PERCEPTIONS OF STREAM COMMUNITY RESIDENTS REGARDING THE NORTH AMERICAN BEAVER: GAINING KNOWLEDGE TO IMPROVE MANAGEMENT PRACTICES

by

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ABSTRACT

Perceptions of Stream Community Residents Regarding the North American Beaver: Gaining Knowledge to Improve Management Practices

Paula Smillie

To date, there have been many studies on the importance of the North American beaver (*Castor canadensis*) as a keystone species and their development of wetlands that are vital for creating biodiversity and ecosystem health. However, as human populations encroach on wildlife habitats, human-wildlife conflicts arise that require management. The primary goal of this research is to gain understanding of public perceptions towards beavers. An understanding of public opinion of beavers is important for wildlife managers to determine how to maximize the benefits beavers provide. In this study, a survey of attitudes toward and management practices of beavers from stream community residents was conducted. Statistical inferences were made to expose patterns and predictors for beaver acceptance. The results of this research showed that overall, people have favorable views toward beavers and wildlife in general, and taking lethal action as a management practice is not generally acceptable, except for extreme cases. Thurston County, Washington has yet to conduct a survey of human-beaver conflicts, and this information provides local wildlife managers knowledge of tolerance levels of residents and their levels of concern about damage to property by beavers. These results are significant for understanding how to address human-beaver conflicts, which could inform wildlife managers' long-term beaver management efforts, and use of beavers in ecological infrastructure building.

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x

CHAPTER 1: INTRODUCTION

The North American beaver (*Castor canadensis)* occupies wetland and riparian habitats across the North American continent, as well as several arid regions in the southwest (Baker & Hill, 2003). Although far from extinction, current beaver populations are only a fraction of historical numbers (Naiman, Johnston, & Kelley, 1988). Several issues contributed to their decline, but fur trade and exports, including a felt-hat fashion craze between the 1600s and the mid-1800s, were the most consequential. This exploitation left the beaver nearly extirpated throughout the United States (Baker & Hill, 2003; Naiman et al., 1988). With the beavers evicted, the fertile and nutrient rich abandoned beaver ponds proved an agricultural goldmine. Human activities such as agriculture, urbanization, and industrialization resulted in drained wetlands and conversion of prime beaver habitat into human settlements (Naiman et al., 1988). However, this loss did not go unrecognized by society. By the early 1900s, beaver populations quickly rebounded due to fur bans, harvest regulations across the nation, and reintroductions to reestablish beaver populations (WHCWG, 2012).

Today, we recognize beavers as a keystone species. Numerous studies document the importance of beavers and their activity as ecosystem modifiers by developing wetlands that are critical to the health of ecosystems across the world (Wright, Jones, & Flecker, 2002). The U.S. Fish and Wildlife service have also recognized the importance of beaver-created habitat for endangered species such as Coho Salmon (*Oncorhynchus kisutch*) and the Oregon spotted frog (*Rana pretiosa*) (Decker, Riley, & Siemer, 2012).

Their dams are not only important to the survival of many species, they also provide ecosystem services such as: reduced stream flow and bank erosion, sedimentation and water filtration, water storage and increased groundwater recharge, flood control, wetland creation, and carbon storage. These features promote ecosystem resilience, which will become increasingly important with continued global climate change.

As human populations encroach on wildlife habitats, human-wildlife conflicts arise and management ensues (Siemer, Jonker, & Brown, 2004). In these situations, the inherent benefits of beaver-created areas are not obtained without public acceptance; however, increased human-beaver conflicts have the potential to lessen support for wildlife conservation. For instance, beaver dams can flood crops, pastures, or roads, and efforts to mitigate this kind of damage often result in trapping, removal, or more lethal measures. So, what can we do to create a mutually beneficial relationship with beavers and encourage co-existence? Beaver management guidebooks provide solutions to mitigating beaver ponds such as flow devices and culvert diversion devices, but without willingness and support from private landowners these techniques may not have continued utility. By exploring human attitudes towards beavers, major damage concerns can be identified and solutions can be developed. Assessing and understanding these attitudes helps wildlife managers determine how best to approach beaver management in areas also populated by people.

What makes a beaver a nuisance can vary based on human perspective and experiences, and these factors can heavily influence action for mitigation. Human dimensions (people's knowledge, values and beliefs) intertwine with the management of wildlife since people provide the basis for conservation decisions. Throughout the U.S.,

many surveys have been conducted to explore perspectives with respect to beavers and attitudes towards beavers to help direct beaver management. Wildlife managers use these surveys to gage stakeholder attitudes, reduce conflict, and educate and encourage people to participate in wildlife-related activities (Decker et al., 2012). This thesis is modeled after and adapted from a study by Siemer, Jonker and Brown (2004), in which New York residents were surveyed regarding their attitudes toward beavers.

The purpose of this thesis is to explore three primary questions: 1. What are the attitudes of private landowners toward beavers who live near streams in Thurston County? and 2. How can these attitudes be used to help predict landowner acceptance of beaver? and 3. How can landowner attitudes influence management practices and reduce human-beaver conflicts? Within a localized study area of Thurston County, I also compare attitudes of residents with residents surveyed in the New York study by Siemer et al. in 2004, as well as residents surveyed in Massachusetts by the same survey instrument (Jonker, Muth, Organ, Zwick, & Siemer, 2006). Providing a baseline of the attitudes about beavers in Thurston County can help land managers assess the wants and needs of landowners and explore the needs for alternative management practices. Subsequent research can explore attitude changes in the future that can be adapted to future management practices.

The theoretical framework of this study is derived from cognitive hierarchy theory. Cognitive approaches, derived from social psychology (the study of how people's environments influence their thoughts), have been used to connect how values, beliefs, norms and attitudes influence a person's behavior (Decker et al., 2012; Jonker et al., 2006). The framework of cognitive hierarchy theory builds on the concept that a person's

values determine their attitudes and norms, which — at least in part — dictate their behaviors and actions. For example, if a person experiences repeated property damage due to beaver activity, they may be inclined to form increasingly negative opinions about beavers, perhaps even showing support for the lethal removal. Conversely, if people have not had conflicts with beavers or show a higher tolerance of beaver damage, they may be more prone to live with the beavers and support non-lethal management practices (Siemer et al., 2004). Cognitive hierarchy theory has also been used to gauge people's participation in hunting or whether they vote for a reintroduction of a species to an area or not (Morzillo & Needham, 2015).

In conclusion, this study surveys private landowners' attitudes towards beavers. Statistical inferences are made to expose patterns and predictors for these attitudes. Human attitudes towards beavers has yet to be assessed in Thurston County; therefore, this investigation provides land and wildlife managers important information to aid management decisions. This could also lead to proactive measures by infrastructure designers that alleviate landowner concerns about beaver damage and yet that are inclusive (rather than exclusive) of beavers within our environment.

CHAPTER 2: LITERATURE REVIEW

This chapter provides background on the North American beaver (*Castor canadensis)* and reviews literature relevant to current and ongoing management of beavers in the United States and in Washington State. The first section reviews the biology of the beaver, its extirpation and reintroduction, and current population estimates. The second section examines the ecological importance of beavers as a keystone species and their contribution to resilient ecosystems. The ecosystem services beavers provide is also outlined, including: increased stream and riparian areas, creation of wetlands, increased biodiversity, and water storage to combat climate change. Section three provides an overview of beaver management, policies regarding beavers and the role beavers play in restoration projects. Recent changes to policies in Washington State have created new opportunities to relocate beavers for stream restoration. By incorporating beavers as a tool for rehabilitating degraded stream systems, we can create a mutually beneficial relationship by increasing the ecosystem services beavers provide while simultaneously restoring our environment.

Human and wildlife interactions, as discussed in section four, contextualizes how the cognitive hierarchy theory provides the framework for this study. Understanding the attitudes of people towards beavers is valuable for wildlife managers when deciding how best to manage beaver habitat as it is overlapped by human encroachment. Gauging public opinion of beavers is also an important factor for wildlife managers to determine how to maximize the benefits beavers provide. Conflicts with beavers and the concept of wildlife acceptance capacity (WAC) is also examined and defined in this section. The last

section reviews the survey on which this study is modeled, and reviews previous studies with similar techniques and theoretical framework.

Beaver exposé

Biology

North American Beavers (*Castor canadensis)* are endemic across the continent occupying wetland and riparian habitats, as well as several arid regions in the southwest as seen in Figure 1 (Baker & Hill, 2003). Beaver's sharp, continuously growing incisors

Figure 1. Current range of the North American beaver.

allow them to fell trees and feed on the inner cellulose layer as well as the bark. They use both terrestrial and aquatic habitats for food and shelter (Baker & Hill, 2003). They are an aquatic mammal with a paddle-like tail, slick insulated fur, and webbed toes on their hind-feet, they can move smoothly through the water, yet can also walk upright carrying sticks and mud for dam construction with their front legs (Baker & Hill, 2003).

Beavers form lifelong partnerships with their mates; females can have offspring (kits) up to six at a time, but average two per yearly mating season. Larger litters appear in areas with supreme habitat conditions whereas reduced size litters are found where food is sparse within the habitat (Baker & Hill, 2003). Kits typically disperse by 2-3 years of age, although beaver families and extended families form colonies (Baker & Hill, 2003).

Beavers' closable nostrils and ears, inner eyelid membranes and extra set of lips that close behind their incisors enable them to submerge underwater and carry logs in their mouth while swimming without drowning (Baker & Hill, 2003; Naiman, Johnston, & Kelley, 1988). All these features enhance the beavers' adaptability to many wetland and riparian environments (Baker & Hill, 2003). They are nocturnal creatures who also have a penchant for damming up flowing waters using mud, rocks, and downed trees. In the ponds formed by the dams, beavers build lodges for their homes, and use the lodges to sleep and to store food to sustain them through the winter months. The multiple underwater entrances to the well-constructed lodges provide refuge from predators and different escape routes if needed (Baker & Hill, 2003).

Expiration and reintroduction

In pre-European North America, up to 400 million beavers inhabited nearly all aquatic habitats spanning across North America. Today's population of beavers are only a fraction of that historical number (Naiman et al., 1988). Fur trade in the 1600s all but eradicated beavers in streams of New England (Naiman et al., 1988). The Hudson Bay Company, a major trading company, exported massive numbers of beaver pelts to Europe

to support a felt-hat fashion craze (Baker & Hill, 2003; Naiman et al., 1988). Castoreum found in beaver castor glands (a buildup of urine forming a brown paste) was also a commodity harvested used in perfumes and in beaver traps as a lure (Baker & Hill, 2003). By the mid-1800s as people migrated west in search of more beaver populations, exploitation left the beaver nearly extirpated throughout the United States (Naiman et al., 1988).

In a further blow to beaver, fertile and nutrient rich abandoned beaver ponds proved an agricultural goldmine. Human activities such as agriculture, urbanization and industrialization resulted in drained wetlands and conversion of prime beaver habitat into human settlements (Naiman et al., 1988). About 53% of wetlands have disappeared, "on average, the lower 48 states have lost over 60 acres of wetlands for every hour between the 1780's and the 1980's" (Dahl, 1990 as cited in WHCWG, 2012, p. A.10-3).

Combined effects of decreased wetlands and decreased beaver populations left the North American landscape irrevocably altered. Due to the absence of beavers, stream systems themselves changed. Without the beaver dams, stream channels narrowed, increasing flow velocities and habitat availability diminished. The disruption of the dynamic processes between the land and surface water changed the evolution of streams (Goldfarb, 2018). Since beaver extirpation had pre-dated the Western academic studying of streams and lakes (limnology), much of the science had not considered the overall and complete influence beavers have on systems ecology (Naiman et al., 1998).

Through re-introduction efforts in the early 1900s, the beavers' population quickly rebounded. Bans on the sale of beaver fur and harvest regulations across the nation, starting the New England area, helped to re-establish beaver populations

(WHCWG, 2012). In the 1940s, decreased shipment of beaver pelts overseas resulted in new introductions of beaver to countries hoping to establish their own fur industries, further extending the range of the North American beaver (Baker & Hill, 2003). Even though beaver populations did not necessarily return to the same environment they had left, the flexibility and resourcefulness of the beaver allowed the species to persevere (Naiman et al., 1988; Baker & Hill, 2003).

Beaver population estimates are currently between 6-12 million in North America (Naiman et al., 1988). The recovered population of the North American beaver ceases to be endangered, but now faces new challenges resulting in human conflicts, which will be discussed in section four: Human dimensions.

Ecological importance of the beaver

Ecosystem engineer

Deemed an ecosystem engineer, the beaver has the capacity to modify their surroundings to fit their habitat needs (Hood & Bayley, 2008; Naiman et al., 1988; M. M. Pollock, Lewallen, Woodruff, K., Jordan, & Castro, J. M., 2018). They cut down trees and prune vegetation, build dams to create livable ponds, forge new channels to bring in their supplies, and do all this for survival. In doing so, they alter stream morphology and hydrology by impounding water and retaining sediments, creating wetland habitat promoting biodiversity, and impacting the ecosystem in its entirety (Naiman et al., 1988; Wright, Jones, & Flecker, 2002). Since the effects of beavers extend to so many aspects of the environment, they are considered a keystone species, or even a keystone modifier: *"A keystone species is one whose effect is large, and disproportionately large relative to its abundance"* (Power & Tilman, 1996). One established colony of beavers can have significant impacts on a single stream.

A 2002 study in the Adirondacks by Wright et al., found a large increase in species richness of beaver-modified habitats as compared to a landscape without beaver-modified habitats by over 33%. Their results showed that the management of a single ecosystem by an engineer, such as the beaver, could promote increase landscape diversity. Furthermore, the study revealed that not only do active beaver ponds provide ecological benefits such as wetland creation and water storage (which will be detailed in the following section), abandoned ponds evolve into beaver meadows where the nutrient rich soils and meticulously pruned surroundings of the riparian forest allow for an

increase in plant species richness and habitat.

Ecosystem service provider

The effect on natural systems from beaver presence can provide humans with many ecosystem services. Table 1 provides a summary of the processes that beaver's effect to create ecosystem services. Most notably, increased water storage can reduce flooding events, habitats can be restored increasing biodiversity, and water quality can improve through filtration of pollutants (Bailey, Dittbrenner, & Yocom, 2018; Buckley, Niemi, Reich, Souhlas, & Warren, 2011). Throughout the many systems effected by beavers, this section showcases just a few of the benefits that beaver activity can have on ecological systems: streams and riparian areas, wetlands, biodiversity, water storage and sediment retention for combating climate change.

Table 1. Ecosystem services beavers provide are a result from their positive effects on the environment. This table shows the ecological process, how beavers benefit the process, and the resulting effect on the process which produce ecosystem services to humans (Adapted from Bailey et al., 2018).

Process	Benefit	Ecosystem Service
Wetland and floodplain connectivity	Reestablish historical floodplains and increase wetland habitat area	**Slow urban runoff**
Water storage	Ponds and side channels increase catchment storage	**Reduce flooding events**
Nutrient cycling	Created ponds increase nitrogen, phosphate, carbon, and other micronutrient availability	**Increasing mineral and carbon cycles that facilitate pollutant break-down**
Sediment transport	Increased sediment accumulation behind dams can improve high sediment systems and improve subsurface flow	**Provide bank erosion and downstream infrastructure protection**
Water quality	Decreasing water temperatures and higher dissolved oxygen improve outflowing water for fish and micro invertebrates	**Created ponds improve water quality by decreasing water temps and increasing pollutant filtration and sequestration**
Stream complexity	Create step-pool sequences and habitat diversity that increase	**Decrease channelization by encouraging hydrological pathways stream meandering**
Climate change and droughts	Increased water storage and carbon collection, address catchment climate change adaptation goals	**Urban landscapes become more adaptive to droughts, floods, and extreme weather events**
Riparian vegetation and buffer zones	Maintained groundwater levels allow for increased, dense, and complex vegetative patches	**Increased riparian vegetation buffer zones in high urban development areas**
Vegetation ground cover	Environment suitable for disturbance-tolerant and fast growing trees and shrubs such as willow and alder	**Increased regionally-appropriate species for pollution filtration**
Species diversity	Increased habitat for insects, amphibians, birds, mammals, fish, bio-indicator, and riparian-dependent species	**Increase bio-indicator and freshwater invertebrate species important to assessing stream and habitat health as well as wildlife viewing opportunities**
Species migration patterns	Increased natural passageways for urban wildlife and greater genetic diversity	**High quality foraging and rearing habitat for culturally significant species such as salmonids, ungulates, and predator species**

Streams and riparian areas

Pollock et al. (2014) used beaver dams to explain the recovery of incised streams which have been disconnected from the floodplain and exhibit lowered streambeds. The study highlights the succession of a stream in Nevada over a 20-year period, but also utilizes a conceptual model aimed and applied to incised streams with low-gradient landscapes, particularly where beavers primarily inhabit. The reduced water flow and sediment retention caused by beaver dams helps with the aggradation of a streams, allowing more sediment to deposit on the streambed, creating a lower gradient (Pollock et al., 2014).

Lower stream gradients increase floodplain connectivity and promote more plant growth in riparian areas, increasing biological diversity and thus the benefits and ecosystem services beaver dams provide. A conceptual model of a streams succession after a beaver dam establishment is shown in Figure 2. It shows how a stream and riparian area can evolve over time and be restored to a more naturally flowing river system.

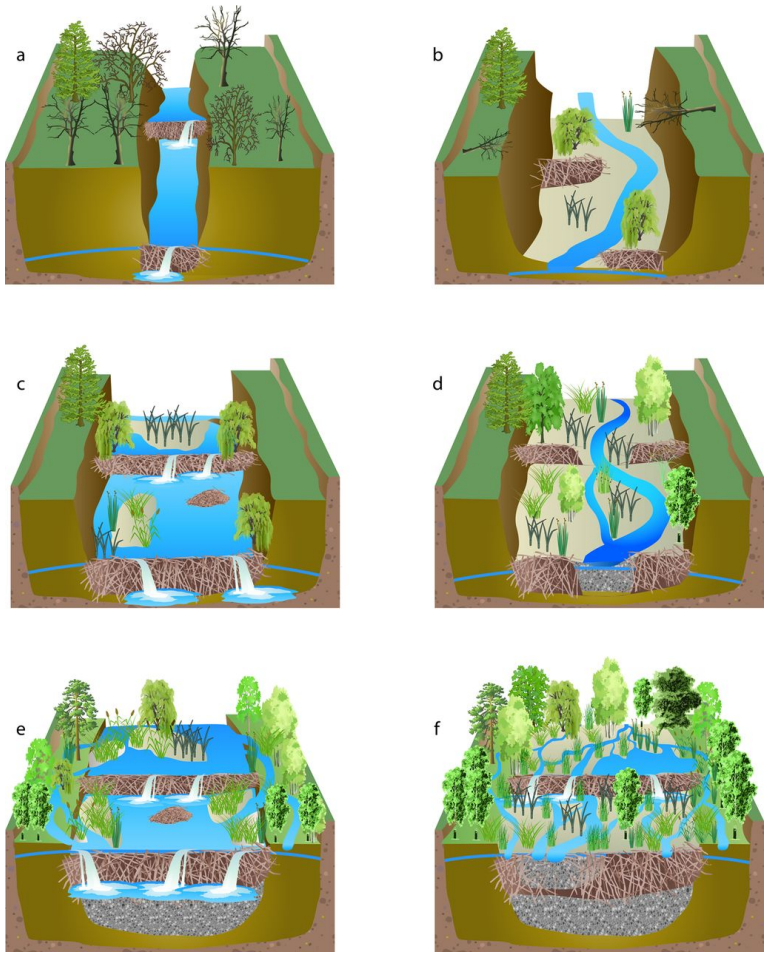


Figure 2. A conceptual model of how a beaver dam can contribute to the restoration of an incised stream. (a) Channelized and incised stream with high velocity flows blowing out any dams built. (b) Blowout of beaver dams allow debris to help form floodplain. (c) With lower flows, beavers can build stable dam in floodplain. (d) Beaver pond quickly fills with sediment from incised stream helping to restore riparian area, but dam is temporarily abandoned. (e) Restored riparian area creates establishment sites for more beaver dams. (f) Beaver dams help to restore wetland area, floodplain connectivity, and ecosystem (Credit: Pollock, Beechie, Wheaton, Jordan, Bouwes, Weber, & Volk (2014). Using Beaver Dams to Restore Incised Stream Ecosystems. *BioScience*, *64*(4), 279–290.

