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Landowner Incentives and Normative Tolerances for Managing Beaver Impacts

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*Limited research has examined landowner acceptance of using incentives for managing wildlife (e.g., compensation schemes). We examined acceptance of strategies for managing beaver impacts, use of incentives to protect habitat and retain beavers on private property, and how responses differed by impact severity, residential location, and experiences with beavers. Data were obtained from surveys of landowners in four regions of Oregon (*n = *1,204). Education about how to coexist with beavers was the most acceptable management response across six impact scenarios (e.g., beaver chews trees, floods buildings). Lethal control was unacceptable across all scenarios. As impacts increased, leaving beavers alone became unacceptable and removing dams became acceptable. Irrespective of impact, landowners would be more likely to use incentives (e.g., financial compensation) than remove beavers. Landowners in Eastern Oregon and those who experienced impacts would be less likely to use incentives and considered aggressive strategies (e.g., removing dams, lethal control) more acceptable.*

Keywords beavers, behavioral intentions, human–wildlife conflict, incentives, norms

Introduction

Humans often determine the outcomes of conflict and damage caused by wildlife (Manfredo & Dayer, 2004; Woodroffe, Thirgood, & Rabinowitz, 2005), and strategies for managing these wildlife impacts vary depending on species, impact type and severity, and public acceptance. Koval and Mertig (2004), for example, reported public and agency support for lethal management of wildlife to address disease, damage, population levels, public safety, human ability to obtain food, and species survival. Others have noted that leaving animals alone is acceptable if impacts are minimal (e.g., animal in neighborhood, eats garbage), but unacceptable for more severe impacts (e.g., animal breaks into homes or is aggressive toward humans; Don Carlos, Bright, Teel, & Vaske, 2009; Morzillo, Mertig, Garner, & Liu, 2007). Vaske and Needham (2007) and Zinn, Manfredo, Vaske, and Wittmann (1998), for example, found that lethal control of various species was publically unacceptable if the species were seen and caused minimal impact, but more acceptable as severity of impacts increased to include risks to humans. Aligning acceptable management

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strategies with different wildlife impacts is an important part of management accountability, and there is a need for greater understanding of interrelationships among acceptability, impacts, and alternative management actions (Vaske & Manfredo, 2012).

Damage compensation schemes offer one alternative strategy for managing conflict and damage caused by wildlife. These schemes are tools where costs for damage caused by wildlife are divided between those managing wildlife species and those experiencing damage (Fourli, 1999). Two types of these tools exist; one reactively addresses damages after occurrence (i.e., ex-post), whereas the other facilitates proactive actions to minimize possible future impacts. Ex-post compensation schemes are a response to damage based on estimated costs of resources lost to those who experienced this damage, with the objective of decreasing landowner motivation for future lethal management (Schwerdtner & Gruber, 2007; Zabel & Holm-Müller, 2008). Potential drawbacks exist, such as challenges with impact verification and assessment (Nyhus, Osofsky, Ferraro, Madden, & Fischer, 2005; Schwerdtner & Gruber, 2007), implementation and administration costs (Dickman, Macdonald, & Macdonald, 2011; Nyhus, Fischer, Madden, & Osofsky, 2003; Treves, Jurewicz, Naughton-Treves, & Wilcove, 2009), moral concerns (Treves et al., 2009), and privilege (Schwerdtner & Gruber, 2007). Some researchers have even suggested that net effects on species conservation from ex-post compensation can be negative (Bulte & Rondeau, 2005).

Proactive actions to minimize impacts are based on predictions of future damage locations and costs (Schwerdtner & Gruber, 2007). Outcomes of these programs include observability and effectiveness at reducing the risk of impact (Nyhus et al., 2005). Actions taken do not always decrease conflict, but allow for quicker response and implementation of preventative measures (e.g., Swenson & Andrén, 2005). In contrast to ex-post compensation tools, the target of proactive actions may vary depending on circumstance. Strategic creation and distribution of waterholes, for example, were used for attracting elephants away from human settlements during the dry season (Jackson, Mosojane, Ferreira, & van Aarde, 2008), thereby manipulating wildlife movements rather than targeting human behavior. Other mechanisms, such as voluntary land conservation programs and habitat offsets, have also been explored (e.g., Poudyal & Hodges, 2009; Sorice & Conner, 2010). Drawbacks to proactive approaches are similar to those of ex-post compensation schemes, but both share the general objective of using incentives to improve human acceptance and tolerance of species (Maclennan, Groom, Macdonald, & Frank, 2009) to increase ecological benefits and decrease social and economic costs. However, there is limited information addressing potential acceptance of these programs by landowners, particularly proactive approaches. In this article, we examine impacts caused by the American beaver (*Castor canadensis*) on private property in Oregon, and landowner acceptance of management actions for addressing these impacts and their intentions to use incentives for conserving this species and its habitat.

Conceptual Background

Beavers are a keystone species that play a critical role in biophysical processes including hydrology, biogeochemistry, and vegetation patterns (Mills, Soulé, & Doak, 1993), maintenance of wetland and riparian ecosystems (Wright, Jones, & Flecker, 2002), and mitigation of impacts of climate change on aquatic systems (Hood & Bayley, 2008). Research suggests that beaver activities help to recharge local water tables (Enck, Connelly, & Brown, 1997; McKinstry & Anderson, 1999), public responses toward beavers are generally positive, and support exists for proactive measures to prevent future impacts caused by this species

(Jonker, Muth, Organ, Zwick, & Siemer, 2006; McKinstry & Anderson, 1999; Siemer, Jonker, Decker, & Organ, 2013; Wittmann, Vaske, Manfredo, & Zinn, 1998).

