study where they ranked beaver damage complaints over a 30-year period in Wisconsin, Payne and Peterson (1986) found that complaints focused on, in decreasing order of importance, roads, timber, lakeshore, railroads, fish habitat, and agriculture. In contrast, most riparian areas in Wyoming have much steeper topography than those in the southeastern United States and Wisconsin, and consequently the amount of area flooded from a beaver dam is not as great. Furthermore, timber found in Wyoming's riparian areas is often aspen or cottonwood, which is not of high commercial value (Knight 1994).

Beaver damage problems in Wyoming, where beaver are considered furbearers, currently fall under the jurisdiction of the WG&FD. The WG&FD presently handles beaver problems by allowing the land manager to trap or kill any beavers that are causing damage. Additionally, WG&FD personnel often assist landowners by trapping problem animals and either killing them or

transplanting them to other more suitable areas. Perhaps increased information, including engineering solutions (fencing of road culverts, pond levelers, protecting trees, etc.), on how to deal with nuisance beaver would help to alleviate some of these problems (Roblee 1983, 1984, Woodward and Hazel 1991, D'Eon and others 1995). Clearly, from our results, both public and private land managers want more information on managing beaver and their habitats.

Perceived benefits from beaver were also different between Wyoming and the southeast United States. Wyoming landowners felt that beaver improve the riparian area by storing water, thus improving vegetation and providing opportunities for watering livestock. Landowners in the southern United States get more benefit from the aesthetic and recreational aspects of beaver ponds such as hunting and fishing (Table 1). Precipitation on lands that we surveyed is typically below 20 cm (Knight 1994), and therefore a higher emphasis is placed on storing water and developing opportunities for stock watering. More research or information on how to use beaver for storing water and providing livestock watering would be valuable to Wyoming landowners.

Many landowners and public-land managers were interested in using beaver for riparian management. Landowners with surface water and no beaver were especially interested in using beaver to help store water and improve their riparian habitat. Ninety-six percent of the public-land managers wanted more information on beaver management, and over 90% expressed an interest in having a statewide beaver management symposium. While beaver can create problems where they are found in conjunction with irrigation structures, roads, and crops, they can be a viable tool in restoring western riparian areas. Areas where beaver are absent and conflicts with humans can be minimized are relatively abundant in Wyoming, and many opportunities exist for using beaver in riparian management.

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