Aggradation of a stream is also associated with increased roughness of a stream stemming from large woody debris (LWD) and instream vegetation (Wohl, 2015). Unfortunately, removing beaver dams and LWD from streams was a common practice throughout North America to clear the way for transporting logs from timber harvest and to maintain navigable waters (Naiman et al., 1988; Pollock et al., 2014; Wohl, 2015). Today, riparian restoration ecologists and natural resource managers introduce LWD to

restore streams as a part of salmon enhancement projects. Anchored to shorelines in confined urban streams, LWD can promote deep pooling and provide refuge for juvenile fish. Although some managers still remove LWD in the name of fish recovery and stream restoration, scientific communities do not recommend the practice for overall stream enhancement (Wohl, 2015).

The use of beaver dam analogs (BDA), structures that mimic beaver dams, have also been used to successfully restore incised streams (Pollock et al., 2014). BDAs can be established at areas of high stream gradients, places where beaver dams would have a higher rate of getting flushed due to an increase in the velocity of stream flows. Preliminary introduction of these structures can start the process of aggradation until beaver dams can withstand flow and be established more securely (Pollock et al., 2014). Beaver dams and BDAs not only create pooling behind them, sequences of pools along a stream increases complexity promoting meandering and diverse hydrologic pathways, which decreases channelization (Bailey et al., 2018, Pollock et al., 2014).

Nutrient storage is also a byproduct of sediment retention behind beaver dams. Sediment and organic matter can hold back nitrogen and carbon, decreasing the amount of nutrients found in water supplies and thus improving drinking water quality (Wohl, 2015). Additionally, decreased nutrients can also decrease the amount of dissolved forms of nitrogen and carbon that can enter the atmosphere and ocean water from water supplies alleviating some global warming stressors (Wohl, 2015).

Wetlands

The creation of wetlands is a natural process, but can also be engineered from either humans or beavers alike. Whether it be a storm water mitigation effort from humans to abate condominium complexes or strip malls, or the result of a beaver dam on a low-gradient stream with acres to spare, both can produce similar impacts to the surrounding ecosystem. The benefits of wetlands are widely studied, and the connection between beaver dams and wetland creation can provide a bridge to understanding the far-reaching benefits of beavers.

Naiman et al. had demonstrated, in a series of aerial photographs from 1940 to 1986, how beavers can alter hydrology and vegetation space on a boreal forest landscape (1988). The study area in Kabetogama Peninsula in northern Minnesota showed a tenfold increase of beaver dams over those forty plus years. The observed beaver impounded landscape revealed the development of a mosaic of marshes, bogs and forested wetlands. This varied mosaic produced different and complex vegetation types found on the Kabetogama Peninsula which increased plant diversity and water storage.

Ultimately, wetland plant communities can take hold when water is captured and can spread out laterally increasing vegetation diversity, habitat and biodiversity. Wetlands also provide sediment retention which can also hold in nitrogen and carbon, acting as a carbon sink (Macfarlane et al., 2017; Povli & Wohl, 2013; Wohl, 2015).

Biodiversity

The mosaic patchwork of riparian habitats beaver activity produce; including water pooling, inundated vegetation, opened woodland areas due to herbivory; all

contribute to the biodiversity in plants and animals found around beaver-created habitats. Taking a comprehensive look at how beaver dams promote biodiversity, Stringer and Gaywood (2016) published a meta-analysis of studies that revealed positive effects of beavers on a wide variety of plants, invertebrates, amphibians, reptile, birds, and mammals. Overall, they found that beaver-created areas increased heterogeneity both spatially and temporally. With the succession of beaver ponds in wetlands in meadows, the variety of habitats created from a single beaver dam is immense.

Aspen, willow and cottonwood trees proliferate despite the heavy grazing from beaver. The rapid regrowth of these trees suggests beaver-preferred plants may have evolved to accommodate such herbivory (Baker & Hill, 2003; Stringer & Gaywood, 2016). Beaver activity also provides increased grazing opportunities of woody and herbaceous plants for moose, elk and deer. Semi-aquatic mammals such as river otter, mink and muskrat flourish. Baker and Hill examined a study in Idaho that showed a doubling of small-mammals in beaver pond habitat verse non-beaver influenced riparian habitat (2003).

Beaver dams that inundate streambanks with vegetated areas promote high bird diversity. Dead wood provides nesting and feeding habitat, protruding beaver lodges give shelter and reprieve from predators, and a diverse range of ecological niches (Stringer & Gaywood, 2016). Finer sediment and slower water produced by beaver ponds have shown to increase in macro-invertebrates, providing an increased food supply and easier foraging for birds and fish (Naiman et al., 1988; Petro, Taylor, & Sanchez, 2015). Such invertebrate communities also provide food for reptiles; increasing prey abundance for mammals as well (Baker & Hill, 2003; Naiman et al., 1988; Stringer & Gaywood, 2016).

In the past, beaver dams have been removed by fisheries managers who believe they impede fish passage, but as the knowledge of riverine habitats increases, managers now deem beaver populations beneficial to fish species (Wohl, 2015). A study in Stillaguamish Basin in Washington State showed a correlation between the loss of winter habitat for Coho Salmon smolts and the loss of beaver ponds created from beaver dams (Pollock et al., 2004). To allay fears that dams block fish passage, Goldfarb (2018) found that many habitat managers agree salmon eventually find a way past beaver dams, either by weaving through the dam structure or by finding alternate routes around the dams found in offshoot channels made by beavers.

Water storage, sediment retention and climate change

Sequestration of harmful pollutants to our atmosphere is a valuable ecosystem service helping to combat the negative effects of climate change (Wohl, 2015). Wetland creation is one of the biggest benefits from beaver dam, as they are big carbon sinks and help to sequester carbon to help combat global climate change effects (Povli & Wohl, 2013; Wohl, 2015). However, slower moving waters due to beaver impoundments also help systems retain water as well as aerobic and anaerobic soils. With the removal of vegetation for food and dam construction, ponds inundate surrounding areas with water, raising the water table. Sediments behind beaver dams can absorb water and retain it during wet months, and slowly release it during hotter ones (Stringer & Gaywood, 2016). The retention of aerobic and anaerobic soil also act as a reserve for carbon which is important for sequestration as shown in Figure 3 (Naiman et al., 1988). Patch bodies created by beavers and their dams are accumulations of water and sediment within the

stream channel. The long these sediments collect, the more carbon they sequester (Naiman et al., 1988).

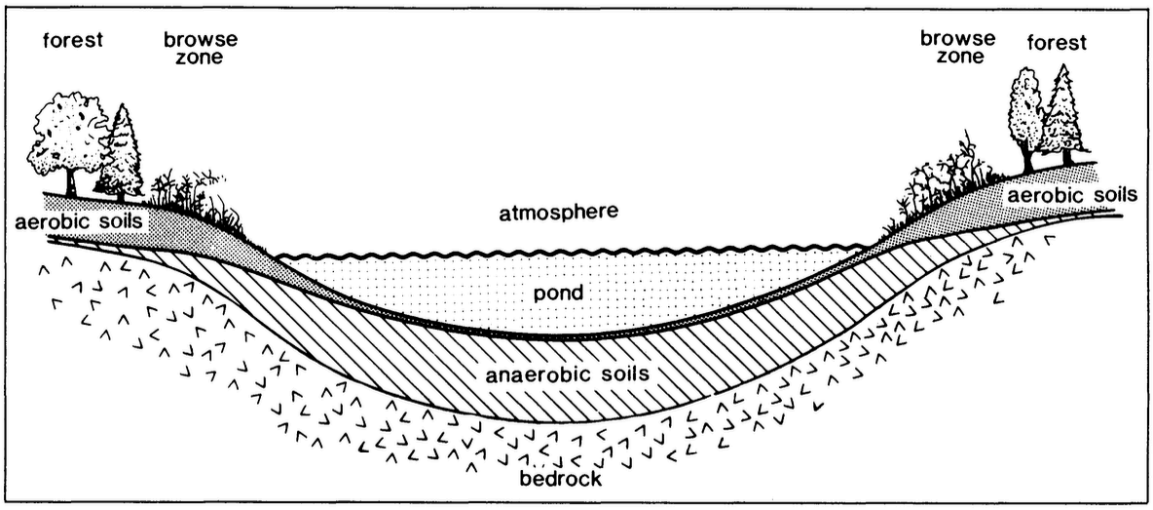


Figure 3. Cross-sectional view of where aerobic and anaerobic soils get stored in a patch body (Credit: Naiman, Johnston, & Kelley (1988). Alteration of North American Streams by Beaver. *BioScience*, *38*(11), 753–762).

Natural water storage provided by beaver ponds has also been shown to increase ground water recharge and buffer areas for flood control (Law, McLean, & Willby, 2016; Macfarlane et al., 2017; Naiman et al., 1988; Puttock, Graham, Cunliffe, Elliott, & Brazier, 2017). This could reduce the cost of having to build man made reservoirs and having to repair flooding damage.

Ecosystem health benefactor

A natural river system is self-sustaining and resilient as it can adapt to natural disturbances. Therefore, a restored river system to a more natural state is more apt to resemble and behave like a self-sustaining system (Law et al., 2016; Palmer et al., 2005). The benefits of having a resilient and self-sustaining system, especially in urban centers,

is the reduced need for on-going management. As stated in the previous section, restoring beaver populations has the potential to improve degraded natural systems that provide humans with valuable ecosystem services (Buckley et al., 2011). Ecosystem services are benefits that we can help create by restoring our ecosystem around us.

To combat negative effects of urbanization to nearby streams, such as surface runoff and pollutants (lawn and agriculture fertilizers, petroleum products, and pet waste), wetlands and beaver-created areas can increase filtration and moderate stream flow variability with natural flood retention (Palmer et al., 2005). Incorporating beaver habitat can help minimize long-term maintenance and repair to natural systems. Urban landscape architects and restoration ecologists are starting to consider incorporating beaver dams and possible beaver activity into design concepts (Bailey et al., 2018). Figure 4 depicts possible outcomes of landscape plans with and without the incorporation of beavers in initial planning and design.

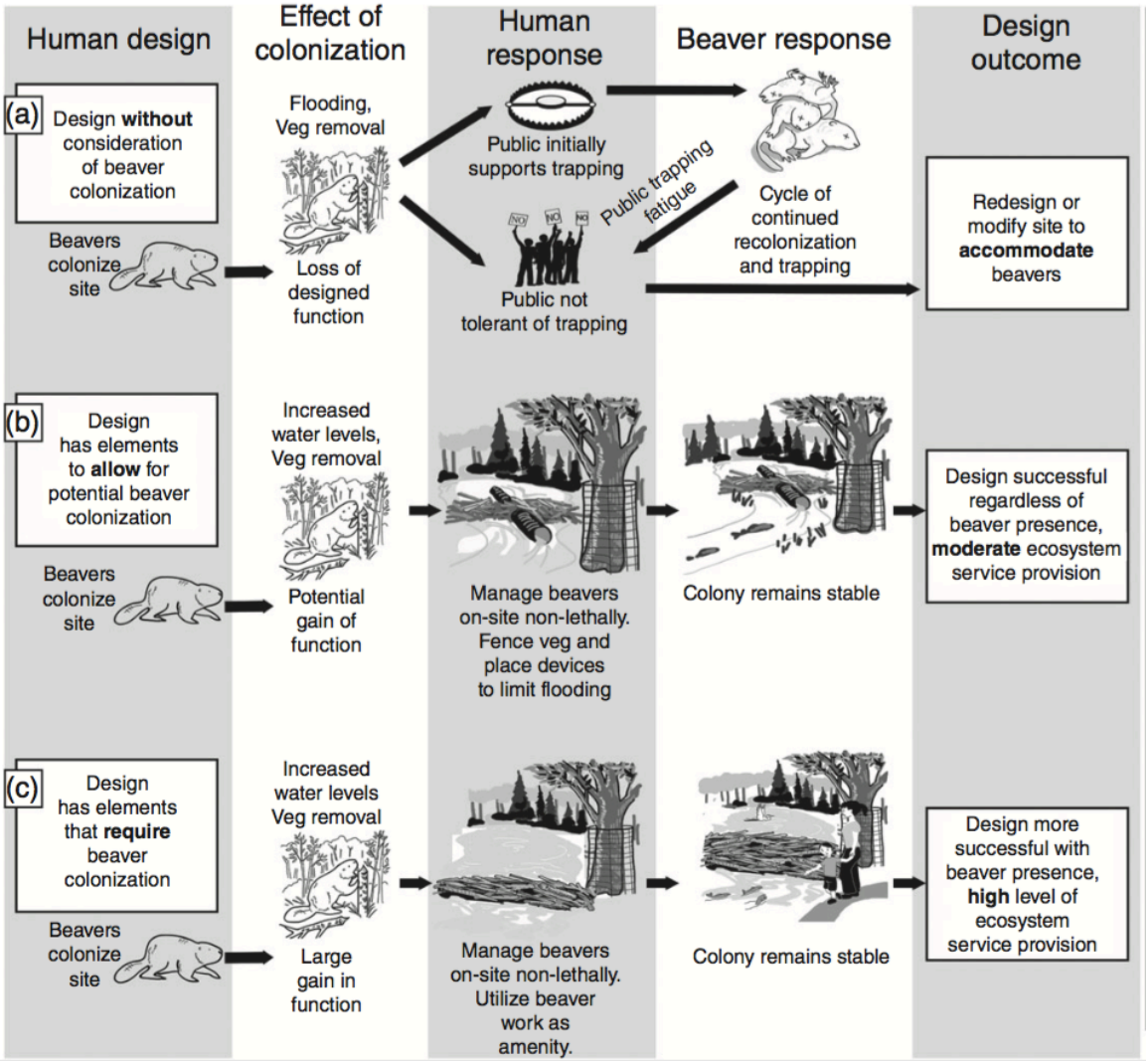


Figure 4. Landscape plans with and without beavers and possible outcomes (Credit: Bailey, Dittbrenner, & Yocom (2018). Reintegrating the North American beaver (*Castor canadensis*) in the Urban Landscape. *Wiley interdisciplinary reviews: water*, e1323).

While removing nuisance beavers has been the typical practice for beaver management, it is generally not sustainable. Nearby beavers can recolonize previously inhabited areas quickly, making the cycle of beaver trapping perpetual to maintain the original "no beaver" project design (Bailey et al., 2018). However, by allowing the beavers to colonize at the beginning of a restoration project, the outcome produced will have the protection from beaver damage inherently solved. Moreover, the design concept will be considered a success.

The roles of beavers in restoration projects is not a new concept, and has been on the rise for over a decade. The Methow Beaver Project (MBP), which started in 2000, have been translocating beavers to other remote areas of the watershed for stream restoration, and for rehoming 'nuisance' beavers ("Methow Beaver Project," 2013). With measured success, the MPB compiled an implementation plan in collaboration with many agencies, creating a protocol for beaver translocations. One notable contribution was from the United States Forest Service. Through Geographic Information System (GIS) assessment, they provided a way to determine suitable and available beaver habitat using stream gradient, stream flow, and food source data ("Methow Beaver Project," 2013).

Habitat suitability models for beavers have been created throughout Washington State to appropriately find areas for beaver translocation. The Northwest Indian Fisheries Commission has spearheaded many projects involving beavers as stream restoration tools. The sovereign status of Tribal nations has allowed them to translocate beavers and incorporate them into stream restoration projects ahead of state regulated restrictions and management. In 2012, the Tulalip Tribes collaborated in a study on the ecological benefits of translocating beavers for stream restoration within the Snohomish River Basin in northwest Washington (Tulalip Tribes, 2013). They identified steps towards successful beaver relocations including: evaluating sites for habitat suitability, pre-release monitoring of beavers, and post-release monitoring of sites (Tulalip Tribes, 2013).

Beaver Management

Federal and state policies

In the United States, wildlife falls under the designation of a "public trust" resource and wildlife management occurs at state, tribal, and federal levels (Decker et al., 2012). The Public Trust Doctrine (PTD) defines ownership and empowers these entities to be trustees of wildlife. Owners/trustees must understand the needs of both citizens and wildlife to determine goals and objectives of the trust (Decker et al., 2012).

In accordance with the Fish and Wildlife Coordination Act of 1934, several federal agencies, including The United States Fish and Wildlife Service (USFWS), The United State Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), and Wildlife Services (WS) have been given the authority to evaluate impacts to fish and wildlife from development projects that modify natural water systems (USFWS, 2018; Dyer, Butler, Ste, & Me, n.d.). The Washington State WS aims to provide "leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist" (2018, p. 1).

The USFWS and WS also provide beaver management methods for state assigned departments. The Washington Department of Fish and Wildlife (WDFW) enforces beaver management regulations in Washington State. Because of its legal status as a furbearer (WAC 220-440-020), beavers are covered by state trapping regulations and open season hunting restrictions. However, if beavers cause damage to personal property, owners may remove the beavers at any time, with no special permits required for lethal removal or live trapping (RCW 77.36.030).

Due to the increasing knowledge of beaver importance over the last few decades, regulations for beaver management have been continually adapted to keep up with current best available science. The passage of the "Beaver Bill" of 2012 (House Bill (HB) 2349, 2012) demonstrated that the Washington State legislature has recognized the benefits of beavers to the ecosystem. The Bill states that beaver play a "significant role in maintaining the health of watersheds in the Pacific Northwest"; it recognized that live trapping and relocation of beavers "as a beneficial wildlife management practice." This bill gave the WDFW authority to relocate beavers to "appropriate" lands between areas east of the Cascade Mountains, and from an area west of the Cascade Mountains to an area east of the mountains.

House Bill 2349 also stated the WDFW had to identify available areas for beaver capture and relocation to help people interested in relocating beaver. A laundry list of qualifications need to be considered before WDFW will issue a permit for beaver relocation including habitat requirements, obtaining necessary permissions and permits, and relinquishing of liability against the state (Vanderhoof, 2018). The 2017 adjustment to the Beaver Bill changed the RCW 77.32.585 to include relocation be permitted in areas west of the mountains as well (House Bill (HB) 1257, 2017). Another change requires the WDFW to issue quarterly reports on nuisance beaver activity, beaver trapping and beaver relocations as shown below in Table 2.

Table 2. Small Game & Trapping: Beaver Management				
License Year	Beaver Relocations	Beaver Take		
		Nuisance Removal	Recreational Harvest	Total Beaver Take
2014	119	1,470	1,302	2,772
2015	127	1,492	1,099	2,591
2016	83	1,743	682	2,425
2017	81	1,521	810	2,331
2018*	1	419	0	419

WDFW online reporting started in 2014 as required by RCW 77.36.160 in accordance with HB 2349. WDFW is also required to report to Wildlife Services. Licenses are issued for recreational trapping, for hides and pelts only, between September 1st and through March 31st. It is worthy to note that first time license holders must take an exam in safe, humane, and proper trapping techniques. *values for 2018 will not be complete until the end of season in 2019 (WDFW, 2018).

WDFW requires a Hydraulic Project Approval (HPA) permit for trapping and relocating wildlife. The potential instream disturbances caused by these activities need to be reviewed to ensure the protection of fish (WAC 220-660-230; RCW 77.55). WDFW also requires a permit when manipulating beaver dams (such as notching out areas in a dam for releasing water or installing water flow or beaver exclusion devices). Beaver management techniques can be found in various beaver management guides and drainage manuals throughout Washington State counties (Vanderhoof, 2018).

Human and wildlife relationship

Human dimensions

Wildlife management has been defined as having three major components: humans, wildlife, and habitats (Decker et al., 2012). Social factors (people's knowledge, thoughts, and actions) intertwine with the management of wildlife since they provide the basis for conservation decisions. By knowing how humans perceive both beavers and specific beaver management principles, wildlife managers can thoughtfully explore a variety of alternatives and long-term conservation plans (Siemer et al., 2004). Wildlife managers can also use this knowledge to predict stakeholder management positions, reduce conflict, and educate and encourage people in wildlife-related activities (Decker et al., 2012). In a similar vein, Baker et al. (2003) suggests that better understanding of beaver management will help to "educate a public that is becoming more removed from the land and more inclined to use legislative or judicial means rather than the judgment of wildlife professionals to manage wildlife populations" (p. 306).