However, some outcomes of beaver behavior, such as damage to trees and shrubs, blocked culverts, and flooding of residences, roads, and fields, can impact humans negatively and be regarded as a nuisance (Enck, Connelly, & Brown, 1996; Ermer, 1988; Harbrecht, 1991; Jonker et al., 2006; Siemer et al., 2013). Traditional management approaches, such as relocation or lethal trapping, can reduce these problems, but are controversial because they are not always publically acceptable, feasible, or effective at achieving desired environmental benefits (Vaske & Needham, 2007; Zinn et al., 1998). Similar to other species (e.g., black bears; Bowman, Leopold, Vilella, Gill, & Jacobson, 2001), some beaver damage seems to be publically tolerable, but inconsistency exists about relationships between human responses to beavers, experiences with impacts, and support for retaining beavers on private property. Jonker et al. (2006) and Siemer et al. (2003, 2004, 2013), for example, reported that residents of Massachusetts and New York who experienced impacts from beavers had more negative responses toward this species than those who did not experience impacts. Residents of Colorado, however, were interested in seeing and protecting beavers regardless of most experiences and impacts (Wittmann et al., 1998; Wittmann, Vaske, & Sikorowski, 1995). Landowners and public land managers in Wyoming expressed appreciation for the benefits of beavers (e.g., maintaining water tables, stock-watering opportunities), concerns about their impacts (e.g., blocked irrigation ditches, flooding; McKinstry & Anderson, 1999), and willingness to incur some damage and modify property to decrease future impacts (Purdy, Decker, Malecki, & Proud, 1985). Although these mixed findings may be influenced by study context (e.g., state, year, stakeholder), they suggest a need for improving understanding of landowner acceptance and tolerance for beaver impacts, and examining alternative management strategies to address these impacts.

The concept of structural norms offers one approach for identifying acceptance of wildlife impacts and management actions (Vaske & Manfredo, 2012; Vaske & Whittaker, 2004). One line of research defines norms as standards that individuals use for evaluating conditions or management strategies as acceptable or unacceptable, such as actions that agencies should or should not take in a given context (Shelby, Vaske, & Donnelly, 1996; Vaske & Whittaker, 2004). Most research using this normative approach is based on Jackson's (1965) model, which describes structural norms using a social norm curve (also known as an impact acceptability curve) where social norms are depicted as averages of evaluations across individuals in a population (Needham, 2013; Vaske & Whittaker, 2004). These curves represent impacts increasing from left to right along the horizontal axis. The vertical axis represents evaluative responses with the most positive evaluation at the top of the axis, the most negative on the bottom, and a neutral category in between. Most studies have used acceptance as the evaluative response (Manning, 2007).

The concept of norms has been applied to many situations in wildlife management, including wildlife presence and damage (Vaske & Needham, 2007; Wittmann et al., 1998; Zinn et al., 1998), wildlife viewing (Whittaker, 1997), and wildlife disease (Needham, Vaske, & Manfredo, 2006). Research has shown that norms and other cognitions can differ by location of residence. Pate, Manfredo, Bright, and Tischbein (1996), for example, reported that resident norms toward wolf reintroduction in Colorado differed between those who lived in the more densely populated areas of the east slope of the continental divide versus those in the more rural and agriculturally dominated west slope of this divide. Oregon is similar demographically with most of its urban centers and population west of the Cascade Mountains compared to the predominantly rural eastern region of the state. Norms and other

cognitions can also differ based on past experience. Siemer et al. (2004, 2013), for example, reported that residents who experienced impacts caused by beavers were more likely to accept lethal management of this species. Lethal management was also more acceptable for situations involving negative economic or human health effects (Siemer et al., 2004, 2013).

Research suggests that norms and other concepts, such as behavioral intentions, are part of a broader cognitive hierarchy (Fulton, Manfredo, & Lipscomb, 1996; Whittaker, Vaske, & Manfredo, 2006). Behavioral intentions are defined as an individual's perceived likelihood or probability that he or she will engage in a given behavior (Fishbein & Manfredo, 1992). Studies have used this concept to understand how humans might behave in response to future wildlife issues, such as the likelihood of participating in hunting (Needham et al., 2006) or voting for species reintroduction (Pate et al., 1996). This concept is also useful for understanding the likelihood that landowners might use incentives or other compensation schemes in response to wildlife damage. In New York, for example, landowners were willing to incur approximately US $800 in damage from beavers and were interested in property modifications to mitigate future beaver impacts (Purdy et al., 1985).

In this article, we addressed three research questions related to landowner intentions to use incentives for conserving beavers, and their normative acceptance of management actions for addressing beaver impacts. First, to what extent do landowners accept various management strategies designed to address beaver impacts? Second, how much do landowners intend to use proactive compensation schemes (i.e., incentives) to protect habitat and retain beavers on their property? Third, to what extent do these intentions and normative responses differ based on severity of impact, location of residence, and past experiences with impacts caused by beavers? We hypothesized that some impacts from beavers would be tolerable, but landowners would be slightly less agreeable to incentives and more accepting of some management strategies: (a) as the magnitude of impact increased, (b) based on location of residence, and (c) if they have experienced impacts from beavers previously.