Cognitive hierarchy theory

Cognitive approaches, derived from social psychology (the study of how people's environments influence their thoughts), have been used to explain how values, beliefs, norms and attitudes influence a person's behavior (Decker et al., 2012; Jonker et al., 2006). The framework of cognitive hierarchy theory builds on the concept that a person's values (personal standards or judgement) determine their attitudes (a person's viewpoint or disposition), and these attitudes determine (at least in part) behaviors and actions. In

Figure 5, this relationship is shown as an upside-down triangle, with behaviors at the top and values at the bottom.

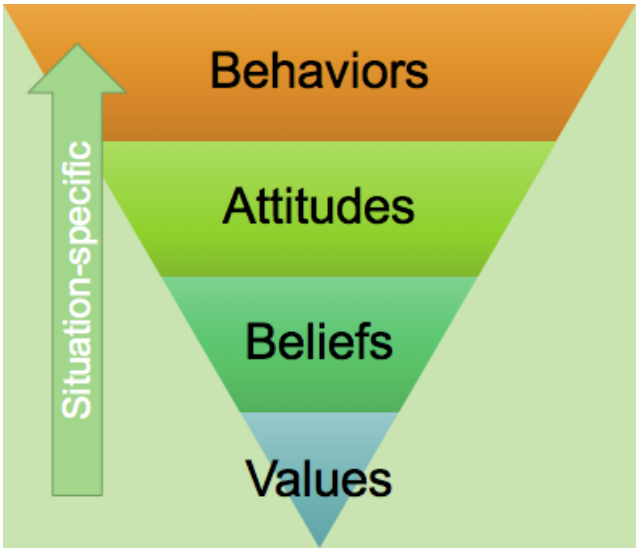


Figure 5. The Cognitive Hierarchy Model (Vaske, Donnelly, Williams, & Jonker (2001). Demographic In£uences on Environmental Value Orientations and Normative Beliefs About National Forest Management. *Society and Natural Resources*, *14*, 761–776).

Values alone do not directly predict behavior. Instead, cognitive theories suggest that attitudes and norms drive the connection between values and predicting behaviors (Decker et al., 2012; Vaske, Donnelly, Williams, & Jonker, 2001). In the case of beavers, the cognitive hierarchy framework can help predict peoples' actions towards beavers based on their attitudes and beliefs. For example, if people experience increased damage to their property from beavers, their attitudes toward them may be increasingly negative and they would show more support to eliminate the problem (i.e. kill the beavers). Conversely, if people have not had conflicts with beaver or show a higher tolerance of beaver damage, they may be more prone to live with the beaver and support management practices that will encourage co-habitation (Siemer et al., 2004).

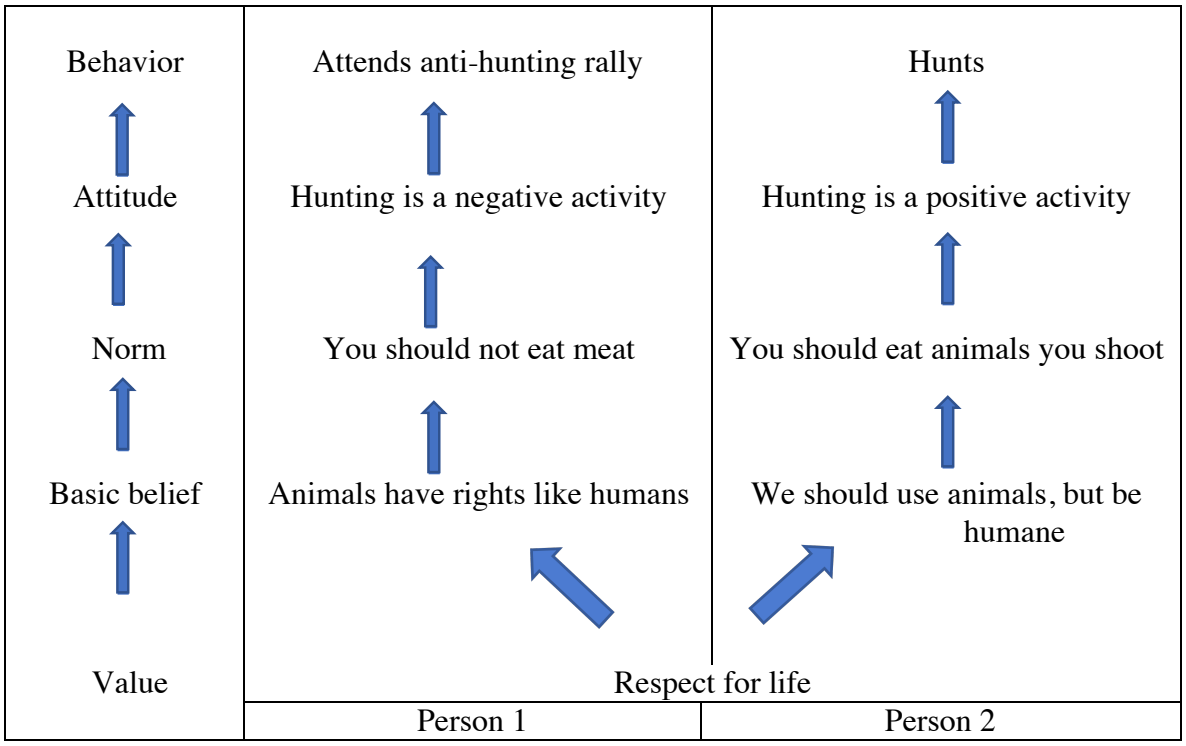


Figure 6. Cognitive hierarchy chart showing two different end behaviors where the stated beginning value is the same (adapted from Decker et al., 2012).

The cognitive hierarchy theory is the framework at the forefront of many human-wildlife studies, but has been used to understand conflicting preservation value orientations verses human domination (or use) orientations; i.e. spotted owl vs loggers, wildlife vs hunter, or national forest vs urban development (Morzillo & Needham, 2015; Vaske et al., 2001). Figure 6 illustrates this idea by charting out the process of two people who have the same value: having respect for life (Decker et al., 2012).

While Person 1 and Person 2 start with the same value position (a respect for life), different behaviors result. Person 2 ends up hunting, and Person 1 attends an anti-hunting rally. Beliefs, norms and attitudes intervene between the starting value position and the ending behavior. Person 1 shares the value of having respect for life for both humans and wildlife, whereas Person 2 shares the value of having respect for life for just humans, not

necessarily wildlife. Attitudes and norms therefore prove to be better predictors of end behaviors than initial values.

In a related study about value orientations and normative beliefs, Vaske et al. examined demographic characteristic and attitudes toward natural forest management within a sample of Colorado residents (2001). The study revealed a significant relationship between demographic influences that could help predict environmental value orientations. Not only can demographic characteristics give insight into who holds certain values, predictors could help identify what environmental management actions are deemed acceptable to them. Vaske et al. found that the longer someone had lived in the same area reflected someone who is more prone to be against national forest preservation (the management action), and females were found to be more pro-preservation (2001). Income was also found to be a predicting factor for environmental preservation. Individuals with higher incomes were found to be supportive of national forest preservation than those found in lower income brackets (Vaske et al., 2001).

This present study falls under the umbrella of conservation social science. The most effective plans for conservation processes (planning, implementation and management) involve the combination of both social and natural sciences (Bennett et al., 2017). This interdisciplinary approach to wildlife management has been included in what is labeled "Human dimensions of natural resource management (HDNRM)." HDRNM has helped to incorporate conceptual frameworks, such as the cognitive hierarchy theory, into many conservation efforts for not only wildlife management, but also management for marine ecosystems, fisheries, forests, and global environmental change (Bennett et al., 2017).

Wildlife acceptance capacity

"Instead of the biological carrying capacity of the landscape, it is often the social carrying capacity, i.e. people's tolerance of beaver that influences where beavers can exist or persist" (WHCWG, 2012, p. A.10-3).

Alongside the concept of biological carrying capacity of a species where environmental factors limit wildlife populations, is wildlife acceptance capacity, where human factors limit wildlife populations. Wildlife acceptance capacity (WAC) factors include people's tolerance levels of damage from 'nuisance' wildlife (i.e. beavers), as well as the values people place on them (Decker & Purdy, 1988). However, this is not a hard and fast number to gauge. Levels of WAC interact with specific situations, economic concerns, ecological, and intrinsic values people hold toward a specific wildlife population (Decker & Purdy, 1988). Nonetheless, knowing the WAC can be valuable to wildlife managers who need to address a wide array of concerns, needs, and preferences from people within a community.

As the cognitive hierarchy theory explains why people may come to conclusions about what they value in a species, WAC helps explain where people's tolerance limits are. Identifying where people stand on specific management practices aids in categorizing what types and levels of management people would deem acceptable.

Surveying attitudes towards wildlife and beavers

Throughout the U.S., many surveys have been conducted to explore perspectives on wildlife management. Wildlife managers use these surveys to gage stakeholder

attitudes, reduce conflict, and educate and encourage people to participate in wildlife-related activities. Many of the studies that focus on human-wildlife conflicts have similar goals: to increase wildlife support and to negate negative impacts people might experience from wildlife.

In Cayuga Heights, New York, a study of human conflicts with urban dwelling white-tailed deer was conducted by Chase, Siemer, and Decker in 2013. They found that 80% of the populations wanted a decrease in deer populations due to increased negative effects including car collisions and damage to landscape. Although the damage and the concerns of people had increased, lethal measures remained less acceptable ranging from 15-34%. A high percentage (98%) agreed that citizens should have an opportunity to weigh in on management practices in many different avenues, from citizen surveys to subcommittees, suggesting that citizen participation would benefit wildlife managers (Chase et al., 2013).

Severe conflicts between beavers and humans can negatively impact social acceptance of them, and therefore decrease wildlife support. Beaver dams could flood out crops, pastures or roads, causing damage to private property and public infrastructure. What makes a beaver a nuisance can vary based on personal perspective and experiences, and can heavily influence the way people respond or perceive mitigation actions. Current mitigation most commonly utilizes trapping, removal, or lethal measures, and so without the willingness of private landowners to consider alternative mitigation, the benefits from beavers will continue to be lost.

The present research is modeled off two separate studies, one in New York (Siemer et al., 2004) and one in Massachusetts (Jonker et al., 2006), which were initiated

to explore relationships between beaver populations, beaver damage and attitudes toward beaver management actions. Nuisance beaver complaints from residents in Massachusetts and New York increased substantially in the 1980s and 1990s (Siemer et al., 2004) sparking concern with wildlife managers, and several studies were initiated by Cornell University in partnership with the New York State Department of Environmental Conservation and Massachusetts Division of Fisheries and Wildlife.

The New York and Massachusetts studies focused on different sample areas within each state, as well as people who have filed beaver related complaints with the state. Both studies used the same survey instrument, and combined data was used in a subsequent study to further investigate their original hypotheses: As people experience increased damage to their property from beavers, their attitudes toward them become increasingly negative. Their findings concluded that as negative personal experiences with wildlife increase, WAC can decrease.

Conclusion

It is widely accepted that beavers enhance riverine habitats in a multitude of ways. The studies discussed in this literature review demonstrate how beaver presence and beaver dams increase biodiversity, create valuable ecosystem services, increase wetland areas, aid in climate change mediation, increase water storage capacities, and help create important habitat for endangered salmonid species. Although the benefits are many, studies discussed in this review also reveal how human-wildlife interactions influence our view of management practices. Cognitive hierarchy theory helps to illustrate the connection between a person's behaviors and their values, attitudes, norms and beliefs.

In the present thesis, residents living proximal to beaver habitat are surveyed on a variety of questions, including their experience with beavers and related property damage, their opinions about beaver management, and their general views about wildlife. Respondents responses may predict which management styles are acceptable to stakeholders, under a range of circumstances.

As humans continue to encroach into wildlife habitat, conflicts can arise and are addressed through management practices, guides, and manuals. Beaver management guides describe many techniques for people to address beavers and beaver dams. Many of these techniques, are tools for co-existing with a beaver; however, agencies that produce these plans can only provide information and have no enforcement authority. Private landowners have the right to lethally remove beavers from their land and are not obligated to use alternatives, as they are the ones who bear the brunt of the costs to do so. Relaying information about the benefits of beavers and providing alternative techniques to euthanasia are strategies that public land managers include in current management practices.

Similarly drafted beaver management plans are presented by numerous state and county wildlife departments across the United States; however, many have not conducted human-beaver conflict based surveys for their region or have reliable beaver population counts. It is beneficial for wildlife managers to be proactive in beaver-conflict concerns rather than reactive to beaver-conflict complaints. Drafting local management plans with guidance from local concerns can bring invaluable insight to target solutions for managing local beaver populations. With the small number of surveys on the human-beaver experience, replicating methods used in previous studies of this nature enhances

understanding of the relationship between beaver-related experiences and management preferences. Survey data of landowners proximate to two local streams in Thurston County provides an examination of experience with beavers in a Washington State context. Many of the questions for the survey instrument were drawn from the surveys conducted by Siemer et al., 2004 and Jonker et al., 2006, and thus comparisons will be drawn between this Washington State study and the New York and Massachusetts studies.

Translocating beavers to degraded streams for restoration is a practice that is becoming widely studied, and it is slowly gaining traction. Furthermore, Washington State has recognized beavers as beneficial to watershed health and their translocations as an enhancement to management plans. However, beavers utilized for restoration purposes has yet to become a mainstream management practice, and much is to be learned about how the public would respond to beaver introductions for stream restoration. Continued research into public perceptions of beaver is thus warranted.

CHAPTER 3: METHODOLOGY

This research utilizes a quantitative survey design to examine attitudes towards, damages from, and tolerances of beavers from private landowners who reside in prime beaver habitat. The primary focus of this study is to explore two research questions: 1. What are the attitudes of private landowners who live near streams in Thurston County toward beavers? and 2. How can these attitudes be used to help predict landowner acceptance of beaver? and 3. How can landowner attitudes influence management practices and reduce human-beaver conflicts? This research seeks to provide wildlife managers with the resources to address beaver-related concerns and to develop socially acceptable solutions to human-beaver conflict.

Study Area

Thurston County

Located at the most southern end of Puget Sound, Olympia, Lacey, and Tumwater are the major cities found in Thurston County. With a population of 280,000 people, Thurston County exhibits both rural and urban communities with requisite differences in land-use, population densities, and human-wildlife interactions (U.S. Census Bureau, n.d.). There are many parks, natural wildlife refuges, and protected corridors found throughout the county, as well as many natural and confined streams.

Thurston County has several major watersheds, and the two main estuaries include that of the Deschutes River and Nisqually River, which both flow into south

Puget Sound. This study focuses on the lower Deschutes River, the Budd Inlet watershed and the Henderson Inlet watershed as shown in Figure 7.

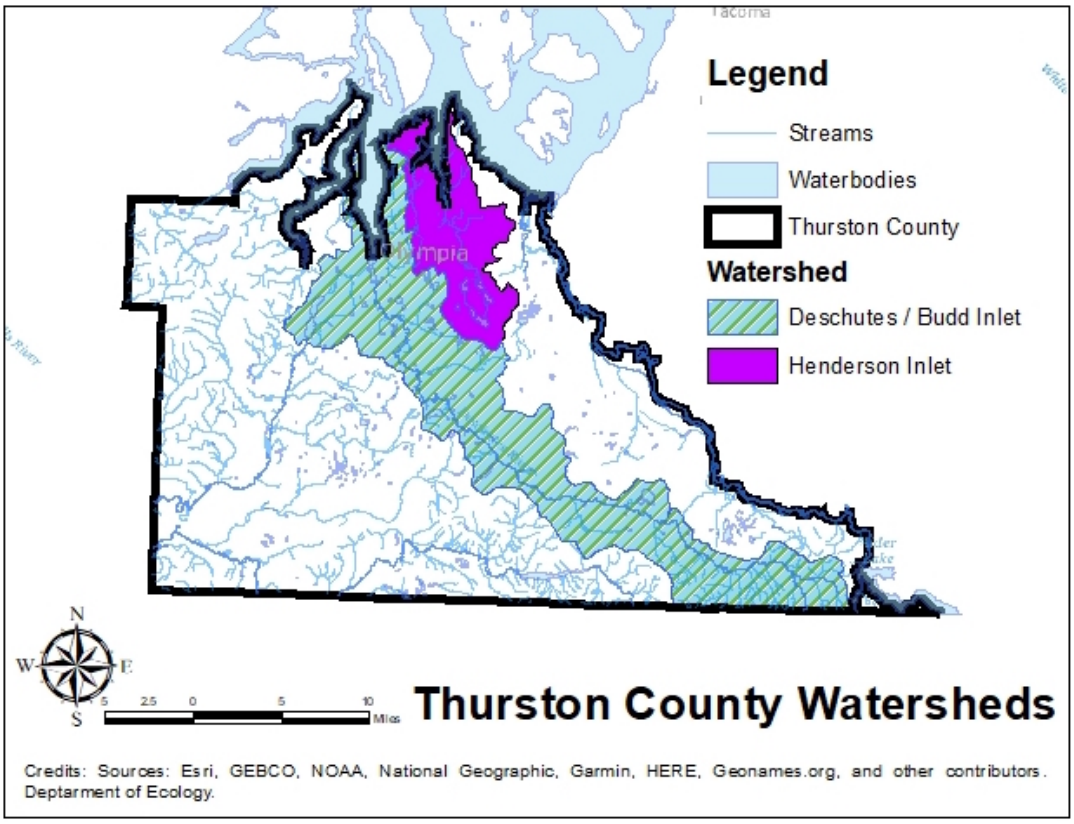


Figure 7. Thurston County watersheds containing survey areas.

These watersheds are included in the Water Resource Inventory Area (WRIA) 13 boundary which exhibits varied landscape types (Figure 8). Surveys for this research were administered to landowners located in beaver-friendly tributaries that flow through the lowland areas of WRIA 13.

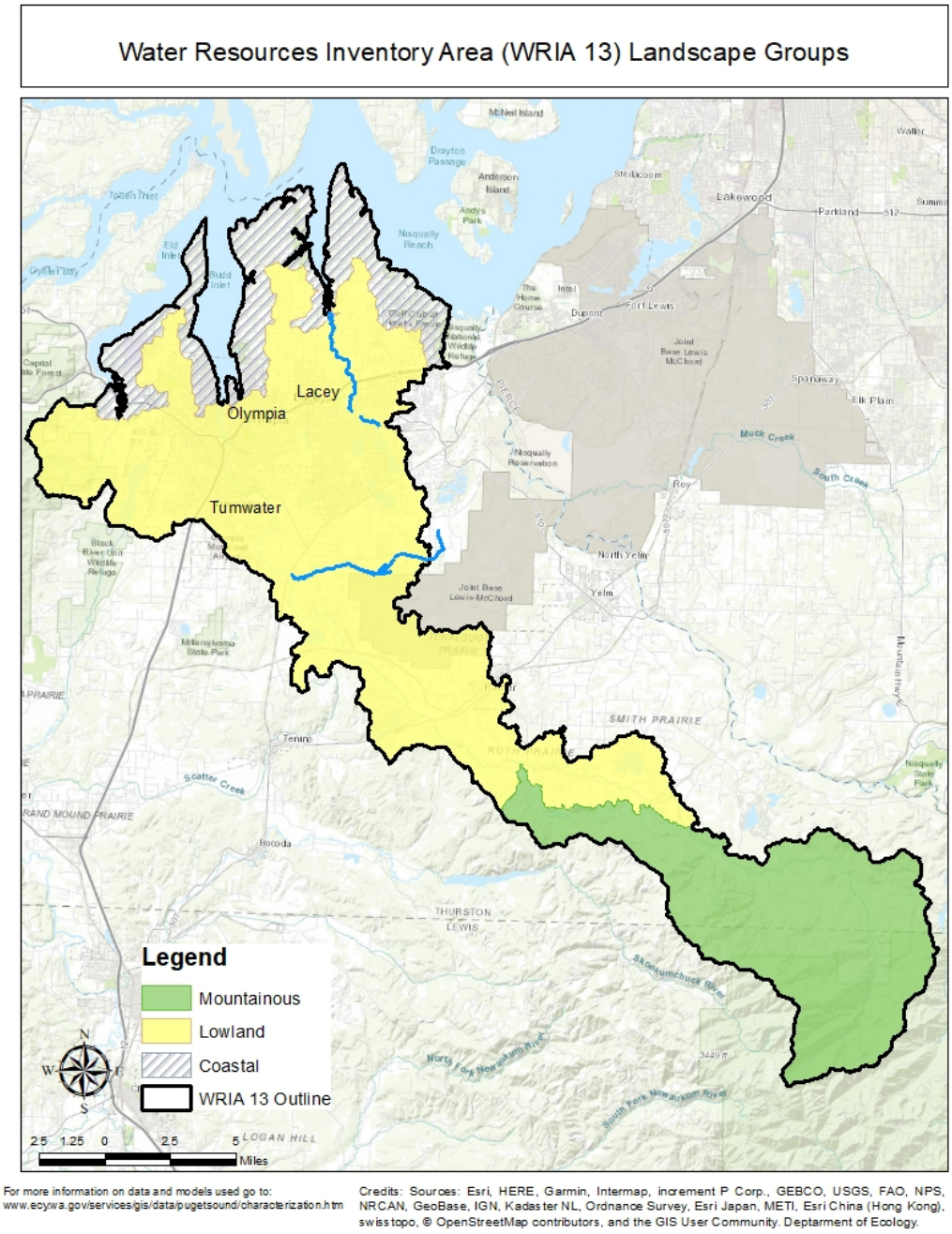


Figure 8. Landscape groups in Water Resources Inventory Area (WRIA) 13. WRIA outline and landscape group data obtained from Dept. of Ecology online spatial datasets.