Methods

Study Context and Locations

In Oregon, agencies such as the Oregon Watershed Enhancement Board (OWEB) have appropriated funding for numerous habitat restoration projects during the last decade. These efforts reflect the Oregon Plan for Salmon and Watersheds, the goal of which is to restore native fish populations and the aquatic systems supporting them to productive and sustainable levels that provide substantial environmental, social, cultural, and economic benefits (OCSRI, 1997). Projects have included placing large logs in streams, increasing in-stream habitat complexity, and thinning juniper in riparian areas to improve groundwater supplies and instream flows. In addition, beavers were identified as a strategic monitoring species in the Oregon Conservation Strategy because of their role in maintaining riparian habitats through activities where the outcomes are similar to human engineered efforts. As a result, agencies have initiated restoration efforts by relocating beavers to areas where the species was extirpated (ODFW, 2012; Petro, Taylor, & Sanchez, 2015).

We collected data from four regions of Oregon: (a) northeast Oregon ("East"; Baker City, Sumpter Valley/Phillips Lake, Haines, Keating, Richland, Halfway); (b) coastal Oregon ("Coast"; Lincoln City/Devils Lake, Otis, Seal Rock, Waldport, Tidewater); (c)

southeast Portland ("Portland"; Johnson Creek, Oaks Bottom, Sellwood, Reed College area); and (d) southwest Oregon ("Southwest"; Medford, Jacksonville, Central Point, White City, Selma, Kerby, Cave Junction). These locations were selected based on agency feedback, maps of known beaver distribution (e.g., dams) and previous beaver damage, and proximity to riparian and wetland areas known to contain beavers and their habitat. This geographical cross-section represents most of Oregon (e.g., urban, rural; east, coast/west, north, south) ranging from temperate forests on the coast to high desert in the east, and from rural to urban areas (e.g., Portland). Despite this diversity, beavers have caused impacts (e.g., flooding, chewing trees) to private property across all regions of the state (e.g., residential, agricultural, ranchlands, private forestlands; ODFW, 2012). This species may still represent a hypothetical risk to some landowners across the state who may or may not have direct experience with beavers.

Data Collection

We collected data from questionnaires administered by mail. Proportionate random samples of 1,300 households in each of these four regions (total = 5,200) were selected based on desired sampling error (±5%) and adequate representation to generalize across regions in the state. Households were defined primarily as duplexes or single family detached dwellings; multi-family dwellings (e.g., apartment buildings) were excluded. Samples were obtained from Marketing Systems Group (Horsham, PA USA), which uses U.S. Postal Service delivery sequence files. Multiple mailings of packets consisting of a cover letter requesting participation, questionnaire, and postage-paid reply envelope were used in an effort to increase response rate (Dillman, Smyth, & Christian, 2014). A questionnaire packet was sent to participants in January 2011 followed by a postcard reminder three weeks later. Another three weeks later, those who had not yet returned the questionnaire received a second full packet. Prior to these three mailings, the sampling methods and questionnaire were reviewed extensively by agency representatives and other stakeholders involved with beaver management.

We received 1,517 completed questionnaires, yielding a 32% response rate. To address potential nonresponse bias, a telephone nonresponse follow-up survey was completed by a random sample of 142 of those who did not complete and return the questionnaire by mail. These participants were asked eight questions from the questionnaire, and only seven of 32 statistical tests (four regions * eight questions = 32) for differences were statistically significant at $p < .05$. Effect size statistics (V, ϕ, r_{pb}) ranged from only .01 to .15, and averaged .07. Using guidelines from Cohen (1988) and Vaske (2008), these effect sizes suggested that the strength of these few differences between respondents and nonrespondents was "small" or "minimal," so nonresponse bias was not considered to be a problem and the data were not weighted.

For this analysis, we assumed that landowners (i.e., property owners, not renters) would be the most likely to bear the costs of any beaver-related damage and arguably more likely to be involved in decision-making about beaver impacts. As a result, we focused on respondents who reported they own the property where they currently reside (i.e., household sampled); renters and others were excluded from further analyses. This reduced the usable sample for this article to 1,204 landowners (East $n = 340$; Coast $n = 324$; Portland $n = 234$; Southwest $n = 306$).

Analysis Variables

Independent Variables. There were two independent variables in this analysis: (a) past experience with beaver impacts and (b) region (the four regions of Oregon described earlier). To measure experiences with beaver impacts, respondents were asked "how often have beavers caused damage to your property or neighboring properties" (*never* = 0; *once or twice* = 1; sometimes = 2; *many times* = 3)?[1] For analysis purposes and consistent with past research measuring conflict experiences (e.g., Vaske, Needham, & Cline, 2007), this variable was recoded into two categories ("never any beaver damage" or "beaver damage at least once").

Dependent Variables. We presented participants with six hypothetical scenarios of possible beaver impacts intended to represent a continuum of increasing impact severity: (a) "a beaver is seen on your property or neighboring properties, but has not caused any impacts or damage"; (b) "a beaver chews down some trees on your property or neighboring properties"; (c) "a beaver plugs culverts on your property or neighboring properties causing damage to pipes, erosion, and ponds or streams to overflow"; (d) "a beaver floods a road or driveway on your property or neighboring properties"; (e) "a beaver floods crops or fields on your property or neighboring properties"; and (f) "a beaver floods a basement, building, or other structure on your property or neighboring properties." Scenario approaches such as these are common in studies examining human dimensions of wildlife and other natural resources (e.g., Don Carlos et al., 2009; Needham et al., 2006; Whittaker et al., 2006; Wittmann et al., 1998; Zinn et al., 1998).

To measure norms toward management responses for each of these six scenarios, respondents rated their acceptance of the following non-structural management strategies: (a) "do nothing by leaving the beaver alone"; (b) "inform landowners about how to coexist with the beaver"; (c) "capture and relocate the beaver to another location"; (d) "frighten the beaver away;"; and (e) "destroy the beaver (lethal control)." Respondents also rated their acceptance of the following structural management strategies: (a) "wrap trees to prevent the beaver from chewing trees"; (b) "install fences or screens to prevent beaver damage"; (c) "install control devices such as water control pipes"; and (d) "remove any beaver dams or lodges in the area." Responses were measured on a five-point recoded scale (−2 = *very unacceptable*; −1 = *slightly unacceptable*; 0 = *neither*; 1 = *slightly acceptable*; 2 = *very acceptable*).

To measure intentions to use compensation schemes (i.e., incentives) for each of the six scenarios, respondents were asked "how unlikely or likely would you be to take advantage of each of the following possible incentives that would allow the beaver to live on your property or neighboring properties": (a) "information sent to you about how to coexist with beavers"; (b) "experts visit your home to provide technical information"; (c) "experts plant trees near your home for food/shelter for beavers"; (d) "experts provide equipment/labor to install things such as tree wrapping materials, fences, or water control pipes"; (e) "financial compensation for fixing damage caused by the beaver"; (f) "financial compensation for preventing future beaver damage"; and (g) "none of these incentives because I would not keep the beaver living on my property or neighboring properties?" Responses were measured on a five-point recoded scale (−2 = *very unlikely*; −1 = *somewhat unlikely*; 0 = *neither*; 1 = *somewhat likely*; 2 = *very likely*).

Results

Sample Characteristics

Among the landowners sampled, 58% were male, average age was 59 (±14) years, and they had lived in Oregon for an average of 39 (±21) years (Table 1). Education level was bimodal with 44% of respondents having completed at least a four-year college degree and 33% having a high school diploma or less. Landowners in the East were slightly more likely than those in the other regions to be male and have lived in Oregon slightly longer. Portland landowners were more likely to have completed more formal education. Most of the landowners currently use their land for residential purposes (86%) and planned to continue doing so in the future (82%). Respondents also reported currently using their land for livestock grazing (24%; highest in East = 54%, lowest in Portland = 2%), agriculture—annuals (15%; highest in East = 27%, lowest in Portland = 5%), timber/forestry (13%; highest in East = 15%, lowest in Portland = 2%), and hunting (12%; highest in East = 28%, lowest in Portland = 1%).

Experiences with Beavers and Impacts

Sixteen percent of the landowners indicated that beavers were currently living on their property or a neighboring property. Those in the East (20%) and on the Coast (27%) were more likely than those in Portland (10%) and the Southwest (6%) to have beavers on their land. Twenty percent of respondents had previously experienced beaver impacts (Table 2). Those in the East (28%) and on the Coast (31%) were more likely than those in Portland (6%) and the Southwest (10%) to have experienced beaver impacts ($\chi^2 = 113.75$, $p < .001$), although the Cramer's V effect size was only .17. Using guidelines from Cohen (1988) and Vaske (2008) for interpreting effect sizes, the strength of this difference among regions can be characterized as relatively "small" or "minimal," respectively.

Normative Acceptance of Management

The norm curves showed that educating landowners about how to coexist with beavers was the most acceptable management response across all six impact scenarios, whereas lethal control was the most unacceptable across all scenarios (Figure 1). Frightening the beaver away was also unacceptable across all scenarios. Capturing and relocating beavers, wrapping trees, installing control devices, and installing fences or screens were acceptable strategies for addressing all impact scenarios (Figures 1 and 2). Doing nothing and leaving the beaver alone was acceptable only in cases of seeing a beaver and beavers chewing trees, but this became unacceptable as impacts increased in severity (Figure 1). Removing beaver dams and lodges was unacceptable in these cases of seeing a beaver and beavers chewing trees, but became more acceptable as the severity of impacts increased (Figure 2).

These patterns in the norm curves were generally consistent across the four regions, but acceptance of management actions in response to increasing beaver impacts did vary among regions. Doing nothing and leaving the beaver alone ($F = 5.79$ to 12.43, $p < .001$, $\eta = .13$ to .18), educating landowners about how to coexist with beavers ($F = 14.38$ to 18.18, $p < .001$, $\eta = .19$ to .22), wrapping trees to prevent beavers from chewing ($F = 9.42$ to 14.29, $p < .001$, $\eta = .16$ to .19), installing fences or screens to prevent beaver damage ($F = 7.71$ to 12.65, $p < .001$, $\eta = .14$ to .19), and installing control devices ($F = 5.77$ to 11.28, $p \leq .001$, $\eta = .12$ to .18) were significantly less acceptable in the East and slightly

Table 1
Landowner demographics for each region[a]