Low-gradient areas such as these reduce the velocity of waterways, allowing beavers to build dams without getting washed out by faster moving water (Naiman, et al., 1998). Specifically, Figure 9 shows the two study sites within Thurston County. The

Deschutes River watershed contains Spurgeon Creek and the Henderson Inlet Watershed contains Woodland Creek.

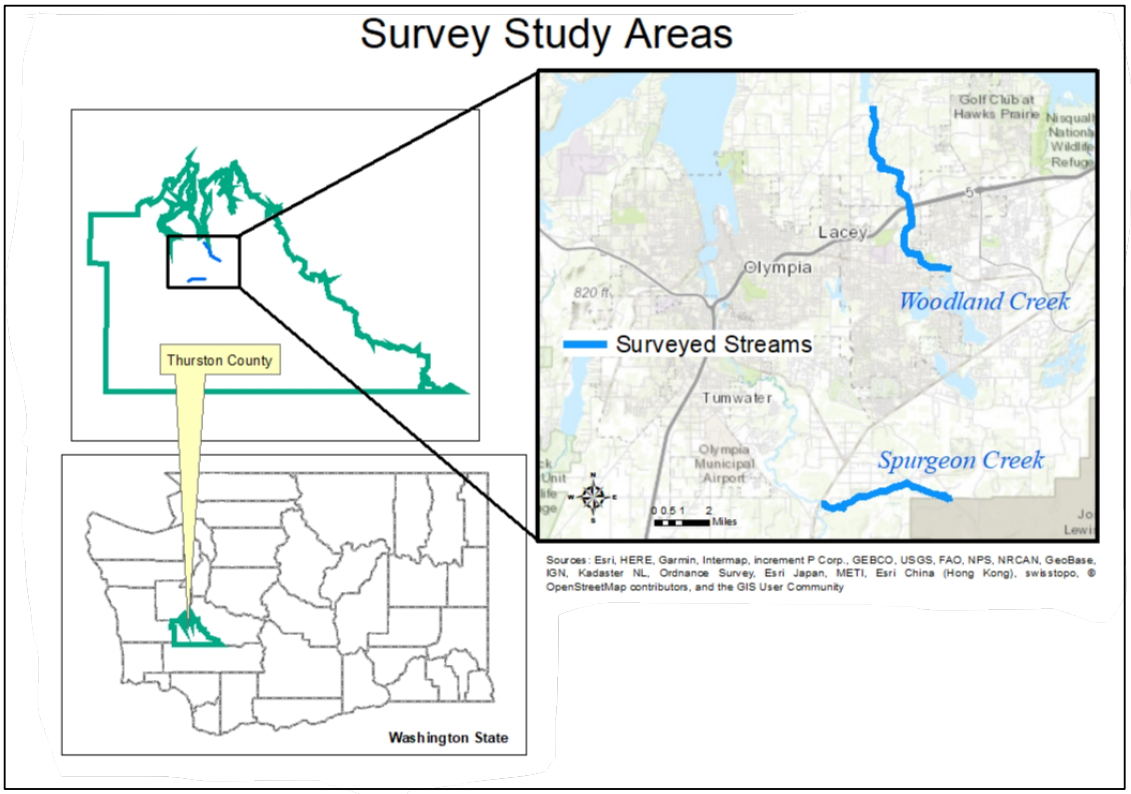


Figure 9. Study survey sites within Thurston County of Washington State. The surveyed streams include Woodland Creek and Spurgeon Creek.

Spurgeon Creek

Towards the outskirts of southeast Tumwater, Spurgeon Creek is a tributary to the Deschutes River approximately 15 miles from where the delta flows into Budd Inlet. The headwaters form from wetlands and beaver ponds in the Evergreen Valley partially located on Joint Base Lewis McCord. The rural surroundings and small number of residential dwellings generally unencumber the natural flow of Spurgeon Creek, however, 'Riverwood' is an isolated neighborhood sub development adjacent to the

creek. Figure 10 shows Spurgeon Creek flowing south of the development, behind houses and eventually through pasture lands, farm acres and wooded areas.

Figure 10. Spurgeon Creek flowing under Equuis Road. Photo credit: Paula Smillie.

Woodland Creek

The headwaters for Woodland Creek start from a string of three lakes including Hicks, Pattison and Long Lake in southeast Lacey and flows northward into Henderson Inlet (Thurston County et al., 2018). The section of Lacey containing Woodland Creek is a moderately populated area. Surrounded by neighborhoods, one rightly named 'Woodland Creek Estates,' it flows through backyards, a community park, Saint Martin's University campus, and under Interstate 5 (culvert under I-5 seen in Figure 11). In the last few miles before its discharge into Henderson Inlet, Woodland Creek winds through wooded areas and rural surroundings. With mixed deciduous and conifer trees throughout the drainage basin, Woodland Creek provides habitat areas and spawning grounds used by anadromous fish species.

Figure 11. Woodland Creek flowing north under Interstate 5 towards Draham Rd. Photo credit: Paula Smillie.

Despite the outfall from storm water runoff and increased disturbance to the stream banks from urbanization (WDFW, n.d.), Woodland Creek remains functional.

Data Collection

Sampling strategy

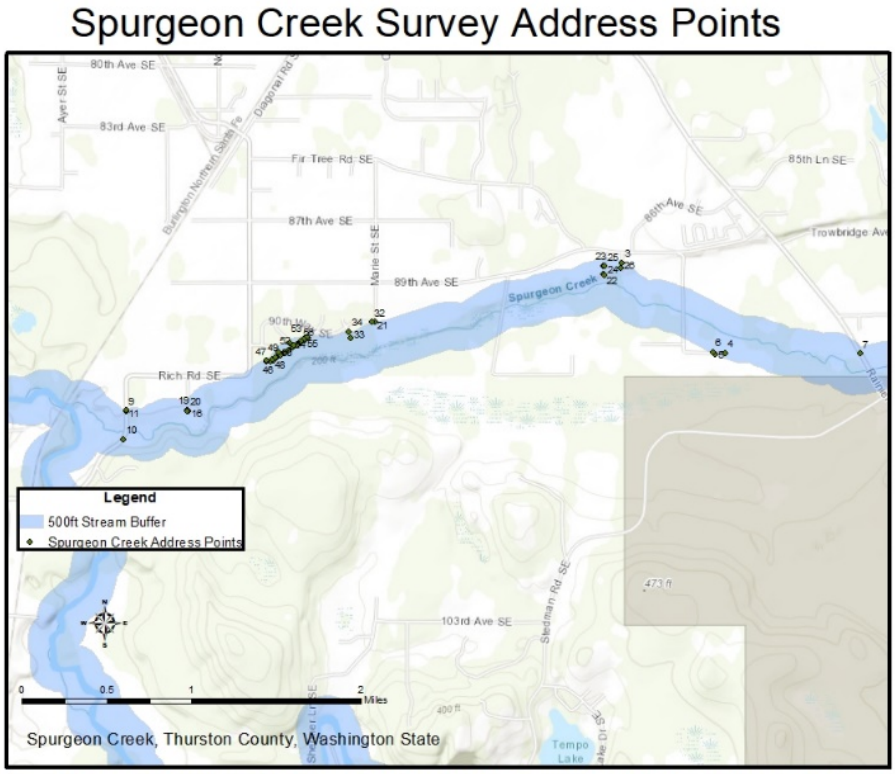
A purposive sampling strategy was used to select stream corridors of possible beaver habitat. Since physical beaver counts have yet to be fully documented in Thurston County, key informant interviews were conducted with land managers at the Washington State Department of Fish and Wildlife and Washington State Department of Transportation who helped identify streams in Thurston County where beaver activity and/or human-beaver interactions are known to occur. Spurgeon Creek and Woodland Creek were both identified by key informants as having either beaver activity, a history

of beaver dams, or anecdotal evidence of beaver activity from residents. These streams were explicitly selected to maximize respondents who were more likely to have had beaver interactions or possible beaver activity on their property.

An initial participant recruitment pool was created utilizing ArcGIS software (ESRI). Publicly available Geographical Information System (GIS) data of Thurston County parcels (obtained through Thurston Geo data) were intersected with Thurston County streams (obtained through US Stream data). A buffer of 500 feet around the streams (250 feet on either side of the stream) was applied to identify all landowners in this proximity to the two streams. The 500-foot buffer was included in part due to the critical areas ordinance enforced by Thurston County to restrict property owners from building too close to stream corridors (in compliance with the 1990 Growth Management Act: RCW36.70A). In this way, two different sample pools were created; (1) landowners within a 500-foot stream buffer area around Woodland Creek and (2) landowners within a 500-foot stream buffer around Spurgeon Creek.

Addresses for sampled properties were extracted from the ArcGIS tabular data into a Microsoft Excel spreadsheet, differentiated by residence in either the Spurgeon Creek or Woodland Creek study sites. The sampling procedure generated 43 addresses for Spurgeon Creek and 174 addresses for Woodard Creek. Due to the smaller sample pool for Spurgeon Creek, landowners at all 43 addresses were invited to participate in the survey. However, for Woodard Creek, a random sample of 120 addresses were drawn from the 174, the necessary amount for proper representation at the 95% confidence level (Dillman, Smyth, & Christian, 2014). To draw the Woodard Creek random sample, the ArcGIS attribute table was used with a randomization tool applied. Figure 12 shows the

site maps of selected residential addresses were created and used in the field for survey distribution. The corresponding numbered survey was recorded to keep track of which paper survey went to each address.



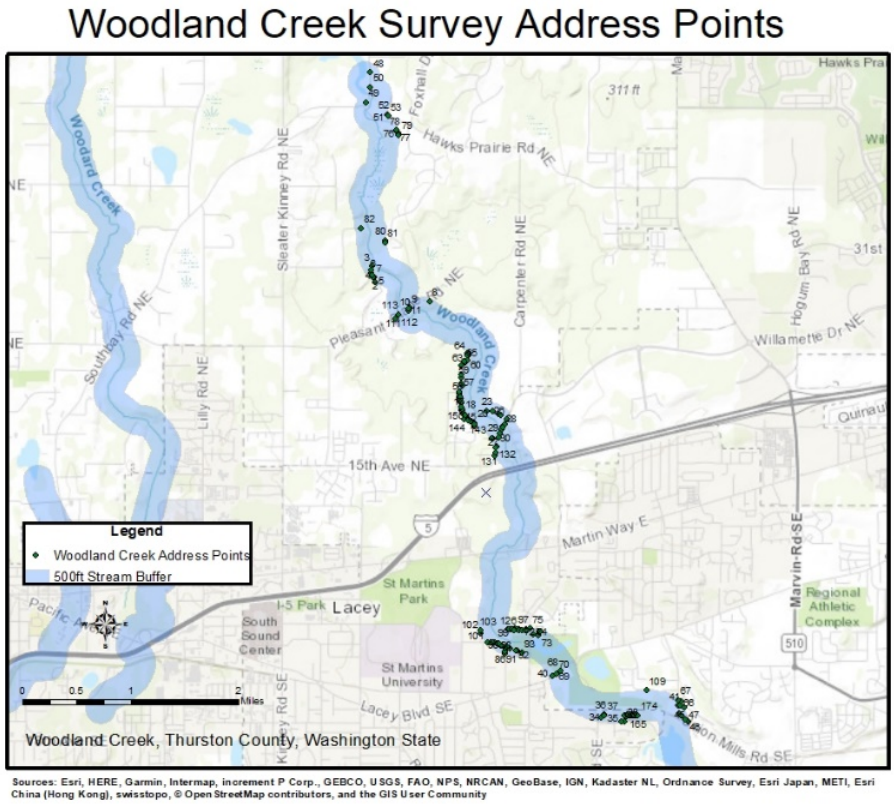


Figure 12. Residential survey sites within 500-foot buffer of Spurgeon Creek and Woodland Creek included in original sample.

Survey Instrument

The survey instrument used for this study (see Appendix A) was adapted from the survey of landowners conducted in New York in 2004, mentioned previously in this thesis (Siemer et al.). Permission was sought and granted for a replication study to be performed in Washington State. The only modification to the survey was to include Thurston County as the target area of inquiry.

A drop-off/pick-up (DOPU) methodology for survey distribution was used to collect landowner responses. DOPU is an alternative to traditional surveys that involves making personal contact with the participant during a door-to-door distribution of a survey (the drop-off), and establishing a verbal communication about participation and an agreed upon time to retrieve the completed survey (the pick-up). This face-to-face interaction with participants has shown to yield higher response rates (up to an average of 80% response rate) than traditional survey methods such as mail surveys or phone interviews (Trentelman, Irwin, Petersen, Ruiz, & Szalay, 2016). With the added element of social exchange in the DOPU method, participants can become more invested with the survey, are more likely to trust the surveyor with confidential information, and are also likely to feel more accountable to complete the survey if they agreed to do so (Trentelman et al., 2016).

The DOPU method was chosen for this study to increase response rate and to engage possible participants in beaver discussion, who in other circumstances may not have participated. Additionally, smaller geographic areas within the sample pools for this study and the smaller size sample pools themselves, allowed for the DOPU method to be an appropriate technique. The survey questionnaire was enclosed in a plastic door hanger

containing a short letter describing the research, along with a beaver sticker (as a token of appreciation for their participation).

Surveys were administered from February 20th to March 17th, 2019. If, during the time of survey distribution, any address was found to be invalid (no residents or unapproachable circumstances), the next closest address number available on the same street was selected. If any address was associated with several apartment complexes, a random number selector was used to randomly select a unit number to survey. Surveys were collected within the week of initial distribution. Multiple attempts were made those who had not yet returned surveys and if personal connection was not made, reminder notes stating the next collection date were placed on their door knobs. Of the 163 respondents contacted for this survey, 66 chose to participate yielding an overall 40.5% response rate.

A human subjects review by The Evergreen State College was conducted and approved for this research prior to data collection to ensure proper ethical procedures. Steps were taken to alleviate concerns over personal information obtained. The survey contained an inform consent statement, in which participants indicated their agreement by either filling out the survey or declining to participate.

Study objectives and measurement

The survey instrument contains four main study objectives: (1) experience with beavers including beaver damage instances, and management actions taken, (2) attitudes and beliefs toward beavers and toward wildlife in general, (3) wildlife acceptance

capacity, (4) management interventions for beaver activity (adapted from Siemer et al., 2004). Each study objective section is described below.

Study objective:

(1) Find people who have had experience with beavers, and to what extent they have experienced damage to their property caused by beavers. The type of damage was ranked from light to severe. To find typical types of beaver damage and control measures the respondents took, a list of choices for both were presented.

(2) Understand respondents' views and feelings towards beavers and about wildlife in general: questions included specific statements about beavers and their impacts on humans and other wildlife and statements about the rights and the use of wildlife in general. Respondents were asked to indicate the extent to which they agree or disagree with each statement given. Choices included: strongly agree, agree, neutral, disagree, strongly disagree, or no opinion.

(3) Find respondents' preferred beaver populations in Thurston County. Preference of future populations of beavers was used as an indicator of wildlife acceptance capacity. Respondents were asked to select their number of beaver preference from: "no beavers", "1/2 as many beavers", "current number of beavers", "50% more beavers", and "twice as many beavers". To further examine acceptance of beavers, respondents were asked if they have had a beaver translocated to their property, and whether they would consider having a beaver translocated to their property.

(4) Understand respondents' views on management interventions for beavers to help find the extent of beaver acceptance and tolerance. Respondents were asked to respond to three different management actions for the same four scenarios of beaver activity. Management actions included: taking no immediate action, installing drainage pipes to control water levels behind a beaver dam, and lethal control.

Demographic information assessed in this study included: age, gender identity, home ownership, years living in current town and in Thurston County, education, size of town raised in, race, household income, and location. These are important factors to include when conducting descriptive and inferential statistics and comparative analysis to the original study. The full survey instrument can be found in Appendix B.

Data Analysis

Responses collected from the administered survey were recoded to provide numerical data for statistical analysis. Descriptive and inferential statistics were conducted utilizing JMP Pro 12 software and included: distribution and frequency analysis, independent *t*-tests, chi-squared tests, and Analysis of Variance (ANOVA) tests to examine associations between a variety of variables.

A multiple regression model was estimated to examine predictor variables associated with wildlife acceptability and beaver acceptability. Independent variables in these two models include numbers of beaver damage instances to property and sociodemographic characteristics.

Coding survey responses

Utilizing Survey 123 in ArcGIS Online, coding was conducted while inputting survey responses from collected surveys. For responses requiring a no or yes, the no was coded to 0, and yes was coded to 1. Survey questions requiring responses on a 5-point Likert-scale were coded in the following way: 1 = strongly agree, 2 = Agree, 3 = neutral, 4 = Disagree, and 5 = strongly disagree. For a complete view of the survey instrument questions and response coding, refer to Appendix B. "No opinion" values were combined with "Neutral" selections, as the values were later considered to be redundant containing the same meaning. Any question left blank on the survey was considered a non-response, and was reflected in a reduced sample size number for that survey question.

Statistical analysis

Internal reliability tests were first performed for two summated rating scales representing two value orientations: beaver attitude scale, and wildlife attitude scale (for full list of question codes see Appendix B). The original beaver attitude rating scale (question 11) had eleven items, two of which were excluded based on an item-total correlation analysis (questions 11.1 and 11.8). The final Cronbach's alpha for the beaver attitude scale was 0.870 (see Table 3). The original wildlife attitude scale (question 17) had eighteen questions, nine of which were excluded based on an item-total correlation analysis as well as a content validity check (17.3, 17.4, 17.7, 17.10, 17.11, 17.12, 17.14, 17.15, 17.17 were excluded). The final Cronbach's alpha score for the wildlife attitude scale was 0.843 (see Table 3). These two final summated rating scales were then used as dependent variables in further statistical tests of association with socioeconomic and other parameters.