	East	Coast	Portland	Southwest	Total	χ^2 or F	p value	V or η
Gender						39.82	<.001	.18
Male	70	54	45	61	58			
Female	30	46	55	39	42			
Age						80.57	<.001	.15
20–29 years old	3	2	3	1	2			
30–39 years old	4	4	16	7	7			
40–49 years old	12	11	22	12	14			
50–59 years old	27	27	25	27	27			
60–69 years old	27	34	22	33	29			
70–79 years old	20	17	5	14	15			
80 or older	7	6	7	6	6			
Average (mean) years	60.3[a]	60.5[a]	53.4[b]	59.5[a]	58.8	16.04	<.001	.20
How long lived in Oregon						44.97	.002	.11
Less than 10 years	6	12	8	11	9			
10–19 years	9	12	16	12	12			
20–29 years	11	14	13	10	12			
30–39 years	16	15	18	21	17			
40–49 years	13	15	12	17	14			
50–59 years	18	13	16	13	15			
60–69 years	14	13	13	12	13			
70 or more years	13	8	5	5	8			
Average (mean) years	43.8[a]	37.8[b]	37.3[b]	37.2[b]	39.2	7.34	<.001	.14
Highest education achieved						51.80	<.001	.12
Less than high school diploma	4	3	2	1	3			
High school diploma or GED	31	34	15	35	30			
2 year associates or trade school	24	25	20	24	24			
4 year college degree (BS)	25	21	36	23	25			
Advanced degree (PhD, MS, MD)	16	16	26	17	19			

[a]Cell entries are percentages (%) unless specified as averages (means). Means with different letter superscripts across a row differ at $p < .05$ using Scheffe or Tamhane's T2 post-hoc tests.

Table 2
Beaver damage experienced by landowners in each region[a]

Experienced beaver damage to property or neighboring properties	East	Coast	Portland	Southwest	Total
Never	72	69	94	90	80
Once or twice	10	16	1	5	8
Sometimes	11	9	4	3	7
Many times	7	6	1	2	5

[a]Cell entries are percentages (%). In total, 20% experienced damage caused by beavers. $\chi^2 = 113.75, p < .001, V = .17$.

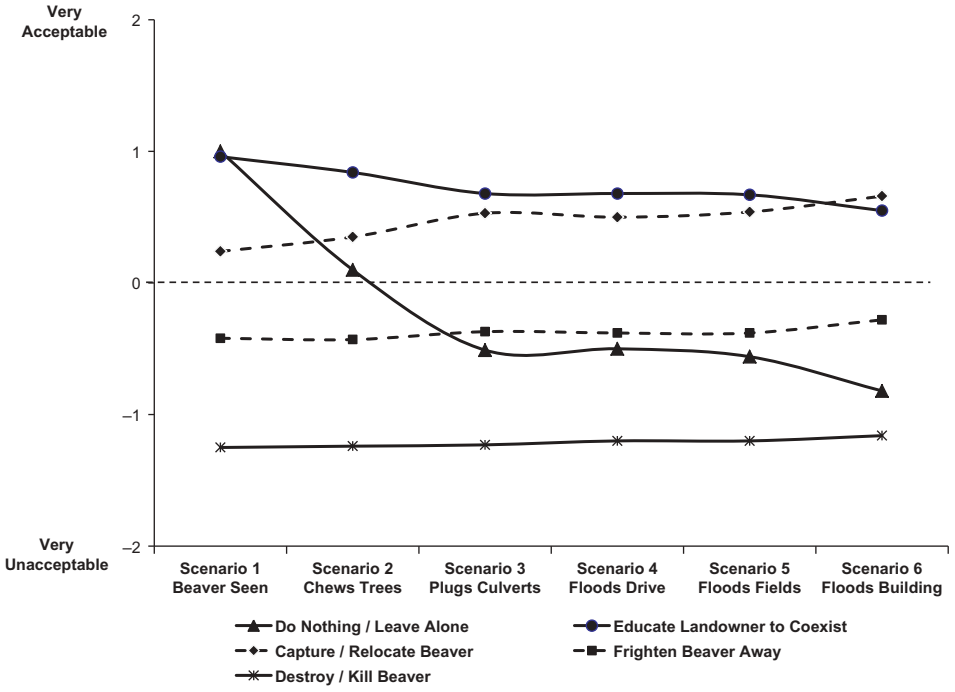

Figure 1. Norm curves showing mean landowner acceptance of *non-structural* management responses to increasing beaver damage.

more acceptable in the other regions, especially the Portland area. Conversely, potentially more aggressive strategies such as capturing and relocating beavers ($F = 3.86$ to 7.96, $p = .009$ to $< .001$, $\eta = .10$ to $.15$), frightening beavers away ($F = 4.44$ to 7.91, $p = .004$ to $< .001$, $\eta = .11$ to $.15$), removing beaver dams and lodges ($F = 1.80$ to 8.36, $p = .146$ to $< .001$, $\eta = .07$ to $.15$), and lethal control of beavers ($F = 20.03$ to 27.57, $p < .001$, $\eta = .22$ to $.27$) were significantly more acceptable in the East and slightly less acceptable in the other regions. These effect sizes suggested "small" to "medium" (Cohen, 1988) or "minimal" to "typical" (Vaske, 2008) differences across these comparisons.

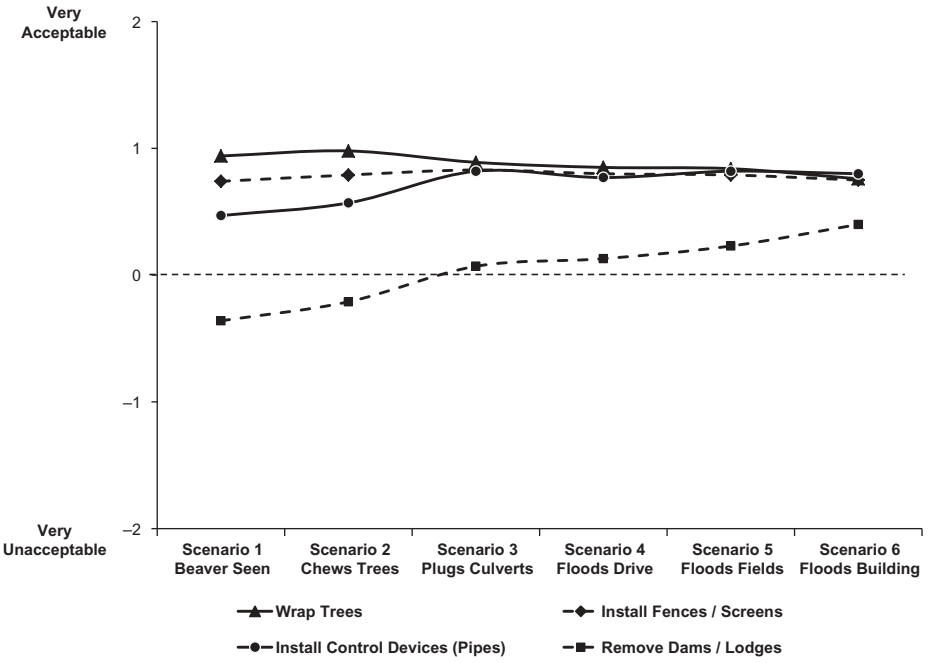

Figure 2. Norm curves showing mean landowner acceptance of *structural* management responses to increasing beaver damage.

Normative acceptance of these management strategies also differed between landowners who have experienced impacts caused by beavers (80%, $n = 947$) versus those who have not experienced impacts (20%, $n = 234$; Table 2). These analyses were aggregated across regions. Compared to landowners who have not experienced beaver impacts, those who have experienced impacts believed that doing nothing ($t = 3.38$ to 4.98, $p \leq .001$, $r_{pb} = .10$ to .16), educating landowners about how to coexist with beavers ($t = 4.59$ to 6.17, $p < .001$, $r_{pb} = .15$ to .20), wrapping trees ($t = 1.40$ to 2.78, $p = .162$ to .006, $r_{pb} = .05$ to .09), installing fences or screens ($t = 1.93$ to 2.79, $p = .055$ to .006, $r_{pb} = .06$ to .10), and installing control devices ($t = 2.48$ to 3.25, $p = .014$ to .001, $r_{pb} = .08$ to .11) were less acceptable. On the other hand, potentially more aggressive strategies such as capturing and relocating beavers ($t = 1.63$ to 2.91, $p = .104$ to .004, $r_{pb} = .05$ to .09), frightening beavers away ($t = 3.47$ to 4.24, $p \leq .001$, $r_{pb} = .11$ to .14), removing beaver dams and lodges ($t = 3.63$ to 5.71, $p < .001$, $r_{pb} = .11$ to .17), and lethal control ($t = 6.04$ to 6.85, $p < .001$, $r_{pb} = .21$ to .24) were significantly more acceptable for those who have experienced beaver impacts. These effect sizes showed "small" to "medium" (Cohen, 1988) or "minimal" to "typical" (Vaske, 2008) differences for these comparisons.

Intentions for Using Incentives

Irrespective of impact severity, landowners were, on average, receptive to a suite of potential incentives to keep beavers on their property (Figure 3). In the future, respondents would be equally likely to take advantage of information sent to them about how to coexist with beavers, financial compensation to fix or prevent impacts caused by beavers, and having experts visit their property to provide technical information, plant trees, and provide