Table 3. Summated attitude scales.						
Scale List of items [1]	# of items	Cronbach's alpha	n	Mean	Sd	Range
Beaver Attitude Scale	9	.870	60	20.98	5.55	9-45
There are too many beavers [R] Beavers are a nuisance [R] Beavers have a right to exist Beavers are a sign of a healthy environment Beaver populations should be left alone Beaver populations should be controlled [R] People don't want a wetland near their home because it could become a haven for beavers [R] Residents should learn to live with beavers The presence of beavers make it a burden to have a wetland near your home [R]						
Wildlife Attitude Scale	9	.843	63	16.68	4.81	9-45
Having wildlife around my home is important to me I notice birds and wildlife around me every day Whether or not I get to see wildlife as much as I like, it is important to know it exists in Thurston Co. An important part of my community is the wildlife I see there from time to time Although wildlife may have certain rights, most human needs are more important than the rights of wildlife [R] It is important to know that there are healthy populations of wildlife in Thurston County The rights of people and the rights of wildlife are equally important We should be sure future generations in Thurston County will have an abundance of wildlife I consider myself to be a conservationist						

1. Variable coded on a 5-point scale from "strongly agree" (1) to "strongly disagree" (5).
[R] Item was reverse coded before analysis

Descriptive statistics were used to examine the profile of respondents' age, gender, education, and income from participants in both Surgeon Creek and Woodland Creek. Other characteristics examined include the number of years lived in current township and within Thurston County, homeownership, and the size of town the respondent primarily grew up in.

Comparative analysis

A comparative analysis between the present study and the original study by Siemer et al. (2004) was undertaken. Differences and similarities between study sites and survey responses were examined. Cronbach's alphas for the attitude scale variables that were created were not calculated in the original study and thus could not be compared with this present study. Main comparisons involve respondents' views on management interventions for beavers across four different scenarios.

CHAPTER 3: RESULTS

Between the Spurgeon and Woodland Creek samples, 163 surveys were distributed with a DOPU methodology. A total of 66 surveys were returned, yielding a total study response rate of 40.5%. Individually, Spurgeon Creek generated a 44.1% response rate (n=19), and Woodland Creek generated a 39.2% response rate (n=47). Although the survey effort did not yield a response rate typical of DOPU, insights regarding predicating factors for value orientation scales, wildlife acceptance capacity and tolerance of beaver management can still be drawn. Results from the study are not intended to make any generalizations about the larger population in Thurston County.

In the following sections, descriptive and statistical differences between the survey creeks will be reported, followed by the differences found between measured parameters. Then, results from a multiple regression model to examine predictors for both the beaver attitude scale and wildlife attitude scale will be presented. Lastly, results will be compared to those found in the study by Siemer et al. (2004) and Jonker et al. (2006).

Differences between study creeks

Socio-demographic profile of respondents

Descriptive statistics for demographic variables are reported in Table 4 and in Appendix A. Overall, respondent populations between Spurgeon Creek and Woodland Creek were similar in average age (above 55 years old) and ethnicity (84-93% of respondents identified as white). Home ownership had an above 90% combined ownership rate, and township and county residency had an average between 23 and 29 years. The majority of respondents were male and with an average income between $60,000-$90,000.

The respondents differed within income brackets; 53.8% of Spurgeon Creek respondents have a combined household income greater than $90,000, verses Woodland Creek's 31.6%. Respondents were primarily male; however, Spurgeon Creek had a considerably higher rate than Woodland Creek (70.6% male verses 53.3% male). More than 50% of respondents received a college degree and the overall majority (41.9%) grew up in a small city between 5,000 and 50,000 people. On average, 27.4% of respondents indicated they were hunters, 30.0% indicated they were an angler, and no respondents were fur trappers. Overall, 65.6% have indicated that they traveled greater than a mile from home to specifically watch wildlife in the past year.

Table 4. Descriptive statistics for sociodemographic variables and for township and county residential status, homeownership, and size of town where they grew up in.

Variable measured	Question	Spurgeon Creek % or mean (sd)	Woodland Creek % or mean (sd)	**Combined** Spurgeon & Woodland Creek % or mean (sd)
Sex [1]	What is your gender?	70.6% Male 29.4% Female n=17	53.3% Male 44.4% Female 2.2% Non-conforming n=45	58.1% Male 40.3% Female 1.6% Non-conforming n=62
Age	What is your age?	63 (19.7) n=17	55 (16.7) n=46	58 (17.4) n=61
Ethnicity [2]	What best describes your ethnic background?	93.8% White n=16	84.1% White n=44	86.7% White n=60
Education [3]	What is the highest level of education you have completed?	62.5% College Degree or higher n=16	57.7% College Degree or higher n=45	59.0% College Degree or higher n=61
Income [4]	Which category best describes your total annual household income before taxes?	21.3% < 60K 23.1% 60K-90K 53.8% > 90K n=13	28.9% < 60K 34.2% 60K-90K 31.6% > 90K n=38	27.5% < 60K 31.4% 60K-90K 41.2% > 90K n=51
Township	How many years have you lived in your current town?	23.4 (15.7) n=17	25.2 (17.1) n=44	24.7 (16.6) n=61
County	How many years have you lived in Thurston County?	24.8 (16.6) n=17	29.1 (20.1) n=45	27.5 (19.2) n=62
Home ownership [5]	Do you own or rent your home?	100% Own n=16	93.3% Own 6.6% Rent or Other n=45	95.1% Own 4.9% Rent or Other n=61
Up bringing [6]	In what size town did you primarily grow up?	29.5% < 15K people 35.3% 15K-50K people 35.3% > 50K people n=17	22.2% < 15K people 44.4% 15K-50K people 33.4% > 50K people n=45	22.6% < 15K people 41.9% 15K-50K people 33.9% > 50K people n=62

1. Variable coded: (1) male, (2) female, (3) non-conforming.
2. Variable coded: White (1), Hispanic (2), Black (3), Bi-racial (4), Asian (5), Native American (6), Other (7).
3. Variable coded: grade school (1), high school or GED (2), tech/vocational school (3), college degree (4), graduate degree or higher (5).
4. Variable coded: less than $15,000 (1), btwn $15,001-$30,000 (2), btwn $30,001-$60,000 (3), btwn $60,001-$90,000 (4), btwn $90,001-$120,000 (5), greater than $120,000 (6).
5. Variable coded: (1) own, (2) rent, (3) other
6. Variable coded: on a farm (1), country-side not on a farm (2), small town (less than 5,000 people) (3), small city (5,001 to 50,000 people) (4), large city (50,001 to 300,000) (5), very large city (more than 300,000 people) (6), more than one area with different sized populations (7).

Experience with beavers

Even with both Woodland and Spurgeon creek bordering many residential dwellings and human populations, reported experience or any associated problems with beavers due to beaver activity was minimal. Shown in Table 5, a total of 17.2% of all respondents reported an experience or problem with beavers, with a combined average of 88% of the severity of those experiences described as being light. However, Spurgeon Creek respondents reported more beaver experiences (22.2% compared with 15.2%) and more repeated instances of beaver experience or damage (10.6% compared with 8.5%) than Woodland Creek. Furthermore, no respondents from Spurgeon Creek have had a beaver translocated to their property, and only 5.6% of respondents would consider having beaver translocated to their property. Conversely, one respondent located on Woodland Creek reported that they have had a beaver translocated to their property and 34.1% of respondents would consider having a beaver translocated to their property (Table 5).

Four respondents reported they have acted upon managing beaver damage that they have experienced. A total of 3% have contacted someone for more information about beaver control methods, including contacting someone for more information on beaver control methods. For Spurgeon Creek, just two respondents (10.5%) have either contacted WDFW for a permit to remove a beaver or beaver dam or a wildlife control operator to trap the beavers (see Appendix A).

Table 5. Frequencies (shown as percentages) of respondents having experienced beaver damage, frequency and overall severity, and beaver translocation experience and consideration.

	Overall	Spurgeon Creek	Woodland Creek
Have had beaver experiences[1]	17.2% (n=64)	22.2% (n=18)	15.2% (n=46)
One or more instance of beaver damage[2]	9.0% (n=66)	10.6% (n=19)	8.5% (n=47)
*Severity of beaver problem categorized as "light"[3]	88.2% (n=17)	64.7% (n=17)	23.5% (n=17)
Have had beaver translocated to property	1.6% (n=63)	00.0% (n=18)	2.2% (n=45)
Would consider having beaver translocated to property	25.8% (n=62)	5.6 % (n=18)	34.1% (n=44)

1. Variable coded: Yes (1) or No (0)
2. Variable coded: "Strongly agree" (1) to "strongly disagree" (5)
3. Based on the total number of people who responded to this question. Variable coded from "light" (1) to "severe" (5).

Figure 13 shows the types of beaver damage people have reported with the highest percentage of damage to individual trees or woodlots of 10.6%. Additionally, one respondent on Woodland creek expression concern about the local salmon run when describing a beaver-built dam found on the creek.

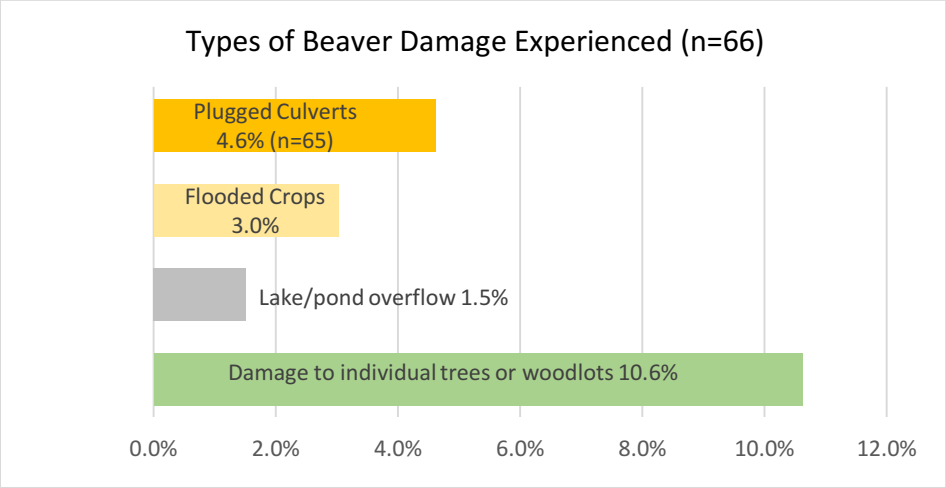


Figure 13. Reported damage from beavers (n=66 unless otherwise noted) as well as the type of damage.

Wildlife acceptance capacity

To identify wildlife acceptance capacity (WAC) of the respondents, question 13 asked about their preferences for future populations of beavers in Thurston County. The overall responses revealed an average of 70% agreement for the current population to remain the same. For Spurgeon Creek, a small percentage on both ends of the spectrum, "no beavers" (13.3% or 2 respondents) and "twice as many beavers" (6.7% or 1 respondent) exhibits a wide range of WAC. Woodland Creek, containing the larger sample pool, had no respondents select "no beavers" and had a higher response (11.9% or 5 respondents) to "twice as many beavers" (see Appendix A).

Statistical differences between survey creeks

To analyze differences between the two creeks, Pearson's chi-squared was conducted for categorical variables and independent t-tests were conducted for continuous variables. Statistical significance was reported at 95% confidence interval and p values less than 0.05 (full list of significant values in Appendix C). No statistically significant difference was found between the two creeks for age, gender, or education, signifying a homogeneous overall population for these three parameters. These findings are congruent with the results found in the study by Siemer et al. in 2004, when they surveyed several areas in New York, as well as in a comparative study in Massachusetts (Jonker et al., 2006). However, income level did vary between the two creeks X^2 (4, N = 51) = 13.04, $p < 0.01$, where respondents in Spurgeon Creek exhibited higher levels of income than in Woodland Creek.

A statistically significant difference between the two creeks was found for respondents who would consider having a beaver translocated to their property X^2 (1, N = 62) = 5.43, $p < 0.02$. Woodland Creek residents showed a higher rate of acceptance for translocation than Spurgeon Creek residents. Several attitude statements used in creating both the beaver value scale and wildlife value scale also showed statistical differences between the two creeks. One item that was left out of the attitude scales, showed statistical difference between the two creeks: "*It is acceptable for human use to cause the loss of some individual wild animals as long as populations are not jeopardized*" X^2 (4, N = 64) = 11.09, $p < 0.03$. This statement was ultimately left out of the attitude scales because item-total correlation showed it did not measure the underlying construct reliably.

Last, included in the set of survey questions regarding the three different management actions for the four different scenarios, only "taking no immediate action" when a beaver is "seen in my yard" was found to be statistically different between the two creeks X^2 (4, N = 64) = 9.67, $p < 0.05$.

As discussed in the methods chapter, two summated rating scales were constructed to represent attitudes toward beavers (beaver attitude scale) and general attitudes toward wildlife (wildlife attitude scale). There was a positive correlation between the final beaver attitude scale ($M = 21.10$, $SD = 5.52$) and the final wildlife attitude scale ($M = 16.69$, $SD = 4.85$), represented by a Pearson's r correlation coefficient of 0.581 ($p < 0.000$, n=60). The correlation coefficient shows strong but not perfect correlation – thus, the two scales are analyzed separately in this analysis.

Independent t-tests were conducted on the two attitude scales to determine statistical differences existing between Spurgeon and Woodland Creek. The wildlife attitude scale showed no statistically significant difference between Spurgeon Creek ($M = 18.59$, $SD = 4.68$) and Woodland Creek ($M = 15.98$, $SD = 4.72$) where $t(61) = -1.95$, $p = 0.055$. Although, these results are close to the significance threshold of $p < 0.05$, they still fall out of the range for the statistical significance for this study. Similarly, the beaver attitude scale resulted in no statistically significant difference between Spurgeon Creek ($M = 22.89$, $SD = 6.67$) and Woodland Creek ($M = 20.17$, $SD = 4.86$) where $t(58) = -1.77$, $p = 0.082$. Thus, data from the two creeks are analyzed as part of one dataset in the following analyses.

Differences between various parameters

One-way analysis of variance (ANOVA) tests were conducted to compare the relationships between several categorical socio-demographic variables (age, gender, education, and income) and scores on the beaver and wildlife scales. Additionally, ANOVAs were conducted to compare the relationship between categories of both beaver management preferences and wildlife acceptance capacity (WAC), and scores on the beaver and wildlife attitude scales. Statistical significance was determined based on the $p < 0.05$ threshold.

No statistically significant differences were found between demographic categories of age, gender, income or education and the beaver attitude scale. However, respondents of different ages had statistically different mean scores on the wildlife attitude scale (F (1,57) = 5.65, p = 0.021).

Furthermore, an ANOVA showed statistically different mean scores on the beaver attitude scale based on whether respondents would consider having a beaver translocated to their property (F (1,54) = 25.93, p = 0.000); the same was true for the wildlife attitude scale (F (1,58) = 10.5, p = 0.002). People who would consider having a beaver translocated to their property was also found to be statistically significant between the two streams, showing that this parameter might be an important factor for determining beaver acceptance.

Last, an ANOVA showed statistically different mean scores on both the beaver and wildlife attitude scales based on the respondents WAC (beaver: F (4,55) = 7.98, p = 0.001; wildlife: F (4,58) = 2.98, p = .026).

Beaver management interventions

To gauge acceptance of management interventions, respondents were asked to respond to three different management actions for the same four scenarios of beaver activity; *a beaver is seen in my yard, a beaver floods a public road, a beaver damages my private property, a beaver carries a disease that is harmful to humans*. Management actions included: taking no immediate action, installing drainage pipes to control water levels behind a beaver dam, and lethal control. Descriptive statistics for these variables are shown in Table 6; for simplicity, responses for the type of management were recoded and categorized into either acceptable or unacceptable.

Table 6. Overall acceptability of various wildlife management interventions in four different scenarios entailing human-beaver interactions.

Scenario	Intervention [2]	n=	Acceptable [1]	Unacceptable [1]
A beaver is seen in my yard				
	No Action	64	68.8%	14.1%
	Management Control	65	13.8%	40.0%
	Lethal Action	63	7.9%	81.0%
A beaver floods a public road				
	No Action	66	22.7%	69.7%
	Management Control	66	77.3%	7.6%
	Lethal Action	62	19.4%	59.7%
A beaver damages my private property (trees, well, etc.)				
	No Action	66	27.3%	57.6%
	Management Control	65	57.0%	10.7%
	Lethal Action	63	22.2%	58.7%
A beaver carries a disease that is harmful to humans				
	No Action	66	18.5%	66.2%
	Management Control	65	58.5%	16.9%
	Lethal Action	64	54.7%	20.5%

1. Variable coded from "strongly agree" (1) to "strongly disagree" (5). Variable collapsed to Acceptable = strongly agree + agree and Unacceptable = strongly disagree + disagree. "Neutral" and "No Opinion" numbers are excluded.
2. For full question statements refer to survey instrument in Appendix.

The highest percentage of agreement for all scenarios (81.0%) was for no lethal action to be taken if a beaver was seen in their yard. As the scenarios increased from least severe (i.e., a beaver seen in my yard), to most severe (i.e., a beaver carries a disease that is harmful to humans) acceptance for no action to be taken decreased from 68.8% to 18.5%, whereas the acceptance for lethal action incrementally increased reaching its highest percentage of acceptance at 54.4%. The second highest percentage of agreement

(77.3%) was for the acceptance of management control if a beaver were to flood a public road. Management control acceptance remained in the 50% range for the more severe scenarios, reflecting a higher average in acceptance for management control of beavers than for unacceptable responses. Overall, taking no action was generally not acceptable when the scenario involved negative effects on humans, also reflected by the increased acceptance of lethal control as scenarios increased from least severe to most severe.

Multiple linear regression analysis predicting beaver and wildlife scale scores

Multiple regression models were estimated to analyze the predictive power of several predictor variables for both beaver and wildlife attitude scales. Results of the beaver attitude scale regression are found in Table 7. The Adjusted R^2 value of 0.13 indicates that the model explains 13% of the variability of the response data (beaver attitude scale). Predictor variables included in the model were: experience with beaver activity, number of years they have lived in Thurston County, gender, age, income, number of trips they have taken more than a mile from their home to see wildlife, homeownership, education, and the survey creek they live on. Income was found to be the only statistically significant predictor of beaver attitudes, exhibiting a negative regression coefficient (-1.89 β) after controlling for the other predictor variables in the model. Therefore, a respondent with a higher income would score lower on the beaver attitude scale, on average.

Table 7. Multiple linear regression of beaver attitude scale (unstandardized beta coefficients).

Predictor variable	β	t Ratio	Prob>|t|
Experience	-3.369	-1.410	0.167
Years in Thurston County	0.068	1.080	0.287
Gender	0.574	0.320	0.753
Age	0.020	0.360	0.721
Trips to see wildlife	0.637	0.300	0.768
Homeownership	1.799	0.420	0.676
Income	-1.896	-2.110	0.042*
Bachelors' degree or higher	-1.205	-0.590	0.556
Spurgeon Creek	3.521	1.950	0.059

R^2 value = 0.307, Adjusted R^2 = 0.129, F Ratio = 1.724
*statistically significant

A similar multiple linear regression model was estimated for the wildlife attitude scale, using the same predictor variables. Table 8 provides the results of this regression. However, no independent variables emerged as statistically significant predictors of wildlife attitudes. This indicates that respondents' attitudes toward wildlife (as measured by the wildlife attitudes scale) are not associated with the variables included in this regression model.

Table 8. Multiple linear regression of wildlife attitude scale (unstandardized beta coefficients).

Predictor variable	β	t Ratio	Prob>|t|
Experience	-3.470	-1.730	0.092
Years in Thurston County	0.022	0.400	0.689
Gender	0.776	0.510	0.616
Age	0.066	1.440	0.157
Trips to see wildlife	-0.487	-0.280	0.784
Homeownership	1.112	0.350	0.728
Income	-0.452	-0.610	0.546
Bachelors' degree or higher	-1.550	-0.900	0.372
Spurgeon Creek	2.958	1.870	0.069

R^2 value = 0.238, Adjusted R^2 = 0.062, F Ratio = 1.355
*statistically significant

CHAPTER 4: DISCUSSION

To provide wildlife managers with the resources to address beaver-related concerns, this study explored three questions: 1. What are the attitudes of private landowners toward beavers who live near streams in Thurston County? and 2. How can these attitudes be used to help predict landowner acceptance of beaver? and 3. How can landowner attitudes influence management practices and reduce human-beaver conflicts? To fully answer these questions, this study aims to model the concepts within the cognitive hierarchy framework using survey data. As outlined earlier (page 26):

"*The framework of cognitive hierarchy theory builds on the concept that a person's values (personal standards or judgement) determine their attitudes (a person's viewpoint or disposition), and these attitudes determine (at least in part) behaviors and actions*."

Since experiences can help to influence our values, it is a good place to start when trying to understand the values people hold. To answer this, Spurgeon Creek and Woodland Creek were selected for this study to showcase possible differences in beaver experience and attitudes resulting from differences in geographic location. However, urban and rural categorizations were not explored between the two creeks as both sites exhibited a mixture of both urban and rural areas.

Attitudes toward beavers and wildlife were reflected in the beaver attitude scale and a wildlife attitude scale. Combining multiple questions to be represented by one number can prove to be more reliable that just referring to one question to represent a whole attitude. A higher mark on the attitude scale would reflected a positive attitude

towards either beavers or wildlife in general. These attitude scales were used in a regression model to find the predictive variables that would help to answer questions two. If we know people's attitudes towards beavers or wildlife, we may be able predict who (in terms of socio-demographic parameters) these people are.

The final layer to cognitive hierarchy related to this study would help to answer the third question presented: How can landowner attitudes influence management practices and reduce human-beaver conflicts? Respondents were asked to select the appropriate management (no action, non-lethal, and lethal) to four different scenarios of beaver activity. The acceptance of certain management practices are the behaviors that are ultimately represented in the cognitive hierarchy framework.

Experiences, value orientations, wildlife acceptance capacity, and acceptance of management practices all contribute to the cognitive hierarchy theory in the same order as values, attitudes, and behaviors do in the inverted triangle (pg. 26). As one influences the other, management acceptability (or the behavior) is the outcome. And what drives one to that outcome is the apex of this study. Moreover, by including socio demographic characteristics into the study and incorporating them into the cognitive hierarchy theory, we can understand who holds certain values and views toward acceptable management practices (Vaske et al., 2001).

Socio-demographic variables

The respondents from both Spurgeon and Woodland Creek had many similarities and did not reflect many statistically significant differences, however, many conclusions and possible predictions could still be made. To generalize only the respondents in this survey, a typical respondent was a white, 55-year-old male, who has lived in the Thurston County over 20 years, owns their home and makes a decent living. Out of the socio-demographic parameters tested for differences between creeks and as predictors for beaver attitudes, income was the only variable that was statistically significant for both. The regression analysis showed that the higher a respondents' income; the lower their attitudes toward beaver.

Additionally, respondents in Spurgeon Creek had higher income than Woodland Creek. However, it must be noted that the sample size between the two creeks vary, and this does not represent Thurston County in its entirety. Increased income may translate into ownership of more acreage, and this in turn may mean that these landowners may have "more to lose" from beaver activity. Furthermore, owners with higher incomes may have put more capital investments into their properties, standing to "lose" more from beaver impacts in this way as well. Income was not found to be statistically significant in the study conducted by Siemer et al. (2004) or Jonker et al. (2006).

Experience with beavers

Although there was only a small percentage of the respondents who had any experience with beavers, it is notable to say that a high percentage of them categorized any damages as being light. Flooding of a public road quickly repaired by the department of transportation could have different interpretations as far as severity. The sample pool of this study contained homeowners with most of them residing in neighborhoods and within city limits. Between wildlife corridors and restricted access to stream sites (i.e. culverts under major roads) many areas beavers are found could already be protected and established areas and may explain the light damage categorization.

During the door-to-door survey distribution, many respondents were surprised to hear that beavers were present along any areas of the stream behind their house. They either had no experience or beaver damage of their own and assumed that that was the case for their neighbors, or due to the nocturnal and stealthily nature of the beaver, had not noticed them (personal communication). A purposive sample of just people who have experienced extensive beaver damage would have provided more insight into the relationship between beaver experience and attitudes towards them.

Wildlife acceptance capacity and attitudes towards beavers

Overall, Woodland Creek residents had a higher overall WAC than Spurgeon Creek residents, since no respondents selected “no beavers” as a response to desired population of beavers and had five times the number of respondents select “twice as many beavers”.

Although these results do not allow us to generalize the population of Thurston County, the results display an overall positive attitude towards beavers. Within the questions used to compile the beaver and wildlife attitude scales, agreement to many of the beaver positive statements overshadowed many negative statements. For instance, most respondents agree to the statement that "beaver–created areas benefit other wildlife", showing knowledge of the importance of beavers and to "people get enjoyment from seeing beaver activity", relaying a positive acceptance of the species. Furthermore, the mean of the beaver scale reflects a high overall attitude toward beavers (M = 20.98, Range = 9-45).

Beaver management interventions

In addition to the attitude scales, agreement from the respondents to several different management techniques provides some insight. Much of the response shows overall support for some sort of management of beavers, however the lethal action towards beavers is only most prevalent in response to beavers having harmful effects towards humans (i.e. a disease). Almost twice as many respondents on Woodland Creek than on Spurgeon Creek strongly agreed that "No beaver should be destroyed". Agreement to this statement coincides with the findings that majority of respondents do not agree with the lethal control of beavers.

Not agreeing with lethal action towards beavers can be perceived as a pro-beaver attitude, however it may not account for extreme cases of beaver damage. People who are experiencing a hardship from the effects of beaver damage may be more prone to accept lethal control of beavers. Studies that have included a sample group of respondents who

had made complaints about beavers to fish and wildlife departments concluded that positive attitudes were still present in some respondents despite damage or economic hardship due to beaver activity (Jonker et al., 2006). Nonetheless, respondents with severe damage experience were found to have less favorable views.

Comparative study analysis

The survey instrument for this present study was adapted from the survey by Siemer et al. (2004), and therefore comparisons can be drawn between the present research and the surveys conducted in New York and Massachusetts (Jonker et al., 2006). Similarities and differences were found between the present study and the original despite the sample size geographic differences. Many sociodemographic variables were similar across all studies. Most the respondents were white males, homeowners, and had an average age over 50 years old. The average income for the original study respondents was in a lower tax bracket ($30,000 to $60,000) compared to Thurston County respondents ($60,000 to $90,000). Overall, sociodemographic parameters did not explain much of the variance between the study sites. However, income was found to be a predicting variable for pro-beaver attitudes within the present study, and not found to be an impacting factor for the original study.

Most notably, sample areas of private landowners across all studies, when asked about beaver management practices, exhibited similar trends. Respondents were asked to rank their acceptability of taking no action, mitigation control action by installing water control devices, or taking lethal action in response to scenarios that increased from least

severe to most severe. Figure 14 shows the mean acceptability responses to the four scenarios of beaver activity for the Thurston County, New York, and Massachusetts studies.

The mean responses for no action show that as the scenario extremity increases, peoples' acceptability decreased. This shows that people agree that some action of management should take place when damages occur. The mean responses for mitigating with water control devices show that as the scenario extremity increases, acceptability increases, but then remains stable between neutral and agreeable. The mean responses for lethal control increases like that of mitigation control, however acceptability only spikes after the most extreme event. This reveals that killing beavers is only acceptable if the scenario involves harm to humans. Between the three management practices, mitigating for water levels was the most acceptable practice. This could mean that people are realizing (to some degree) the value of living with beavers.

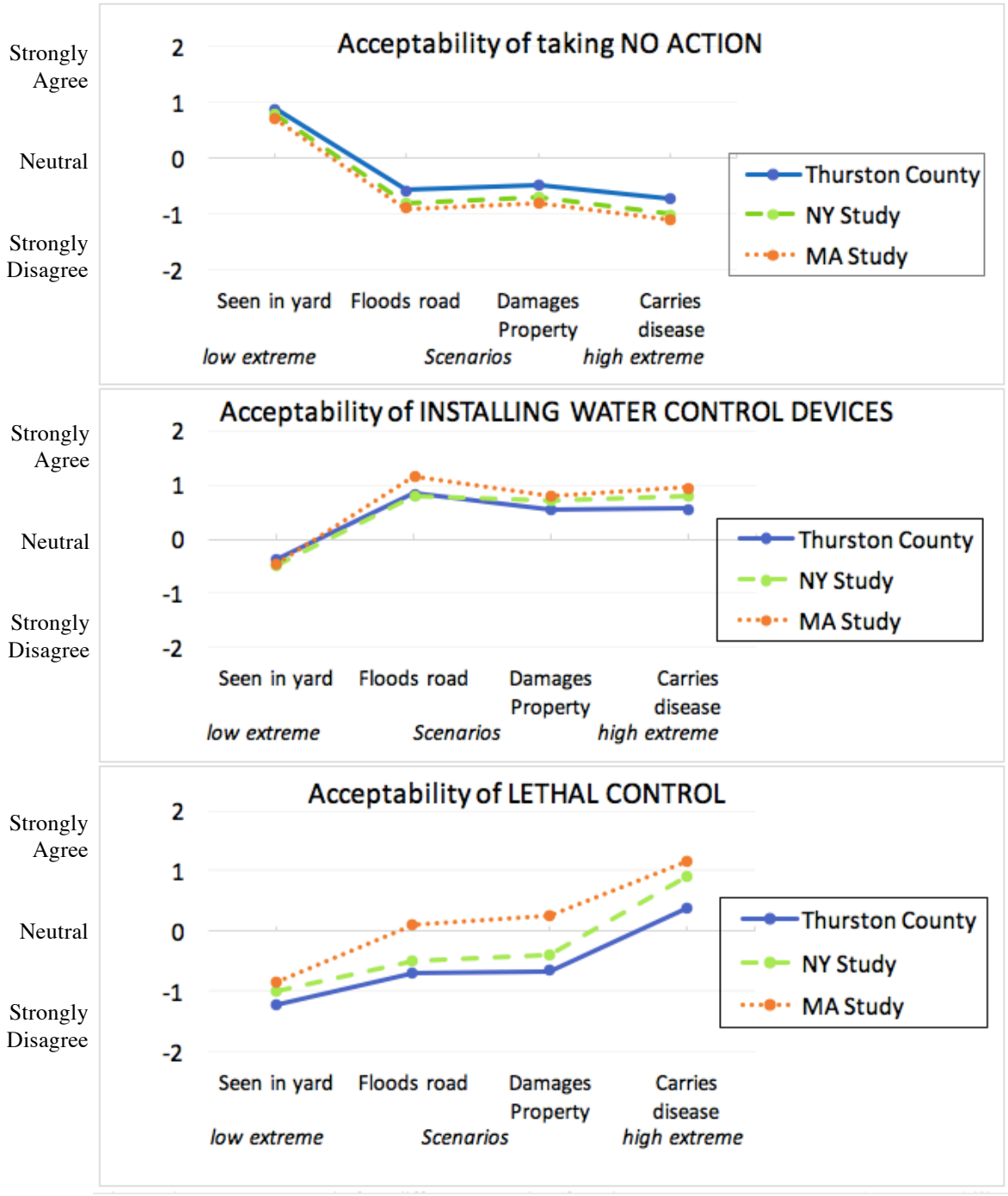


Figure 14. Mean responses in four different scenarios. Scenarios on x-axis are from least extreme to most extreme. Acceptability of management actions recoded from "Strongly agree" (1) to "strongly disagree" (5) to (2=Strongly agree=2, Neutral=0, Strongly disagree=-2). Data from NY (New York) study obtained from Siemer et al., 2004. Data from MA (Massachusetts) study obtained from Jonker et al. 2006.

Although clear distinctions were not made between the different study areas in terms of urban verses rural areas, one distinction was clear. The original study included a separate sample set of people who had filed complaints about beaver damage to the department of fish and wildlife. There was no such sample included in the present study. With this extra data set, Siemer et al. (2004) concluded that personal experiences with beavers had a considerable influence on their attitudes toward beavers. The preference for future beaver populations (measurement for wildlife acceptance capacity) decreased with those who had filed complaints, suggesting tolerance for beavers have been exceeded.

Implications of the present study

This study explores the attitudes towards beavers among two different creeks within Thurston County and seeks to provide wildlife managers with the resources to address beaver-related concerns and to develop socially acceptable solutions to human-beaver conflict. A study of this nature has yet to be assessed in Thurston County. By knowing the attitudes of Thurston County residents, wildlife managers can better anticipate reactions of residents when it comes to issues that arise from human-beaver conflict. Moreover, gauging the support people have for different beaver management techniques, such as controlling water levels of beaver ponds, can allow wildlife managers to adapt current management to more socially acceptable techniques.

To reflect on the results for Thurston County, people only slightly agree with lethal control, and only in the scenarios where beavers carry a disease. It is worth noting that beavers generally do not carry diseases that are lethally harmful to humans. The

'beaver fever' that is associated with beavers refers to Giardiasis; an intestinal illness caused by *Giardia lamblia,* typically contracted when humans ingest contaminated water (New York Department of Health, n.d.). This contamination is typically fecal matter from wildlife, however failing septic systems and household pet waste are also contributors.

Although not asked in the survey if respondents in Thurston County drank from the creeks behind their house, it would be safe to assume that they do not. This would decrease the possibility of contracting 'beaver fever'. According to the data for Thurston County, without this scenario (carries diseases), taking lethal action as a management practice towards beavers is not acceptable at all. Wildlife managers could take this into consideration when creating management plans for beavers. If it is not socially acceptable according to the public, plans should adapt to make this measure unacceptable in practice.

Limitations and Future Research

This initial study of Thurston County residents could act as a pilot study for one to be done on a grander scale. Baseline data of people attitudes towards beaver could be used to show trends in evolving attitudes and shifts towards beaver acceptance and management styles. One of the major limiting factors of this study was sample size. Due to the smaller sample size, generalization about beaver attitudes cannot be made about all Thurston County landowners. Additionally, an increased sample size would allow for a more robust analysis and comparison with the original surveys conducted in New York and Massachusetts. However, patterns and inferences could still be made. Regarding the survey instrument, questions that involve Likert scale responses may also create problems as reliable measures, as respondents tend to avoid the extreme ends of the scale (Mazzocchi, 2008).

Alongside distributing surveys to different areas in MA and NY, Siemer et al. (2004) and Jonker et al. (2006) had also distributed their survey to people who had filed complaints about beaver damage to their states department of fish and wildlife. For the present study, attempts were made to collected data from people who have filed damage complaints with WDFW in Thurston County, however, the small game trapping department within the WDFW do no retain personal records of complainants or types of complaints. As in accordance with the RCW 77.36.160, WDFW is required to report and display catch records by WCOs, applications for beaver removal and any translocation of beavers on their website. They are not, however required to actively keep records about where beaver damage complaints originate. Therefore, a sample pool containing people who have complained about beaver activity in or around their property was not included

in this study of Thurston County. With the added study population of people who have complained about beaver damage, relationships between beaver damage experience and attitudes could be further explored.

Another avenue that could be used to help wildlife managers understand and know where beaver related issues are, is to have a place where people can report any experiences. Much along the line of nuisance wildlife crop loss reports, where farmers can report losses to their crop due to wildlife, a website application where people can report areas of beaver damage and obstructions could also be beneficial to wildlife managers as well as to infrastructure maintenance crews. Although farmers with large acreage and farmland would most likely experience larger disturbances, the idea remains the same. If types of damage reported to the WDFW were documented, records could be examined for repeat occurrences and severity of the damages. This could also provide insight into residents' WAC by finding out what type of damage people will tolerate before seeking additional help from the WDFW or WCOs. This also contributes to the movement of "citizen science". People can report instances, help local wildlife managers, and be a part of creating a solution.

Incorporating beavers into infrastructure designs in urban environments is a burgeoning idea. To increase the benefits from beavers and to not lose them as a resource, it is also important to get support from the public to preserve beavers in our waterways and to incorporate them into infrastructure plans. Ecosystems as infrastructure is used to incorporate the natural functions of our surroundings to help mitigate much of the negative impact humans have on the ecosystem. Ultimately, gaining understanding of public perceptions towards incorporating beavers into design concepts could provide

insight into factors that may be limiting the transition to ecological infrastructure within communities.

CHAPTER 5: CONCLUSION

Over the past few decades, restrictions on beaver trapping (i.e. foot hold traps) and stricter harvesting laws have contributed to an increase in beaver populations across the nation. This has inevitably increased beaver-human interactions and increased perceived damages to private lands. Although good for prospective beaver enthusiasts, this also means more human-beaver conflicts, increased business for wildlife control operators, and a greater need for beaver management. As human-beaver conflicts are at the forefront of management, a balance between ecosystem health and human habitation is essential for a sustainable environment.

As discussed earlier, it is widely accepted that beavers enhance riverine habitats and provide humans with many important ecosystem services. Moreover, the inherent benefits of beaver-created areas are not obtained without public acceptance of beavers themselves. Public surveys can be used to gauge public perceptions and attitudes towards beavers to help direct beaver management.

This research aimed to identify three fundamental questions: what are the attitudes of residents towards beavers, who are the residents that hold these attitudes, and how can these attitudes influence beaver management? Understanding how the attitudes of people can affect wildlife management can also help managers adapt to changing attitudes and tolerance of humans towards beavers.

The findings of this study suggest that people generally have favorable views towards beavers and do not find lethal control acceptable in situations that do not involve direct harm to humans. Based on these conclusions wildlife managers should further explore adaptive management plans that incorporate beavers into infrastructures within

our communities to lessen the need for unfavorable lethal action. Furthermore, as people find new ways to solve problems caused by beavers, they can also develop higher tolerances of beavers over time.

Ideally, these findings should be replicated in a study where Thurston County in its entirety can be surveyed about attitudes toward beavers and current beaver management practices. The results found within this study is merely a snap shot of the whole picture. A countywide survey could provide a baseline of attitudes about beavers that could help land managers assess the wants and needs of landowners and explore the needs for alternative management practices. Additionally, subsequent research could explore any attitude changes that could inform and urge future management practices to adapt.

In conclusion, highlighting the saliency of human dimension research within wildlife management can help current policies become more inclusive and adaptable to changing attitudes. Policies in Washington State are becoming more geared towards beaver protection and acceptance. Provisions to past laws regarding beaver management focus on long-term plans to improve beaver viability for habitat restoration through translocations and public awareness of the benefits of beavers. Habitat protection laws for beavers would be far-reaching due to their keystone species status. Protecting beavers and a move toward co-habitation can bring us closer to a homeostasis where conflicts are fewer and benefits are higher for our ecosystem.