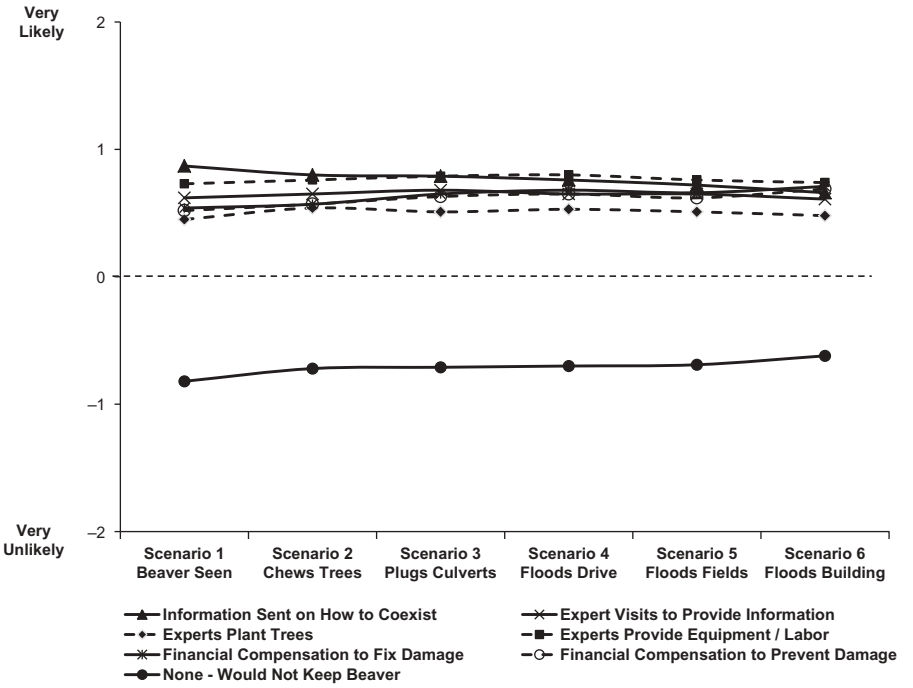

Figure 3. Mean landowner likelihood of taking advantage of possible incentives to retain beavers on their property or neighboring properties.

equipment or labor. In other words, across all types of impacts examined, landowners intended to take advantage of any incentives instead of removing beavers from private property.

These patterns were generally consistent across the four regions, but likelihood of taking advantage of these incentives varied among regions. Across all scenarios, landowners in the Portland area were most likely to report they would take advantage of information sent to them about how to coexist with beavers ($F = 8.45$ to 15.01, $p < .001$, $\eta = .16$ to .20), financial compensation to fix or prevent damage (fix: $F = 4.36$ to 8.92, $p = .005$ to $< .001$, $\eta = .11$ to .16; prevent: $F = 4.62$ to 8.79, $p = .003$ to $< .001$, $\eta = .11$ to .16), and having experts visit to provide technical information ($F = 13.23$ to 18.86, $p < .001$, $\eta = .19$ to .22), plant trees ($F = 5.77$ to 9.41, $p \leq .001$, $\eta = .13$ to .16), and provide equipment or labor ($F = 6.59$ to 11.62, $p < .001$, $\eta = .13$ to .18), whereas those in the East were least likely to take advantage of these incentives. Landowners in the East were most likely to avoid taking advantage of incentives ($F = 4.03$ to 7.11, $p = .007$ to $< .001$, $\eta = .11$ to .14). These effect sizes revealed "small" to "medium" (Cohen, 1988) or "minimal" to "typical" (Vaske, 2008) differences across these comparisons.

Both landowners who have and have not experienced impacts caused by beavers intended to take advantage of these possible incentives. In all cases, however, those who have not experienced any previous impacts were significantly more likely to take advantage of these incentives across all scenarios (information: $t = 4.50$ to 5.46, $p < .001$, $r_{pb} = .15$ to .18; expert visits: $= 3.98$ to 4.89, $p < .001$, $r_{pb} = .13$ to .16; experts plant trees: $t = 4.28$ to 6.29, $p < .001$, $r_{pb} = .14$ to .19; experts provide equipment or labor:

$t = 2.95$ to 3.61, $p = .003$ to $< .001$, $r_{pb} = .10$ to .12; financial compensation to fix damage: $t = 2.00$ to 3.14, $p = .047$ to .002, $r_{pb} = .07$ to .10; financial compensation to prevent damage: $t = 1.95$ to 2.95, $p = .050$ to .003, $r_{pb} = .06$ to .09). Both groups were unlikely to avoid taking advantage of these possible incentives, but those who have experienced beaver impacts were slightly more likely to avoid these incentives ($t = 1.60$ to 2.89, $p = .110$ to .004, $r_{pb} = .05$ to .09). Most of these effect sizes, however, showed only "small" (Cohen, 1988) or "minimal" (Vaske, 2008) differences for these comparisons.

Taken together, these results generally supported our hypothesis that some impacts from beavers appeared to be tolerable (e.g., beaver chews trees) and landowners were slightly more accepting of some management strategies (e.g., capture and relocate beavers, remove dams or lodges): (a) as the magnitude of impacts increased, (b) based on location of residence, and (c) if they have experienced impacts from beavers. Other strategies (e.g., frighten beavers, lethal control), however, were unacceptable irrespective of impact severity, location, or previous experience. Results also supported our hypothesis that landowners would be slightly less agreeable to incentives based on location of residence within the state (e.g., Eastern Oregon) and if they have experienced impacts from beavers. Contrary to our hypothesis, however, likelihood of taking advantage of incentives was consistently high across all scenarios and did not decrease as the severity of impacts caused by beavers increased.

Discussion

Oregon agencies are exploring the idea of relocating beavers to public and private lands as part of a statewide beaver restoration strategy. Relocation guidelines are drafted (ODFW, 2012) and research is exploring the viability and potential success of relocation (Petro et al., 2015). In collaboration with this effort, we explored the extent that Oregon landowners would: (a) accept various management strategies designed to address beaver impacts and (b) intend to use proactive compensation schemes (i.e., incentives) that protect habitat and retain beavers on their property. Results suggested that the largest proportion of these landowners was amenable to having beavers on their property because most wanted to know about how to coexist with this species despite various levels of impacts. Instead of removing beavers from their property, landowners also intended to take advantage of any available incentives to retain beavers (e.g., experts provide equipment or labor, financial compensation to fix or prevent damage) irrespective of the severity of impacts caused by this species. In addition, lethal control was unacceptable across all impacts. Results, therefore, were consistent with other studies suggesting that although landowners expressed concerns about impacts caused by beavers (e.g., McKinstry & Anderson, 1999), they were interested in protecting this species (e.g., Wittmann et al., 1995, 1998), willing to incur some damage, and would modify their property to help mitigate future impacts (e.g., Purdy et al., 1985). These responses, however, could change if individuals eventually live closer to beavers or interact with this species more frequently (e.g., relocation).

Consistent with our hypothesis, however, landowner acceptance of management strategies and likelihood of using incentives, such as damage compensation schemes, varied depending on location within the state and previous experience with beaver impacts. Landowners who had experience with beaver damage and those living in the more rural and agricultural areas of Eastern Oregon were slightly more accepting of the most aggressive strategies for managing beavers (e.g., removing dams, lethal control) and were slightly less likely to take advantage of incentives for retaining beavers on their land. Similar trends have been reported in other studies of beavers. Jonker et al. (2006) and Siemer et al. (2003,

2004, 2013) reported that residents who previously experienced impacts caused by beavers had more negative responses toward this species and were more likely to accept lethal management.

Our findings and those reported in other studies of beavers were also consistent with research on different species. West and Parkhurst (1995), for example, reported that residents and agricultural producers experiencing severe damage from deer were more likely to consider this a nuisance species and support efforts that reduced deer populations. This was also the case for Bowman et al. (2001) who reported that landowners in areas with large black bear populations and those who experienced damage from bears were less likely to support increases in the black bear population compared to those who lived in areas with no or few bears and had not experienced damage. From a location standpoint, our results were similar to Pate et al. (1996) who reported that Colorado residents in the more agricultural and less densely populated west slope of the continental divide were less supportive of wolf reintroduction. Although deer, bears, and wolves are different species than beavers, our results were similar, suggesting that general patterns of relationships among experience, residential location, and responses to wildlife may exist across species. Our results, however, showed majority acceptance of management strategies and incentives designed to retain beavers, even in the more rural and agricultural areas of Eastern Oregon and among landowners who have experienced damage caused by this species. Although speculative, it is possible this acceptance is partially driven by beavers being the official state animal of Oregon, state nickname ("The Beaver State"), and mascot of the major state university.

Our results also suggested a desire by landowners to be able to "do something" about beavers if impacts occur. Consistent with some other studies (Koval & Mertig, 2004; Vaske & Needham, 2007), however, lethal management was the most unpopular option. Instead, other strategies were favored by landowners, such as compensation, education, relocation, wrapping trees, and installing control devices and fences. In addition, the severity of impacts did not influence acceptance of lethal management, as acceptance of this strategy did not change across the six scenarios. This finding differs from Massachusetts and New York where Siemer et al. (2004, 2013) found that lethal management of beavers was more acceptable for situations involving more severe impacts. In Oregon, it appears unlikely that most landowners would avoid incentives and non-lethal strategies, and simply choose to completely restrict beavers from their property irrespective of impact severity. Instead, there was evidence that landowners may take advantage of information sent to them about how to coexist with beavers, and other incentives such as financial compensation to fix or prevent impacts and also in-person visits by agency personnel and other experts to provide technical expertise, equipment, and labor. Regardless, potential regional differences may still exist in response to impacts such that landowners in one region may be more amenable to certain mitigation tactics than those in other areas.

Ultimately, our results suggested that a suite of possible incentives may allow landowners to: (a) select mitigation tactics that are appropriate for individual impacts (whether ex-post or compensation in advance), and (b) believe that wildlife managers are supportive of their concerns about beaver impacts and their personal property. Although there are few other studies examining incentives and compensation schemes in the context of beavers that collectively allows for within-species comparisons, our results are consistent with research in Wisconsin where a variety of compensation options and payment mechanisms were favored by landowners in response to damage caused by wolves (Treves et al., 2009). In our study, no single incentive was preferred over another and a "kill first" approach was unacceptable to most landowners. Consequently, many non-lethal approaches to mitigating impacts and incentivizing conservation were deemed to be plausible. It remains an issue

for managers to identify on a case by case basis what strategies and possible incentives would work best for a given location and property, and then work alongside landowners to address current impacts and prevent future incidents. Agency outreach efforts publicizing available incentive programs, clear and straightforward communication about program objectives and procedures, and iterative assessment of landowner responses to incentives and other efforts to relocate or restore beavers will be important to determine if these initiatives are perceived to be efficient and effective over the long term. Regardless, most landowners surveyed believed that lethal control is largely unacceptable and they are willing to try alternative management approaches and incentives irrespective of most impacts caused by beavers. This willingness is an important first step if retaining beavers on private land is necessary for helping to achieve the ecosystem (e.g., fish, watershed) benefits associated with beavers and their habitat.

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Note

1. Although personal property (i.e., respondent owns) and neighboring properties (i.e., respondent may not own) represent different jurisdictions, impacts caused by beavers (e.g., flooding) are seldom isolated to a single property and instead they often transcend boundaries (Deblinger, Field, Finn, & Loomis, 1999; Harbrecht, 1991; ODFW, 2012). Examination of whether landowner responses differ when evaluations are based on their own property versus adjacent or neighboring properties is beyond the scope of our data and warrants further research.

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