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APPENDIX A: DESCRIPTIVE STATISTICS OF SURVEY QUESTIONS

Categories	Question codes	Response codes	Count	% or m (sd)	Spurgeon Creek	% or m (sd)	Woodland Creek	% or m (sd)
	Q1	Total (N)	63		17		46	
		Missing (N)	3		2		1	
		YES	60	95.2%	16	94.1%	44	95.7%
		NO	3	4.8%	1	5.9%	2	4.3%
Beaver experience	Q2	Total (N)	64		18		46	
		Missing (N)	2		1		1	
		YES	11	17.2%	4	6.3%	7	10.9%
		NO	53	82.8%	14	77.8%	39	84.8%
Experience severity	Q3	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		zero	60	90.9%	17	89.5%	43	91.5%
		1 time	3	4.5%	1	5.3%	3	6.4%
		2 or more times	3	4.5%	1	5.3%	1	2.1%
	Q4	Total (N)	66		19		47	
		zero	49	74.2%	13	68.4%	36	76.6%
		1=Light	15	22.7%	4	21.1%	11	23.4%
		2	1	1.5%	1	5.3%	0	0.0%
		3	1	1.5%	1	5.3%	0	0.0%
		4	0	0.0%	0	0.0%	0	0.0%
		5=Severe	0	0.0%	0	0.0%	0	0.0%
pro-beaver	Q5	Total (N)	63		18		45	
		Missing (N)	3		1		2	
		YES	1	1.6%	0	0.0%	1	2.2%
		NO	62	98.4%	18	100.0%	44	97.8%
Pro-translocation	Q6	Total (N)	62		18		44	
		Missing (N)	4		1		3	
		YES	16	25.8%	1	5.6%	15	34.1%
		NO	46	74.2%	17	94.4%	29	65.9%
Beaver damage types								
	Q7_1	Total (N)	65		19		46	
		Missing (N)	1		0		1	
		YES	0	0.0%	0	0.0%	0	0.0%
		NO	65	100.0%	19	100.0%	46	100.0%
	Q7_2	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	0	0.0%	0	0.0%	0	0.0%
		NO	66	100.0%	19	100.0%	47	100.0%
	Q7_3	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	7	10.6%	2	10.5%	7	14.9%
		NO	59	89.4%	17	89.5%	42	89.4%
	Q7_4	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	1	1.5%	0	0.0%	1	2.1%
		NO	65	98.5%	19	100.0%	46	97.9%
	Q7_5	Total (N)	66		19		47	
		Missing (N)	0		0		0	

		YES	2	3.0%	1	5.3%	1	2.1%
		NO	64	97.0%	18	94.7%	46	97.9%
	Q7_6	Total (N)	65		18		47	
		Missing (N)	1		1		0	
		YES	3	4.6%	3	16.7%	0	0.0%
		NO	62	95.4%	15	83.3%	47	100.0%
	Q7_text							
Beaver action	Q8_1	Total (N)	65		19		46	
		Missing (N)	1		0		1	
		YES	32	49.2%	8	42.1%	24	52.2%
		NO	33	50.8%	11	57.9%	22	47.8%
	Q8_2	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	2	3.0%	1	5.3%	1	2.1%
		NO	64	97.0%	18	94.7%	46	97.9%
	Q8_3	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	1	1.5%	1	5.3%	0	0.0%
		NO	65	98.5%	18	94.7%	47	100.0%
	Q8_4	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	0	0.0%	0	0.0%	0	0.0%
		NO	66	100.0%	19	100.0%	47	100.0%
	Q8_5	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	0	0.0%	0	0.0%	0	0.0%
		NO	66	100.0%	19	100.0%	47	100.0%
	Q8_6	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	1	1.5%	1	5.3%	0	0.0%
		NO	65	98.5%	18	94.7%	47	100.0%
	Q8_7	Total (N)	66		19		47	
		Missing (N)	0		0		0	
		YES	0	0.0%	0	0.0%	0	0.0%
		NO	66	100.0%	19	100.0%	47	100.0%
	Q8_text							
Beliefs about management								
	Q9_1	Total (N)	65		19		46	
		Strongly Agree (1)	20	30.8%	4	21.1%	16	34.8%
		Agree (2)	31	47.7%	8	42.1%	23	50.0%
		Neutral (3)	7	10.8%	2	10.5%	5	10.9%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	7	10.8%	5	26.3%	2	4.3%
	Q9_2	Total (N)	66		19		46	
		Strongly Agree (1)	2	3.0%	0	0.0%	2	4.3%
		Agree (2)	16	24.2%	6	31.6%	10	21.7%
		Neutral (3)	19	28.8%	4	21.1%	15	32.6%
		Disagree (4)	14	21.2%	2	10.5%	12	26.1%
		Strongly Disagree (5)	4	6.1%	3	15.8%	1	2.2%

		No opinion (6)	9	13.6%	3	15.8%	6	13.0%
	Q9_3	Total (N)	65		19		46	
		Strongly Agree (1)	20	30.8%	4	21.1%	16	34.8%
		Agree (2)	30	46.2%	11	57.9%	19	41.3%
		Neutral (3)	9	13.8%	3	15.8%	6	13.0%
		Disagree (4)	3	4.6%	0	0.0%	3	6.5%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	3	4.6%	1	5.3%	2	4.3%
	Q9_4	Total (N)	64		19		45	
		Strongly Agree (1)	7	10.9%	4	21.1%	3	6.7%
		Agree (2)	9	14.1%	9	47.4%	3	6.7%
		Neutral (3)	18	28.1%	4	21.1%	14	31.1%
		Disagree (4)	9	14.1%	1	5.3%	8	17.8%
		Strongly Disagree (5)	4	6.3%	1	5.3%	3	6.7%
		No opinion (6)	17	26.6%	3	15.8%	14	31.1%
Management Favorability	Q10_1	Total (N)	64		19		45	
		Strongly Agree (1)	20	31.3%	3	15.8%	17	37.8%
		Agree (2)	25	39.1%	8	42.1%	17	37.8%
		Neutral (3)	12	18.8%	6	31.6%	6	13.3%
		Disagree (4)	1	1.6%	0	0.0%	1	2.2%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	6	9.4%	2	10.5%	4	8.9%
	Q10_2	Total (N)	65		19		46	
		Strongly Agree (1)	7	10.8%	2	10.5%	5	10.9%
		Agree (2)	33	50.8%	10	52.6%	23	50.0%
		Neutral (3)	18	27.7%	6	31.6%	12	26.1%
		Disagree (4)	1	1.5%	0	0.0%	1	2.2%
		Strongly Disagree (5)	2	3.1%	1	5.3%	1	2.2%
		No opinion (6)	4	6.2%	0	0.0%	4	8.7%
	Q10_3	Total (N)	65		19		46	
		Strongly Agree (1)	15	23.1%	4	21.1%	11	23.9%
		Agree (2)	30	46.2%	8	42.1%	22	47.8%
		Neutral (3)	10	15.4%	4	21.1%	6	13.0%
		Disagree (4)	6	9.2%	1	5.3%	5	10.9%
		Strongly Disagree (5)	1	1.5%	0	0.0%	1	2.2%
		No opinion (6)	3	4.6%	2	10.5%	1	2.2%
	Q10_4	Total (N)	64		18		46	
		Strongly Agree (1)	22	34.4%	22	122.2%	16	34.8%
		Agree (2)	32	50.0%	32	177.8%	20	43.5%
		Neutral (3)	7	10.9%	7	38.9%	7	15.2%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	1	1.6%	1	5.6%	1	2.2%

		No opinion (6)	2	3.1%	2	11.1%	2	4.3%
Beaver Favorability	Q11_1	Total (N)	63		19		44	
		Strongly Agree (1)	1	1.6%	0	0.0%	1	2.3%
		Agree (2)	18	28.6%	8	42.1%	10	22.7%
		Neutral (3)	12	19.0%	3	15.8%	9	20.5%
		Disagree (4)	18	28.6%	3	15.8%	25	56.8%
		Strongly Disagree (5)	4	6.3%	2	10.5%	2	4.5%
		No opinion (6)	10	15.9%	3	15.8%	7	15.9%
	Q11_2	Total (N)	63		19		44	
		Strongly Agree (1)	0	0.0%	0	0.0%	0	0.0%
		Agree (2)	1	1.6%	1	5.3%	0	0.0%
		Neutral (3)	20	31.7%	9	47.4%	11	25.0%
		Disagree (4)	15	23.8%	2	10.5%	13	29.5%
		Strongly Disagree (5)	16	25.4%	3	15.8%	13	29.5%
		No opinion (6)	11	17.5%	4	21.1%	7	15.9%
	Q11_3	Total (N)	61		19		42	
		Strongly Agree (1)	0	0.0%	0	0.0%	0	0.0%
		Agree (2)	3	4.9%	3	15.8%	0	0.0%
		Neutral (3)	20	32.8%	5	26.3%	15	35.7%
		Disagree (4)	17	27.9%	4	21.1%	13	31.0%
		Strongly Disagree (5)	14	23.0%	4	21.1%	10	23.8%
		No opinion (6)	7	11.5%	3	15.8%	4	9.5%
	Q11_4	Total (N)	64		19		45	
		Strongly Agree (1)	32	50.0%	7	36.8%	25	55.6%
		Agree (2)	26	40.6%	9	47.4%	1	2.2%
		Neutral (3)	3	4.7%	1	5.3%	2	4.4%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	3	4.7%	2	10.5%	1	2.2%
	Q11_5	Total (N)	65		19		46	
		Strongly Agree (1)	25	38.5%	5	26.3%	20	43.5%
		Agree (2)	24	36.9%	7	36.8%	17	37.0%
		Neutral (3)	11	16.9%	4	21.1%	7	15.2%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	5	7.7%	3	15.8%	2	4.3%
	Q11_6	Total (N)	64		19		45	
		Strongly Agree (1)	10	15.6%	2	10.5%	8	17.8%
		Agree (2)	16	25.0%	2	10.5%	14	31.1%
		Neutral (3)	24	37.5%	7	36.8%	1	2.2%

		Disagree (4)	7	10.9%	4	21.1%	3	6.7%
		Strongly Disagree (5)	2	3.1%	1	5.3%	1	2.2%
		No opinion (6)	5	7.8%	3	15.8%	18	40.0%
	Q11_7	Total (N)	65		19		46	
		Strongly Agree (1)	5	7.7%	2	10.5%	3	6.5%
		Agree (2)	22	33.8%	7	36.8%	15	32.6%
		Neutral (3)	15	23.1%	4	21.1%	11	23.9%
		Disagree (4)	13	20.0%	1	5.3%	12	26.1%
		Strongly Disagree (5)	4	6.2%	2	10.5%	2	4.3%
		No opinion (6)	6	9.2%	3	15.8%	3	6.5%
	Q11_8	Total (N)	65		18		47	
		Strongly Agree (1)	18	27.7%	3	16.7%	15	31.9%
		Agree (2)	17	26.2%	4	22.2%	13	27.7%
		Neutral (3)	14	21.5%	2	11.1%	12	25.5%
		Disagree (4)	11	16.9%	5	27.8%	6	12.8%
		Strongly Disagree (5)	2	3.1%	1	5.6%	1	2.1%
		No opinion (6)	3	4.6%	3	16.7%	0	0.0%
	Q11_9	Total (N)	65		18		47	
		Strongly Agree (1)	2	3.1%	1	5.6%	1	2.1%
		Agree (2)	7	10.8%	4	22.2%	3	6.4%
		Neutral (3)	19	29.2%	1	5.6%	18	38.3%
		Disagree (4)	25	38.5%	7	38.9%	18	38.3%
		Strongly Disagree (5)	4	6.2%	3	16.7%	1	2.1%
		No opinion (6)	8	12.3%	2	11.1%	6	12.8%
	Q11_10	Total (N)	66		19		47	
		Strongly Agree (1)	13	19.7%	4	21.1%	9	19.1%
		Agree (2)	23	34.8%	5	26.3%	18	38.3%
		Neutral (3)	25	37.9%	6	31.6%	19	40.4%
		Disagree (4)	2	3.0%	2	10.5%	0	0.0%
		Strongly Disagree (5)	1	1.5%	0	0.0%	1	2.1%
		No opinion (6)	2	3.0%	2	10.5%	0	0.0%
	Q11_11	Total (N)	66		19		47	
		Strongly Agree (1)	2	3.0%	0	0.0%	2	4.3%
		Agree (2)	5	7.6%	4	21.1%	1	2.1%
		Neutral (3)	17	25.8%	1	5.3%	16	34.0%
		Disagree (4)	26	39.4%	8	42.1%	18	38.3%
		Strongly Disagree (5)	8	12.1%	3	15.8%	5	10.6%
		No opinion (6)	8	12.1%	3	15.8%	5	10.6%
Wildlife Acceptance Capacity	Q12	Total (N)	66		19		47	
		Greatly increased (1)	0	0.0%	0	0.0%	0	0.0%

		Slightly increased (2)	3	4.5%	0	0.0%	3	6.4%
		Remained the same (3)	13	19.7%	5	26.3%	8	17.0%
		Slightly decreased (4)	2	3.0%	1	5.3%	1	2.1%
		Greatly decreased (5)	1	1.5%	0	0.0%	1	2.1%
		No opinion (6)	47	71.2%	13	68.4%	34	72.3%
WAC	Q13	Total (N)	57		15		42	
		No beavers (5)	2	3.5%	2	13.3%	5	11.9%
		1/2 as many beavers (4)	2	3.5%	0	0.0%	5	11.9%
		Current amount of beavers (3)	40	70.2%	10	66.7%	30	71.4%
		50% more beavers (2)	7	12.3%	2	13.3%	2	4.8%
		Twice as many beavers (1)	6	10.5%	1	6.7%	0	0.0%
							0	0.0%
Beaver Management attitudes								
No Action	Q14_1	Total (N)	64		18		46	
		Strongly Agree (1)	25	39.1%	6	33.3%	19	41.3%
		Agree (2)	19	29.7%	3	16.7%	16	34.8%
		Neutral (3)	10	15.6%	3	16.7%	7	15.2%
		Disagree (4)	7	10.9%	4	22.2%	3	6.5%
		Strongly Disagree (5)	2	3.1%	2	11.1%	0	0.0%
		No opinion (6)	1	1.6%	0	0.0%	1	2.2%
	Q14_2	Total (N)	66		19		47	
		Strongly Agree (1)	3	4.5%	2	10.5%	1	2.1%
		Agree (2)	12	18.2%	4	21.1%	8	17.0%
		Neutral (3)	5	7.6%	0	0.0%	5	10.6%
		Disagree (4)	37	56.1%	11	57.9%	26	55.3%
		Strongly Disagree (5)	9	13.6%	2	10.5%	7	14.9%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q14_3	Total (N)	66		19		47	
		Strongly Agree (1)	4	6.1%	0	0.0%	4	8.5%
		Agree (2)	14	21.2%	5	26.3%	9	19.1%
		Neutral (3)	9	13.6%	0	0.0%	9	19.1%
		Disagree (4)	27	40.9%	10	52.6%	17	36.2%
		Strongly Disagree (5)	11	16.7%	4	21.1%	7	14.9%
		No opinion (6)	1	1.5%	0	0.0%	1	2.1%
	Q14_4	Total (N)	65		18		47	
		Strongly Agree (1)	5	7.7%	1	5.6%	4	8.5%

		Agree (2)	7	10.8%	2	11.1%	5	10.6%
		Neutral (3)	6	9.2%	2	11.1%	4	8.5%
		Disagree (4)	25	38.5%	7	38.9%	18	38.3%
		Strongly Disagree (5)	18	27.7%	4	22.2%	14	29.8%
		No opinion (6)	4	6.2%	2	11.1%	2	4.3%
Management	Q15_1	Total (N)	65		18		47	
		Strongly Agree (1)	4	6.2%	1	5.6%	3	6.4%
		Agree (2)	5	7.7%	1	5.6%	4	8.5%
		Neutral (3)	25	38.5%	5	27.8%	20	42.6%
		Disagree (4)	17	26.2%	6	33.3%	11	23.4%
		Strongly Disagree (5)	9	13.8%	3	16.7%	6	12.8%
		No opinion (6)	5	7.7%	2	11.1%	3	6.4%
	Q15_2	Total (N)	66		19		47	
		Strongly Agree (1)	9	13.6%	3	15.8%	6	12.8%
		Agree (2)	42	63.6%	12	63.2%	30	63.8%
		Neutral (3)	6	9.1%	0	0.0%	6	12.8%
		Disagree (4)	5	7.6%	3	15.8%	2	4.3%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	4	6.1%	1	5.3%	3	6.4%
	Q15_3	Total (N)	65		18		47	
		Strongly Agree (1)	7	10.8%	3	16.7%	4	8.5%
		Agree (2)	30	46.2%	9	50.0%	21	44.7%
		Neutral (3)	16	24.6%	3	16.7%	13	27.7%
		Disagree (4)	6	9.2%	2	11.1%	4	8.5%
		Strongly Disagree (5)	1	1.5%	0	0.0%	1	2.1%
		No opinion (6)	5	7.7%	1	5.6%	4	8.5%
	Q15_4	Total (N)	65		18		47	
		Strongly Agree (1)	13	20.0%	3	16.7%	10	21.3%
		Agree (2)	25	38.5%	6	33.3%	19	40.4%
		Neutral (3)	7	10.8%	2	11.1%	5	10.6%
		Disagree (4)	5	7.7%	1	5.6%	4	8.5%
		Strongly Disagree (5)	6	9.2%	2	11.1%	4	8.5%
		No opinion (6)	9	13.8%	4	22.2%	5	10.6%
Lethal	Q16_1	Total (N)	63		18		45	
		Strongly Agree (1)	4	6.3%	1	5.6%	3	6.7%
		Agree (2)	1	1.6%	0	0.0%	1	2.2%
		Neutral (3)	5	7.9%	1	5.6%	4	8.9%
		Disagree (4)	17	27.0%	7	38.9%	10	22.2%
		Strongly Disagree (5)	34	54.0%	8	44.4%	26	57.8%
		No opinion (6)	2	3.2%	1	5.6%	1	2.2%

	Q16_2	Total (N)	62		18		44	
		Strongly Agree (1)	5	8.1%	1	5.6%	5	11.4%
		Agree (2)	7	11.3%	1	5.6%	46	104.5%
		Neutral (3)	10	16.1%	5	27.8%	5	11.4%
		Disagree (4)	15	24.2%	4	22.2%	11	25.0%
		Strongly Disagree (5)	22	35.5%	5	27.8%	17	38.6%
		No opinion (6)	3	4.8%	2	11.1%	1	2.3%
	Q16_3	Total (N)	63		18		45	
		Strongly Agree (1)	4	6.3%	1	5.6%	3	6.7%
		Agree (2)	10	15.9%	4	22.2%	6	13.3%
		Neutral (3)	9	14.3%	4	22.2%	5	11.1%
		Disagree (4)	16	25.4%	3	16.7%	13	28.9%
		Strongly Disagree (5)	21	33.3%	5	27.8%	16	35.6%
		No opinion (6)	3	4.8%	1	5.6%	2	4.4%
	Q16_4	Total (N)	64		18		46	
		Strongly Agree (1)	10	15.6%	3	16.7%	7	15.2%
		Agree (2)	25	39.1%	7	38.9%	18	39.1%
		Neutral (3)	12	18.8%	3	16.7%	9	19.6%
		Disagree (4)	8	12.5%	3	16.7%	5	10.9%
		Strongly Disagree (5)	5	7.8%	1	5.6%	4	8.7%
		No opinion (6)	4	6.3%	1	5.6%	3	6.5%
General wildlife attitudes								
	Q17_1	Total (N)	64		18		46	
		Strongly Agree (1)	43	67.2%	10	55.6%	33	71.7%
		Agree (2)	18	28.1%	7	38.9%	11	23.9%
		Neutral (3)	2	3.1%	0	0.0%	2	4.3%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	1	1.6%	1	5.6%	0	0.0%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q17_2	Total (N)	64		18		46	
		Strongly Agree (1)	47	73.4%	11	61.1%	36	78.3%
		Agree (2)	15	23.4%	6	33.3%	9	19.6%
		Neutral (3)	1	1.6%	0	0.0%	1	2.2%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	1	1.6%	1	5.6%	0	0.0%
	Q17_3	Total (N)	64		18		46	
		Strongly Agree (1)	12	18.8%	2	11.1%	10	21.7%
		Agree (2)	27	42.2%	11	61.1%	16	34.8%
		Neutral (3)	18	28.1%	3	16.7%	15	32.6%

		Disagree (4)	5	7.8%	2	11.1%	3	6.5%
		Strongly Disagree (5)	1	1.6%	0	0.0%	1	2.2%
		No opinion (6)	1	1.6%	0	0.0%	1	2.2%
	Q17_4	Total (N)	63		18		45	
		Strongly Agree (1)	12	19.0%	2	11.1%	10	22.2%
		Agree (2)	26	41.3%	11	61.1%	15	33.3%
		Neutral (3)	15	23.8%	3	16.7%	12	26.7%
		Disagree (4)	4	6.3%	1	5.6%	3	6.7%
		Strongly Disagree (5)	1	1.6%	0	0.0%	1	2.2%
		No opinion (6)	5	7.9%	1	5.6%	4	8.9%
	Q17_5	Total (N)	63		17		46	
		Strongly Agree (1)	34	54.0%	34	200.0%	30	65.2%
		Agree (2)	26	41.3%	26	152.9%	14	30.4%
		Neutral (3)	3	4.8%	3	17.6%	2	4.3%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q17_6	Total (N)	64		18		46	
		Strongly Agree (1)	35	54.7%	7	38.9%	28	60.9%
		Agree (2)	23	35.9%	10	55.6%	13	28.3%
		Neutral (3)	6	9.4%	1	5.6%	4	8.7%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q17_7	Total (N)	64		18		46	
		Strongly Agree (1)	1	1.6%	1	5.6%	0	0.0%
		Agree (2)	6	9.4%	2	11.1%	4	8.7%
		Neutral (3)	17	26.6%	4	22.2%	13	28.3%
		Disagree (4)	20	31.3%	7	38.9%	13	28.3%
		Strongly Disagree (5)	16	25.0%	3	16.7%	13	28.3%
		No opinion (6)	4	6.3%	1	5.6%	3	6.5%
	Q17_8	Total (N)	64		18		46	
		Strongly Agree (1)	4	6.3%	0	0.0%	4	8.7%
		Agree (2)	15	23.4%	9	50.0%	6	13.0%
		Neutral (3)	18	28.1%	4	22.2%	14	30.4%
		Disagree (4)	18	28.1%	4	22.2%	14	30.4%
		Strongly Disagree (5)	9	14.1%	1	5.6%	8	17.4%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q17_9	Total (N)	64		18		46	
		Strongly Agree (1)	36	56.3%	7	38.9%	29	63.0%
		Agree (2)	24	37.5%	9	50.0%	15	32.6%

		Neutral (3)	3	4.7%	2	11.1%	1	2.2%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	1	1.6%	0	0.0%	1	2.2%
	Q17_10	Total (N)	64		18		46	
		Strongly Agree (1)	6	9.4%	2	11.1%	4	8.7%
		Agree (2)	15	23.4%	5	27.8%	10	21.7%
		Neutral (3)	16	25.0%	3	16.7%	13	28.3%
		Disagree (4)	19	29.7%	7	38.9%	12	26.1%
		Strongly Disagree (5)	5	7.8%	0	0.0%	5	10.9%
		No opinion (6)	3	4.7%	1	5.6%	2	4.3%
	Q17_11	Total (N)	64		18		46	
		Strongly Agree (1)	8	12.5%	1	5.6%	7	15.2%
		Agree (2)	23	35.9%	11	61.1%	12	26.1%
		Neutral (3)	15	23.4%	3	16.7%	12	26.1%
		Disagree (4)	13	20.3%	1	5.6%	12	26.1%
		Strongly Disagree (5)	1	1.6%	1	5.6%	0	0.0%
		No opinion (6)	4	6.3%	1	5.6%	3	6.5%
	Q17_12	Total (N)	64		18		46	
		Strongly Agree (1)	1	1.6%	0	0.0%	1	2.2%
		Agree (2)	4	6.3%	1	5.6%	3	6.5%
		Neutral (3)	18	28.1%	6	33.3%	12	26.1%
		Disagree (4)	19	29.7%	6	33.3%	13	28.3%
		Strongly Disagree (5)	20	31.3%	5	27.8%	15	32.6%
		No opinion (6)	2	3.1%	0	0.0%	2	4.3%
	Q17_13	Total (N)	64		18		46	
		Strongly Agree (1)	8	12.5%	1	5.6%	7	15.2%
		Agree (2)	22	34.4%	6	33.3%	6	13.0%
		Neutral (3)	15	23.4%	3	16.7%	12	26.1%
		Disagree (4)	14	21.9%	8	44.4%	6	13.0%
		Strongly Disagree (5)	5	7.8%	0	0.0%	4	8.7%
		No opinion (6)	0	0.0%	0	0.0%	0	0.0%
	Q17_14	Total (N)	63		18		45	
		Strongly Agree (1)	7	11.1%	0	0.0%	7	15.6%
		Agree (2)	29	46.0%	11	61.1%	18	40.0%
		Neutral (3)	15	23.8%	5	27.8%	10	22.2%
		Disagree (4)	5	7.9%	1	5.6%	4	8.9%
		Strongly Disagree (5)	2	3.2%	1	5.6%	1	2.2%
		No opinion (6)	5	7.9%	0	0.0%	5	11.1%
	Q17_15	Total (N)	62		18		46	

		Strongly Agree (1)	8	12.9%	1	5.6%	7	15.2%
		Agree (2)	27	43.5%	8	44.4%	19	41.3%
		Neutral (3)	23	37.1%	9	50.0%	14	30.4%
		Disagree (4)	4	6.5%	0	0.0%	4	8.7%
		Strongly Disagree (5)	1	1.6%	0	0.0%	1	2.2%
		No opinion (6)	1	1.6%	0	0.0%	1	2.2%
	Q17_16	Total (N)	62		18		46	
		Strongly Agree (1)	29	46.8%	6	33.3%	23	50.0%
		Agree (2)	30	48.4%	10	55.6%	20	43.5%
		Neutral (3)	4	6.5%	1	5.6%	3	6.5%
		Disagree (4)	0	0.0%	0	0.0%	0	0.0%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	1	1.6%	1	5.6%	0	0.0%
	Q17_17	Total (N)	62		17		45	
		Strongly Agree (1)	3	4.8%	0	0.0%	3	6.7%
		Agree (2)	16	25.8%	5	29.4%	11	24.4%
		Neutral (3)	24	38.7%	6	35.3%	18	40.0%
		Disagree (4)	8	12.9%	4	23.5%	4	8.9%
		Strongly Disagree (5)	4	6.5%	0	0.0%	4	8.9%
		No opinion (6)	7	11.3%	2	11.8%	5	11.1%
	Q17_18	Total (N)	64		18		64	
		Strongly Agree (1)	13	20.3%	1	5.6%	13	20.3%
		Agree (2)	26	40.6%	10	55.6%	26	40.6%
		Neutral (3)	17	26.6%	4	22.2%	17	26.6%
		Disagree (4)	4	6.3%	1	5.6%	4	6.3%
		Strongly Disagree (5)	0	0.0%	0	0.0%	0	0.0%
		No opinion (6)	4	6.3%	2	11.1%	4	6.3%
Demographics	Q18		61	24.656 (16.587)	17	23.353 (15.720)	44	25.159 (17.059)
	Q19		62	27.5 (19.181)	17	24.765 (16.574)	45	29.911 (20.068)
	Q20	Total (N)	62		17		45	
		Missing (N)	4		2		2	
		Male (1)	36	58.1%	12	70.6%	24	53.3%
		Female (2)	25	40.3%	5	29.4%	20	44.4%
		Non-conforming (3)	1	1.6%	0	0.0%	1	2.2%
	Q21	5=no response	61	58 (17.419)	17	63 (19.691)	55.477(16.705)	46.0
	Q22_1	Total (N)	62		17		45	
		Missing (N)	4		2		2	
		YES	17	27.4%	3	17.6%	14	31.1%
		NO	45	72.6%	14	82.4%	31	68.9%

	Q22_2	Total (N)	60		17		43	
		Missing (N)	6		2		4	
		YES	18	30.0%	4	23.5%	14	32.6%
		NO	42	70.0%	13	76.5%	29	67.4%
	Q22_3	Total (N)	60		17		43	
		Missing (N)	6		2		4	
		YES (1)	0	0.0%	0	0.0%	0	0.0%
		NO (0)	60	100.0%	17	100.0%	43	100.0%
	Q23	Total (N)	61		16		45	
		Missing (N)	5		3		2	
		YES	40	65.6%	11	68.8%	29	64.4%
		NO	21	34.4%	5	31.3%	16	35.6%
	Q24	Total (N)	61		16		45	
		Missing (N)	5		3		2	
		Own (1)	58	95.1%	16	100.0%	42	93.3%
		Rent (2)	2	3.3%	0	0.0%	2	4.4%
		Other (3)	1	1.6%	0	0.0%	1	2.2%
	Q25	Total (N)	61		16		45	
		Grade school (1)	0	0.0%	0	0.0%	0	0.0%
		High school or GED (2)	15	24.6%	4	25.0%	11	24.4%
		Tech/Vocational school (3)	10	16.4%	2	12.5%	8	17.8%
		College Degree (4)	26	42.6%	6	37.5%	20	44.4%
		Graduate Degree or higher (5)	10	16.4%	4	25.0%	6	13.3%
	Q26	Total (N)	62		17		45	
		On a farm (1)	3	4.8%	2	11.8%	2	4.4%
		Country-side not on a farm (2)	5	8.1%	1	5.9%	4	8.9%
		Small town: less than 5,000 people (3)	6	9.7%	2	11.8%	4	8.9%
		Small city: 5,001 to 50,000 people (4)	26	41.9%	6	35.3%	20	44.4%
		Large city: 50,001 to 300,000 people (5)	13	21.0%	4	23.5%	9	20.0%
		Very large city: more than 300,000 people (6)	5	8.1%	2	11.8%	3	6.7%
		More than one area with different sized populations (7)	3	4.8%	0	0.0%	3	6.7%
	Q27	Total (N)	60		16		44	
		White (1)	52	86.7%	15	93.8%	37	84.1%
		Hispanic (2)	5	8.3%	1	6.3%	4	9.1%

		Black (3)	0	0.0%	0	0.0%	0	0.0%
		Bi-racial (4)	1	1.7%	0	0.0%	1	2.3%
		Asian (5)	1	1.7%	0	0.0%	1	2.3%
		Native American (6)	1	1.7%	0	0.0%	1	2.3%
		Other (7)	0	0.0%	0	0.0%	0	0.0%
	Q28	Total (N)	51		13		38	
		less than $15,000 (1)	0	0.0%	0	0.0%	0	0.0%
		btwn $15,001-$30,000 (2)	4	7.8%	1	7.7%	3	7.9%
		btwn $30,001-$60,000 (3)	10	19.6%	2	15.4%	8	21.1%
		btwn $60,001-$90,000 (4)	16	31.4%	3	23.1%	13	34.2%
		btwn $90,001-$120,000 (5)	13	25.5%	1	7.7%	12	31.6%
		greater than $120,000 (6)	8	15.7%	6	46.2%	0	0.0%

APPENDIX B: SURVEY QUESTIONS AND CODING

Question codes	Questions - sub-questions	Response coding
Q1	1. Do you know beavers are living in Washington State?	1=Yes, 0=No, (.)=no response
Q2	2. Have you ever had an experience or a problem at or around you home that resulted from beaver or beaver activity?	1=Yes, 0=No, (.)=no response
Q3	3. Approximately how many times have you experiences property damage from beavers?	number
Q4	4. Overall, how would you describe the severity of the problems you experienced with beavers?	1=Light, to 5=Severe, (.)=no response
Q5	5. Have you ever had beavers translocated to your property?	1=Yes, 0=No, (.)=no response
Q6	6. Would you ever consider having beavers translocated to your property?	1=Yes, 0=No, (.)=no response
7	7. What types of beaver-related property damage have you personally experienced?	
Q7_1	7a. Flooding of a basement, well, or septic system	1=Yes, 0=No
Q7_2	7b. Flooding of a private road or driveway	1=Yes, 0=No
Q7_3	7c. Damage to individual trees or woodlots	1=Yes, 0=No
Q7_4	7d. Private lake/pond damaged or caused to overflow	1=Yes, 0=No
Q7_5	7e. Flooding that damaged crops, crop fields, or a crop field drainage system	1=Yes, 0=No
Q7_6	7f. Plugged culvert pipes	1=Yes, 0=No
Q7_text	7g. What types of beaver-related property damage have you personally experienced? Other	open
8	What actions have you taken to control property damage or nuisance problems caused by beavers?	
Q8_1	8a. I have taken no action to control the problems	1=Yes, 0=No
Q8_2	8b. I have contacted someone for information about beaver control methods	1=Yes, 0=No
Q8_3	8c. I have contacted the WDFW for a permit to remove beavers or beaver dams	1=Yes, 0=No
Q8_4	8d. I have tried to remove beavers myself	1=Yes, 0=No
Q8_5	8e. I have tried to control water levels by installing water control devices in dams by myself	1=Yes, 0=No
Q8_6	8f. I have hired a private Wildlife Control Operator to remove beavers	1=Yes, 0=No
Q8_7	8g. I have hired a private contractor to control water levels by installing water control devices in dams	1=Yes, 0=No
Q8_text	8h. What actions have you taken to control property damage or nuisance problems caused by beavers? Other	open
9	In Thurston County:	
Q9_1	9a. Beaver-created areas benefit other wildlife	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q9_2	9b. Beaver damage to roads and bridges is a problem	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response

Q9_3	9c. People get enjoyment from seeing beaver activity	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q9_4	9d. Drinking water contaminated by beaver flooding exposes people to diseases	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
10	Wildlife manager should:	
Q10_1	10a. Maintain beaver-created areas as a means to benefit other wildlife	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q10_2	10b. Reduce the cost of beaver damage to roads and bridges	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q10_3	10c. Create opportunities for the public to see beaver activity	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q10_4	10d. Ensure that beaver flooding does not contaminate drinking water	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
11	In the area where I live:	
Q11_1	11a. Beavers are common	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_2	11b. There are too many beavers	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_3	11c. Beavers are a nuisance	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_4	11d. Beavers have a right to exist	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_5	11e. Beavers are a sign of a healthy environment	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_6	11f. Beaver populations should be left alone	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_7	11g. Beaver populations should be controlled	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_8	11h. No beavers should be destroyed	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_9	11i. People don't want a wetland near their home because it could become a haven for beavers	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_10	11j. Residents should learn to live with beavers	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q11_11	11k. The presence of beavers make it a burden to have a wetland near your home	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q12	12. Based upon your present knowledge about and/or experience with beaver damage in Thurston County, in your opinion, what best describes the extent of beaver damage in the county over the last five years?	1=Greatly Increased, 2=Slightly Increased, 3=Remained the same, 4=Slightly Decreased, 5=Greatly Decreased, 6=No Opinion, (.)=no response
Q13	13. Which number below best represents your preference for the future population of beavers in Thurston County?	No Beavers=5, 1/2 beaver=4, Current beaver=3, 50%more=2, Twice as many=1, (.)=no response
14	To what extent do you agree or disagree that TAKING NO IMMEDIATE ACTION would be justified for each situation described below?	
Q14_1	14a. NO ACTION IF: A beaver is seen in my yard	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q14_2	14b. NO ACTION IF: A beaver floods a public road	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q14_3	14c. NO ACTION IF: A beaver damages my private property (trees, well, etc.)	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q14_4	14d. NO ACTION IF: A beaver carries a disease that is harmful to humans	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
15	To what extent do you agree or disagree that INSTALLING DRAINAGE PIPES TO CONTROL WATER LEVELS BEHIND A BEAVER DAM would be justified for each situation described below?	

Q15_1	15a. CONTROL WATER LEVELS IF: A beaver is seen in my yard	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q15_2	15b. CONTROL WATER LEVELS IF: A beaver floods a public road	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q15_3	15c. CONTROL WATER LEVELS IF: A beaver damages my private property (trees, well, etc.)	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q15_4	15d. CONTROL WATER LEVELS IF: A beaver carries a disease that is harmful to humans	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
16	To what extent do you agree or disagree that LETHAL CONTROL OF BEAVER would be justified for each situation described below?	
Q16_1	16a. LETHAL CONTROL IF: A beaver is seen in my yard	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q16_2	16b. LETHAL CONTROL IF: A beaver floods a public road	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q16_3	16c. LETHAL CONTROL IF: A beaver damages my private property (trees, well, etc.)	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q16_4	16d. LETHAL CONTROL IF: A beaver carries a disease that is harmful to humans	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
17	Indicate the extent to which you agree or disagree with the following statements of your beliefs about wildlife.	
Q17_1	17a. Having wildlife around my home is important to me	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_2	17b. I notice birds and wildlife around me every day	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_3	17c. It is important for humans to manage wild animal populations	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_4	17d. If wildlife populations are not in danger of extinction, we should have the opportunity to use them to add to the quality of human life	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_5	17e. Whether or not I get to see wildlife as much as I like, it is important to know it exists in Thurston County	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_6	17f. An important part of my community is the wildlife I see there from time to time	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_7	17g. Participation in regulated hunting makes people insensitive to suffering	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_8	17h. Although wildlife may have certain rights, most human needs are more important than the rights of wildlife	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_9	17i. It is important to know that there are healthy populations of wildlife in Thurston County	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_10	17j. The rights of wildlife are more important than the human use of wildlife	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_11	17k. It is acceptable for human use to cause the loss of some individual wild animals as long as populations are not jeopardized	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_12	17l. Participation in regulated hunting is cruel and inhumane to animals	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_13	17m. The rights of people and the rights of wildlife are equally important	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response

Q17_14	17n. Participation in regulated hunting helps people appreciate wildlife and natural processes	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_15	17o. Humans should manage wild animal populations for the benefit of all people	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_16	17p. We should be sure future generations in Thurston County will have an abundance of wildlife	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_17	17q. Participation in regulated hunting allows people to feel more self-reliant	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q17_18	17r. I consider myself to be a conservationist	1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, 5=Strongly Disagree, 6=No Opinion, (.)=no response
Q18	18. How many years have you lived in your current town?	number
Q19	19. How many years have you lived in Thurston County?	number
Q20	20. Are you...? Gender	1=male, 2=female, 3=non-conforming, (.)=no response
Q21	21. What is your age?	number
22	Are you a hunter, angler or fur trapper	
Q22_1	22a. Are you a Hunter	1=Yes, 0=No, (.)=no response
Q22_2	22b. Are you an Angler	1=Yes, 0=No, (.)=no response
Q22_3	22c. Are you a Fur trapper	1=Yes, 0=No, (.)=no response
Q23	23. In the past year, have you taken 1 or more trips more than 1 mile from home specifically to watch wildlife (excluding zoos or hunting/fishing trips)?	1=Yes, 0=No, (.)=no response
Q24	24. Do you own or rent the residence that you currently live in?	1=Own, 2=Rent, 3=Other, (.)=no response
Q25	25. What is the highest level of education you have completed?	1=GradeSchool, 2=Highschool, 3=Tech/Vocational, 4=CollegeDegree, 5=GraduateDegree, (.)=no response
Q26	26. In what size town did you primarily grow up?	1=On a farm, 2=Country-side not on a farm, 3=Small town (less than 5,000 people), 4=Small city (5,001 to 50,000 people), 5=Large city (50,001 to 300,000), 6=Very large city (more than 300,000 people), 7=More than one area with different sized populations, (.)=no response
Q27	27. What best describes your ethic background?	1=White, 2=Hispanic, 3=Black, 4=Bi-racial, 5=Asian, 6=NativeAmerican, 7=Other, (.)=no response
Q28	28. Which category best describes your total annual household income before taxes?	1=< $15,000, 2=$15,001-$30,000, 3=$30,001-$60,000, 4=$60,001-$90,000, 5=$90,001-$120,000, 6=> $120,000, (.)=no response
Q29	29. Address point	geocode point (GIS)
Q30	30. SFID # (Survey #) - unique identifier	number
Q31	31. Spurgeon Creek	1=Yes, 0=No
Q32	32. Woodland Creek	1=Yes, 0=No

APPENDIX C: PEARSON'S CHI-SQUARED STATISTIC VALUES

Pearson's chi-square tests: Spurgeon vs Woodland					
Variable	**Survey Question**	**N**	**DF**	X^2	***p* value**
Beaver attitude scale					
	There are too many beavers	63	3	7.36	0.06
	Beavers are a nuisance	61	3	7.16	0.07
	People don't want a wetland near their home because it could become a haven for beavers	65	4	11.71	0.02
	The presence of beavers makes it a burden to have a wetland near your home	66	4	9.55	0.05
Wildlife attitude scale					
	It is important to know it exists in Thurston County	63	2	8.91	0.01
	Although wildlife may have certain rights, most human needs are more important than the rights of wildlife	64	4	11.01	0.03
*Not included in either attitude scale	It is acceptable for human use to cause the loss of some individual wild animals as long as populations are not jeopardized	64	4	11.09	0.03
Would consider beaver translocation					
	1 = Yes, 0 = No	62	1	5.43	0.02
Income					
	1 = less than $15,000, 2 = btwn $15,001-$30,000, 3 = btwn $30,001-$60,000, 4 = btwn $60,001-$90,000, 5 = btwn $90,001-$120,000, 6 = greater than $120,000	51	4	13.04	0.01
No Action management					
	If seen in yard	64	4	9.67	0.05
Pearson's chi-square tests: Wildlife acceptance capacity of more beaver vs less beaver					
No action management					
	If seen in yard	16	3	7.47	0.06
Control water levels management					
	If seen in yard	17	3	7.47	0.06
	If carries disease	17	4	9.28	0.05

Lethal action management					
	If seen in yard	16	3	9.98	0.02
	If floods road	16	4	11.62	0.02
	If damages property	16	3	10.09	0.02